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Newness, Givenness and Discourse Updating: Evidence from Eye Movements

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Abstract

Three experiments examined the effect of contextual givenness on eye movements in reading, following Schwarzschild's (1999) analysis of givenness and focus-marking in which relations among entities as well as the entities themselves can be given. In each study, a context question was followed by an answer in which a critical word was either given, new, or contrastively (correctively) focused. Target words were read faster when the critical word provided given information than when it provided new information, and faster when it provided new information than when it corrected prior information. Repetition of target words was controlled in two ways: by mentioning a non-given target word in the context in a relation other than that in which it occurred as a target, and by using a synonym or subordinate of a given target to refer to it in the context question. Verbatim repetition was not responsible for the observed effects of givenness and contrastiveness. Besides clarifying previous inconsistent results of the effects of focus and givenness on reading speed, these results indicate that reading speed can be influenced essentially immediately by a reader's discourse representation, and that the extent of the influence is graded, with corrections to a representation having a larger effect than simple additions

Keywords

information status; givenness; focus; discourse representation; discourse updating; reading

The most informative parts of a sentence receive 'focus,' which can be signaled by prosody or by syntax or both. In English (and in many other languages), focus influences rhythm, stress and intonation (Beaver & Brady, 2008; Büring, 2012; Selkirk, 1984, 1995). In spoken English, focused words in (1a) and (1b), marked by the F subscript, must receive pitch accents to be felicitous. English focus can also be signaled syntactically, e.g., by clefting, as in (1c) or by focus particles like *only* (1d). Phrases syntactically marked as focused also receive pitch accents in English.

- (1)
 - a. Who talked to Mary? [John]_F talked to Mary.
 - b. Did John or Bill talk to Mary? [John]_F talked to Mary.
 - c. It was [John]_F that talked to Mary.
 - d. Only [John]_F talked to Mary.

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Focus has semantic and pragmatic consequences, including the fact that focus evokes alternatives (Rooth, 1992). The meaning of a question (as in (1a) and (1b)) is generally analyzed as the set of alternative (possibly true) answers (Karttunen, 1977); the existence of these alternatives licenses focus marking in the answer. Similarly, the focused words in (1c) and (1d) presuppose the existence of possible (if not actual) alternatives.

The psycholinguistic literature has addressed focus in various ways. Most salient for the present work is the question of whether focused material is processed and comprehended more quickly or more slowly than non-focused material. As we review below, the literature contains inconsistent answers to this question, very likely because ‘focus’ has been defined and manipulated in inconsistent ways.

Focus is one (or more) of a collection of concepts used to analyze ‘information structure’ (Büring, 2007; Roberts, 1996/2012; Vallduvi, 1992). These concepts include the contrasts between background and focus, given and new, theme and rheme, and topic and comment. We submit that the variety of contrasts that the term ‘focus’ covers may engage a variety of distinct psychological mechanisms, and that as a result the literature contains inconsistent claims about how focus affects language processing. We first review a selection of this literature, illustrating the different effects that different ‘flavors’ of focus seem to have, and then propose a resolution based on a widely-cited semantic analysis of one of the core concepts covered by focus, the given/new distinction (Schwarzschild, 1999).

One way that focus has been manipulated in the psycholinguistic literature is to treat the answer to a wh-question as focused (as in (1a), above). Early research (e.g., Cutler & Fodor, 1979) showed that words that answered a wh-question received more attention, as reflected in faster times to detect a phoneme in a sentence. A similar conclusion was supported by Ward and Sturt (2007), who found that changes made to a word between readings of a passage were detected more frequently when the word answered a wh-question, and by Blutner and Sommer (1988), who found enhanced priming of the multiple meanings of an ambiguous word that answered a wh-question. Other ways of manipulating focus have also led to the conclusion that extra attention is paid to focused material. Birch and Garnsey (1995) showed that using clefting to place a word in focus led to enhanced memory for the word form, and McKoon, Ward, Ratcliff and Sproat (1993) used various manipulations of syntactic prominence (some of which could support focus-marking and be viewed as manipulations of focus) to show that prominent material supported faster resolution of anaphoric reference.

While there is substantial evidence that various ways of placing a word or phrase in focus increase the attention paid to it, it is far from clear whether this extra attention speeds or slows comprehension of the focused material. The results that have been reported appear to be inconsistent. Birch and Rayner (1997) reported that eye movements were slowed while reading focused information, but Birch and Rayner (2010) reported that they were speeded. To add to the uncertainty, Ward and Sturt (2005) found no effect of focus on reading speed in a change-detection task, and Morris and Folk (1998) found no effect of focus on early reading times, but shorter re-reading times and fewer regressions back into focused elements than non-focused ones.

The reason for this lack of consistency may lie in the various ways that focus (or more generally, prominence) was manipulated in these experiments. Some of the experiments focused a word or phrase by making it the answer to a wh-question, while others focused a word by clefting it (*It was the X that...*) or even by placing words in different syntactic positions, e.g., direct vs. oblique object, or predicate vs. prenominal adjective (which are probably better thought of as manipulations of prominence, not focus per se). However,

even a single way of manipulating focus had different effects on reading speed in different experiments. In some cases (e.g. Ward & Sturt, 2007), focusing a word was confounded with repeating it in the prior context (which speeds reading; Raney & Rayner, 1995; Raney, 2003). In other cases (e.g., Birch & Rayner, 1997) focus was placed on a relatively large phrase, not a single word, potentially diluting its effects. Manipulating focus via clefting brings multiple factors to bear on processing: clefting a phrase introduces various exhaustiveness and existence presuppositions, and in some cases (Birch & Rayner, 1997; Morris & Folk, 1998) the manipulation of clefting a word or phrase was confounded with varying the prominence of other phrases in the sentence. All these factors could have contributed to the varying effects focus has been reported to have on reading time.

We thus suggest that these findings are inconsistent because they represent a variety of different manipulations of focus. We further suggest that this is the case because the manipulations were not based on clear theories of what focus is (and even because focus per se may not be a simple or coherent theoretical concept). In the present paper, we follow one widely-cited semantic analysis of the concepts that underlie focus (Schwarszchild, 1999). Schwarzschild's starting point is that linguistic prominence, or focus-marking, is an observable linguistic property (appearing, e.g., in English by a pitch accent – lengthening and pitch movement – or by syntactic devices such as clefting) (cf. Selkirk, 1984), and that lack of prominence indicates givenness. That is, while a word or phrase that is already given in a discourse may or may not receive focus-marking, a word or phrase that is not given must be prominent. Schwarzschild's novel contribution was a development of the idea (Halliday, 1967) that a word or phrase is given (and thus noninformative) if it is entailed by previous context. This analysis makes 'givenness' distinct from sheer prior occurrence in a discourse: Words and phrases that haven't appeared already can be given, if they are entailed; phrases that contain words that have appeared before can be non-given (which we will sometimes refer to as 'new') if they are not entailed by the context. For example, in the discourse *Mary thought about ordering duck, chicken, or beef. In the end, she ordered beef* the second occurrence of the word *beef* is given, but the phrase *ordered beef* is not, since it can't be inferred from prior context. This phrase must therefore receive focus-marking, which will fall on *beef* as the argument of the phrase's head (Selkirk, 1984). From this perspective, givenness is the fundamental concept, and focus is derivative, possibly but not necessarily reflecting lack of givenness.

Schwarzschild's (1999) analysis is extensive and detailed, and only a superficial description of it can be given here. As indicated above, the discourse status of a phrase is determined by what is entailed by the context. Roughly speaking, a part of a discourse is given if it corefers with, or is entailed by, an earlier part of a discourse. Givenness involves an entailment relationship from the prior discourse, e.g. *collie* entails *dog*, *golden retriever* entails *dog*, and *A golden retriever barked* entails *A dog barked*.¹ Schwarzschild's analysis differs from some commonly-used analyses of givenness in that expressions or utterances, not just possible referents, are given. While the existence of a referent in prior discourse may be very important for some aspects of language processing (e.g., choice of word order and referring terms in production; Arnold, 2010), givenness, as used in this paper, is not limited to such prior introduction of a discourse referent. Rather, expressions corresponding to propositions (see fn 1) are given. To take an example from Schwarzschild (1999, example (20)), in the

¹In Schwarzschild's terms, an utterance U is defined as being given if it has a "salient antecedent A and (a) if U is type e, then A and U corefer; (b) otherwise: modulo -type-shifting, A entails the existential F-closure of U" (Schwarzschild, 1999, pg.151). This formulation requires that phrases larger than a single referring word but smaller than propositions be existentially type-shifted to the status of a proposition, since only propositions, not referring terms, can be entailed. Thus, the occurrence of *big dog* entails an existential type-shifted mention of dog as well as of canine. Further, the formulation describes the 'existential closure' of utterances in which focused (F-marked) terms are replaced by variables that are then existentially quantified over. We refer the reader to Schwarzschild (1999) for the detailed argument.

context of *John ate a green apple*, the utterance *No, John ate a RED apple* is given, apart from the new and focus-marked *red*, because the initial utterance entails the existentially quantified proposition $\exists Y(\text{John ate a } Y \text{ apple})$. Thus, the utterance needs no focus-marking apart from the focus on *red*. Intuitively, relations among referents, not just referents themselves, are given or not-given.

Material that is not given (not entailed) must be focused (or, in Schwarzschild's term, F-marked); material that is given can be focused, for various pragmatic reasons. Thus givenness, not focus, is the critical notion. The derivative nature of focus, and the resulting potential multiple reasons why material is focused, may be responsible for the inconsistent effects focus has been observed to have on reading. Because of this, we present research in which we explicitly manipulate givenness. Although the manipulations we use are similar to those that have been used in previous studies of the effect of focus on reading, we suggest that analyzing them in terms of manipulations of givenness may bring some order to some apparently-inconsistent phenomena. In particular, in the following section we sketch a model in which material that requires a change in the representation of a discourse is read more slowly than material that does not require such a change, i.e., material that is given.

Givenness and File Change

Given material is entailed by a discourse context; new material is not, and therefore (if accepted by a reader or listener) requires a change in the discourse representation. An explicit and useful theory of how discourse is updated is Heim's (1983) "File Change Semantics." In Heim's theory, the basic semantic value of a sentence (roughly, what it adds to a discourse) differs depending on context. Heim compares our understanding of a discourse to a file that contains cards associated with 'discourse entities' and the information associated with them. An entity that is already in the discourse is considered to be 'active' and new information can be entered onto its file card. However, if we encounter a new referent, we need to update our discourse in order to create a new file card, and if we encounter a new relation we must update the file card(s) that contain the entities involved.

Since given information is entailed by the context, we can assume that it does not require any new file cards. For example, the second sentence of the 2-person dialog in (2a) does not introduce a new file card (because *Bill* is given) but (2b) requires the introduction of a file card associated with Bill, presumably requiring additional processing. In contrast, (2c) requires not only the introduction of a file card for Bill, but also a change in the content of the file card that represents Sue (removal of Fred). This case is commonly referred to as involving 'contrastive focus' (or more specifically, 'corrective focus'), terms which we will use even though they do not play a formal role in Schwarzschild's (1999) analysis of givenness and F-marking. We propose that, at least in the case of corrective focus as illustrated in (2c), additional updating is required in (2c) compared to simple newness as in (2b), and this extra updating will be reflected in increased time to comprehend a discourse.

- (2)
- a. Did John introduce Bill to Sue? Yes, John introduced Bill to Sue.
 - b. Who did John introduce to Sue? John introduced Bill to Sue.
 - c. Did John introduce Fred to Sue? No, John introduced Bill to Sue.

A recent experiment that measured eye movements while reading Chinese (Chen, Li, & Yang, 2012) illustrates the value of explicitly distinguishing givenness and focus, and yielded results that supported the prediction that given material will result in less updating cost than new material. Chen et al. found that a critical word was read more slowly when it was the name of a previously-unmentioned individual than when the name had been used earlier (in which case it was considered to be 'given,' even though the proposition in which

it appeared would not be considered to be given in Schwarzschild's analysis). Chen et al. attributed this effect to the need for memory updating in the non-given case (in our application of Heim's analysis, the introduction of a new file card for the new individual, as opposed to simply adding a new proposition to an existing file card). Chen et al. manipulated focus by having a focus-marking particle *shi* occur immediately before the critical word, a proper name. They analyzed this particle as having much the same focusing effect as clefting does in English, and found that the critical word was read more quickly when the particle was present than when it was not present. They interpreted this finding as indicating that increased processing resources were allocated to the target word when it followed the focusing particle (as did Birch & Rayner, 2010; cf. Cutler & Fodor, 1979). One complicating result, however, was that there was an interaction (fully significant only by items) between the presence of the focusing particle and givenness in the region following the critical word (but not on the critical word itself). The region following a new (non-given) word was read more slowly than that following a given word when the critical word was focused by *shi*, but not when it was not focused. This suggests that the focusing particle might have delayed or extended processing rather than speeding it.

The present series of experiments systematically explore effects of givenness on sentence reading time. The experiments employ a manipulation of givenness that has been used to manipulate focus in previous research (including research on the acoustic correlates of focus-marking; Breen, Fedorenko, Wagner, & Gibson, 2010), namely preceding a constant target sentence with contextual questions that affect the givenness and focus-marking of the target sentence. Since two of the experiments to be reported below use YES-NO questions rather than the more commonly used wh-questions as the contexts, a word about the interpretation of such questions is needed. Schwarzschild adopts an analysis (attributed to Bäuerle, 1979) in which the denotation of a YES-NO question like *Did John leave* is the set containing the proposition that John left, if in fact John left, and the empty set otherwise. He notes that the existential type-shift of *Did John leave* is thus the proposition that John left, and thus the relation of John's leaving is given in the context of the question *Did John leave?*. In effect, the possibility of John's leaving is "on the table," and thus can be treated as given.

We propose that, when a reader or listener is presented with information that is not given, s/he must update the discourse. With 'corrective focus,' the previous discourse needs correcting, while discourse-new focus involves updating the discourse with something that was not there before. We will test whether discourse updating is reflected in eye movements. For the series of experiments that follow, we predict that readers will take longer to read focused items than given items and that there will be a cost for reevaluating a referent that is already in the discourse (i.e. when the new referent is contrastive), when compared to information that is simply new (i.e., non-contrastive).

Experiment 1

Experiment 1 compares reading times on a critical word when the preceding context question makes it anaphorically recoverable (i.e. given) to when it is in focus. We also introduce a condition to control for simple repetition of lexical items. As noted in the previous section, we predict that readers will take longer to read focused items than given items.

Method

Materials—We used a question and answer manipulation in order to encourage interpretation of the target word (*Natalie* in (3)) in terms of given (3a) and not-given ('new') (3b) information. In the 'New/Rep' condition (3b), the target word had previously been

introduced into the discourse ('repeated'), and could be considered to be given under some analyses of givenness. However, in Schwarzschild's analysis, the relevant part of the question (*Does Kyle care about someone?*) does not entail that Kyle cares about Natalie, and thus *cares about Natalie* is not given in the answer *Kyle cares about Natalie*. In Heim's (1983) terms, caring about Natalie is not included in Kyle's file card. We included a second 'New/NoRep' condition (3c) where the target word was new to the discourse in addition to being a part of a clause that introduces new information. This last condition was included in order to determine how sheer repetition of a lexical item contributes to this updating effect. In (3), analysis regions are indicated by / followed by region number. Region 4 is the target word; Region 1 is the entire first line, Region 2 is *Speaker B*; Region 3 is the part of the second sentence preceding the target; and Region 5 is the 'spillover' region following the target. Subjects in the experiment were presented with the phrases *Speaker A*: and *Speaker B*: before the sentences but seldom actually fixated them.

- (3) a. Word repeated and answer proposition given (Given)
 Speaker A: I'm confused, does Kyle care about Natalie?/_1
 Speaker B:/_2 Kyle cares about/_3 Natalie/_4 but he doesn't/_5 show it.
- b. Word repeated, but not given in answer proposition (New/Rep):
 Speaker A: Natalie is confused, does Kyle care about someone?/_1
 Speaker B:/_2 Kyle cares about/_3 Natalie/_4 but he doesn't/_5 show it.
- c. Word not repeated, not given in answer proposition (New/NoRep):
 Speaker A: Isabella is confused, does Kyle care about someone?/_1
 Speaker B:/_2 Kyle cares about/_3 Natalie/_4 but he doesn't/_5 show it.

Twenty-seven items were constructed, each with the three conditions illustrated in (3). All experimental items appear in Appendix A. On every trial, subjects read two lines of text on the screen. The top line was a question, attributed to 'Speaker A,' used to pick out the focused element in the answer (attributed to 'Speaker B'). The critical region (located in the second line) always consisted of a single target word. This target word was always a proper name that was 3–7 characters long.

In addition to the items that contained the target stimuli, subjects saw 44 sentences from two unrelated experiments (studying conjunctions and complements), 18 sentences from another study from the current series (Experiment 3), and 30 filler sentences. Responding to an anonymous reviewer's concern that the nature of the filler sentences might affect the results of the experiment, Appendix D provides descriptions and examples of the filler sentences used in all three experiments. Half of the sentences were followed by simple 2-choice questions, designed to assess comprehension.

Participants—Thirty-six students from the University of Massachusetts Amherst received course credit for participating in this experiment. The participants were naive to the study. All subjects had normal or corrected-to-normal vision and were native speakers of English. Eight subjects were excluded because of excessive track loss or problems with calibration. Twenty-eight subjects were thus included in the analysis. All of these subjects answered at least 85% of the comprehension questions correctly. (Note, Experiment 1 was run concurrently with Experiment 3, so generalizations from both must be based on the same sample of subjects.)

Procedure—The procedure outlined below will be nearly identical to the other two experiments. These experiments were all programmed using Eyetrack software (<http://>

blogs.umass.edu/eyelab/). Eye movements were recorded using an Eyelink 1000 eye-tracker (SR Research, Toronto, Ontario, Canada), connected to a PC computer, sampling at 1000 Hz. The subjects viewed the two-line discourses binocularly on a CRT monitor from a distance of 55 cm. They were always instructed to read sentences (presented in 11-pt Monaco font) silently and at their own pace, and they could take as many breaks as they wanted.

At the beginning of the experiment, all subjects were presented with a 13-point grid in order to calibrate their eye movements with the locations on the screen. If the initial calibration was especially difficult due to factors such as glare from glasses, the experimenter presented the subjects with a 9-point calibration grid instead. Recalibration between trials took place as needed. Each trial was triggered when the subject fixated a box on the left edge of the computer screen.

Before seeing the target stimuli and the fillers, participants were presented with seven 2-line practice trials. The experimental items were then presented along with the fillers in a pseudo-randomized order. “Speaker A’s” question and “Speaker B’s” answer appeared simultaneously on the monitor, one above the other. Each subject only saw one possible condition for each item. Comprehension questions were asked after half of the practice and the experimental trials to encourage careful reading. Early stages of data analysis were conducted using EyeDoctor and EyeDry software (<http://blogs.umass.edu/eyelab/>).

Results

All trials where the subject blinked near the initial fixations on the critical word or produced a long (>100ms) saccade near the critical region (Region 4 in (3)) were deleted (7% of the trials). Data of interest on the target word and the next (spillover) region included the duration of the first fixation, the gaze duration (the sum of fixations on the word before leaving it for the first time), the go-past time (the sum of all fixations from first fixating the word until leaving it to the right, including regressive re-reading), the total time, and the proportion of regressions out of the region. The means and standard errors of these measures appear in Table 1.

To assess the effects of focus on fixation durations, linear mixed effects models were fit to the data. Analyses were conducted using the lme4 package (Bates & Sarkar, 2007) for mixed effects models in R, an open source environment for statistical computing (R Development Core Team, 2007). The fixed effect of interest was the three-level factor Given (e.g., 3a), New/Rep (‘repeated’) (3b), and New/NoRep (3c). Random intercepts and slopes were included for both subjects and items, except in the cases where a model comparison (Baayen, Davidson, & Bates, 2008) indicated that a simpler model with only random intercepts was clearly not less adequate than the more complex model (a very conservative criterion was used, such that the simpler model was chosen only if the p value for the significance of the difference between the models exceeded 0.40, making it unlikely to accept the simpler model when in fact it was less adequate; see Barr et al., 2013, for discussion and an argument for using random slopes). When the random intercepts model was chosen, p values for each contrast between two levels of the 3-level fixed effect were estimated using a Markov chain Monte Carlo estimate ((Baayen, 2008), and are reported as pMCMC. Since such an estimate is not possible with random slopes and intercepts using current implementations in R (Bates, 2005), the t values that such models produce were treated as approximations to z (because of their large df), and thus differences were considered significant when the absolute value of t was greater than 2 (absolute values of t are reported in the text).

As a first step, models were fitted with and without the fixed effect, and the significance of the effect was evaluated using the chi-square provided by model comparison. This is analogous to testing the significance of the 3-level fixed effect in an ANOVA. Significant effects were followed up with lmer as described above, using treatment contrasts, with the NewRep condition (3b) as the baseline condition. Such contrasts enabled the NewRep condition to be contrasted with the Given condition, evaluating the effect of givenness when the target item had previously appeared in the context, as well as with the New/NoRep condition, evaluating the effect of prior mention of the target word. Model comparisons indicated that, in the critical region, Region 4, the effects of condition on first fixation, first pass, total time, and go-past time were all significant (ChiSquare(2) = 20.82, $p < .001$, ChiSquare(2) = 14.58, $p < .001$, ChiSquare(2) = 8.39, $p < .02$, and ChiSquare(2) = 7.73, $p < .03$, respectively). The only effects that reached or approached significance in the other regions were the effects of total time in Region 3 and Region 5 (ChiSquare(2) = 4.26, $p < .11$ and ChiSquare(2) = 5.69, $p < .06$, respectively), together with the effect of go-past time and probability of a regression out in Region 5 (ChiSquare(2) = 9.06, $p < .02$, and ChiSquare(2) = 13.0, $p < .002$, respectively).

These significant “main effects” were followed up by comparing (3b) to (3a) (New/Rep and Given in Table 1). Reading times were longer on the target word when it introduced new and presumably focused information about a previously mentioned referent than when it constituted given relational information (e.g. gaze duration: 234 vs. 194 ms). This effect reached significance in first fixation duration ($b = -27.25$, $SE = 6.4$, $t = -4.3$, $pMCMC < .001$), gaze duration ($b = -35.98$, $SE = 8.9$, $t = -4.05$), and total time ($b = -54.7$, $SE = 19.08$, $t = -2.87$). The go-past time effect in this region was marginal at best ($b = -32.5$, $SE = 19.15$, $t = -1.70$, $pMCMC < .10$). Frequency of regressions out of Region 4 did not differ between these two conditions ($t < 1.0$).

The only effect that approached significance in the preceding region (Region 3) was the total time effect, reflecting the longer time spent re-reading the region after regressing from the region that introduced the new word. in the New/Rep compared to the Given condition ($b = -63.0$, $SE = 30.1$, $t = 2.09$). Further, the post-critical (spillover) region (Region 5 in (3)) provided some evidence of increased processing difficulty in the New/Rep condition compared to the Given condition. The latter condition was read significantly faster than the former in go-past time ($b = -128.41$, $SE = 42.37$, $t = -3.03$) and total time ($b = -52.22$, $SE = 23.68$, $t = -2.21$), and showed more regressions out ($b = -2.25$, $SE = 0.49$, $z = 4.58$, $p < .001$). However, there were no significant differences in the ‘early’ measures, first fixation duration or gaze duration (both t 's < 1).

Returning to the critical region, the two conditions that introduced new information ((3b) and (3c)) were compared. Reading times on the target word associated with a new referent were numerically longer in the critical region than the times associated with a previously mentioned but non-given referent, but these effects were not significant in first fixation duration, in gaze duration, or in total time (all t 's < 1.5). The effect did reach significance, however, in go-past time ($b = 51.5$, $SE = 18.7$, $t = 2.75$, $pMCMC < .01$). While the proportion of regressions out appeared to be large in the New/NoRep condition (.21), the difference between it and the New/Rep condition was nonsignificant ($b = 0.39$, $SE = 0.37$, $z = 1.06$, $p > .28$). There were no previous region or spillover region effects associated with this difference (all t 's < 1).

Discussion

Reading times were longer when the target word was part of a clause that introduced non-given and necessarily focus-marked information than when it presented given information.

This finding is expected given Heim's "File Change Semantics" (1983), as the non-given (new) conditions involved more updating than the given condition.

Furthermore, the condition without the repeated name led to numerically longer fixation durations on the target word than the condition with the repeated name, but this effect was significant only in go-past time. While repetition has been reported to speed the reading of individual words (e.g., Raney & Rayner, 1995), these reports have generally examined word repetition in the context of repetition of a full passage (Raney, 2003; cf. Klin, Drumm, & Ralano, 2009). In the present experiment, the earlier occurrence of a single word (a proper name) had only delayed effects on reading time.

A reviewer raised the question of the relation of these results to the repeated name penalty (Gordon, Grosz, & Gilliom, 1993), in which reading of the second occurrence of a name is slowed when the previous occurrence had been in a prominent (subject) position. The target name in the New/Rep condition (3b) had occurred as subject of the first sentence, and its reading could conceivably have been slowed (relative to e.g. a pronoun) because of this. We do not think that this would actually be the case, noting that even a pronoun would have to be focused (made prosodically prominent) in this condition which is not the case in the repeated name conditions that have previously been studied, and noting further that reading times are at least as slow in the New/NonRep condition, which is not subject to the repeated name penalty. However, Experiment 2 introduces a new manipulation of givenness that is not subject to this concern.

Experiment 2

While Experiment 1 showed minimal effects of the sheer repetition of a lexical item in the discourse, it is possible that repetition of the target word in the given condition (3a) contributes to the fast reading time observed in that condition. The word is, after all, not only repeated, but given as part of the phrase it appears in (*Kyle cares about Natalie*). Experiment 2 investigated whether given information is significantly easier to process than new (focused) information in the absence of lexical repetition. It made a phrase given by previously referring to a synonym or a hyponym of the target item. As Rochemont (1986) noted (and as Schwarzschild, 1999, developed at length), earlier use of a word like *gorilla* makes a co-referring occurrence of *animal* given. We note that, in addition, this manipulation permits comparison with a non-given condition which similarly lacks lexical repetition, eliminating concern about any possible cost of a repeated name penalty.

Method

Materials—We employed a similar question and answer paradigm to Experiment 1 in order to manipulate givenness. The New condition involved asking about "something" or "someone" in order to request more information, while the Given condition involved making the critical word either a synonym or a hyponym of another referent in the discourse rather than actually repeating the word.

In contrast to the proper names used in Experiments 1 and 3, critical stimuli were twenty-four concrete nouns across a range of log frequencies from the HAL corpus (Balota et al., 2007) (6.03–12.47; mean frequency: 9.53). Nouns were embedded in an answer sentence frame that was held constant across conditions, following a wh-question asked by 'Speaker A' which did or did not make the critical noun given in the answer sentence.

An example is shown below, with analysis regions indicated by / followed by the region number. (4a) is the Given condition, and (4b) is New.

(4) a. Given:

Speaker A. Tell me, when did Caitlin leave to go to the cardiologist?/1

Speaker B:/2 I believe she left/3 to go to/4 the doctor/5 just a little/6 while before 11 this morning./7

b. New:

Speaker A. Tell me, when did Caitlin leave to go somewhere?/1

Speaker B:/2 I believe she left/3 to go to/4 the doctor/5 just a little/6 while before 11 this morning./7

In the above example, (4a) is an example of inferential givenness of the target term *the doctor* (Region 5) while (4b) is an example where the target item is not given, and thus requires focus marking. The critical region was either the direct or the oblique object of Speaker B's sentence, *the doctor*. Note that the critical word in these items is not the conventionally-identified focus of Speaker A's wh-question. Rather, it is given vs. not given (and thus new and informative), in version (4a) vs. version (4b), respectively.

As illustrated, two versions of each dialog were constructed and assigned in counterbalanced fashion to two separate lists, each containing 12 instances of each type of dialog (given vs. new). The resulting 24 dialogs (which appear in Appendix B) were combined with 76 other sentences from unrelated experiments (involving relative clause processing and lexical ambiguity; see Appendix D). A simple 2-choice question followed 1/3 of the items.

Participants—Sixty students from the University of Massachusetts Amherst received course credit for participating in this experiment. The subjects were naïve to the study and were native speakers of English. They all had normal or corrected-to-normal vision. Data from 12 subjects were dropped due to eye-tracker calibration problems, issues with the tracker or for getting fewer than 75% of the questions right. Forty-eight subjects were included in the analysis.

Procedure—The procedure for Experiment 2 was essentially the same as Experiment 1.

Results

The data analysis was similar to Experiment 1, where trials with blinks near the first fixation on the critical word or long saccades near the first reading on the critical region were deleted (constituting 5% of the data). Table 2 presents the various eye movement measures for the critical noun phrase, Region 5 in (4), together with the two preceding regions and the following region.

The fixed effects of givenness were evaluated primarily by using a linear mixed model with random slopes and intercepts for subjects and items, taking an absolute value of t greater than 2.0 to be significant, but using a model with only random intercepts when a model comparison conservatively indicated that the p value for the difference between models was greater than 0.40. In the former case, the ChiSquares and associated p values resulting from comparing models with and without the fixed effect of givenness are also presented, while in the latter case, pMCMC are shown. First fixations were significantly faster for the target word when it was given than when it was new ($b = -10.63$, $SE = 4.17$, $t = 2.55$, $mPCMC < .02$). A nearly significant difference in the same direction was found for gaze duration ($b = -16.50$, $SE = 8.49$, $t = -1.94$; $\text{ChiSquare}(1) = 3.59$, $p < 0.06$). The tendencies to faster reading for given words in go-past time and total time did not reach significance. The only significant effect in the preceding or following regions appeared in the probability of a regressive saccade from Region 4, the region prior to the critical region. Regressions were

more frequent for new than for given items, 0.088 vs 0.059, $b = -0.67$ in the logistic regression analysis, SE 0.27, $z = 2.44$, $p < .02$.

Discussion

Experiment 2 extends Experiment 1 in showing that given information is read faster than new (and therefore focused) information even when the given word had not appeared in the previous discourse. Givenness was adequately conveyed by a synonym or a superordinate of the given term, as expected given Schwarzschild's (1999) (and Rochemont's, 1986) analysis. Verbatim repetition, as has been used in previous manipulations of givenness, is not obligatory. Using a different term to refer to a given entity does not require costly updating of a discourse model, when the phrase containing the term (*she left to go to the doctor* in (4)) is, in Schwarzschild's (1999) analysis, given. Reading is slowed when the term is new, and focused. We note that an effect of givenness was found with very different materials in Experiments 1 and 2 (proper names vs. definite descriptions, respectively), and with filler materials of very different composition (see Appendix D).

The reading time effects were limited to 'early' measures of reading. They were not significant in the go-past and total time measures, possibly because of the higher variability of these measures, but also possibly indicating that the effect is transient. The effects presumably reflect the very easy integration of the new information into the discourse model. The very early appearance of discourse integration effects could be considered unexpected. Our materials may facilitate integration, given that the context immediately preceding the target word can allow it (or the concept it denotes) to be anticipated (in (4a), *go to the....* could support the expectation of a term referring to a doctor). The decreased frequency of regressions out of the region preceding the target in the given condition may also reflect such anticipation of an upcoming word. Further, we note that other very early effects of plausibility and other discourse relations have been reported (e.g., Rayner, Warren, Juhasz, & Liversedge, 2004).

It is possible that the faster reading time in the given condition reflects simple lexical priming rather than the costs of informationally-based discourse integration. Substituting a synonym for a repeated word in re-readings of an otherwise unchanged text does not reduce the increase in reading speed (Raney & Rayner, 1995), but this effect could reflect conceptual facilitation rather than lexical priming. More relevantly, in a single-sentence eyetracking study, Traxler et al., (2000) found that while verbatim repetition of words across phrases speeded the early measures of reading where the effects were found in the present Experiment 2, the earlier occurrence of one of two synonymous words failed to speed reading of its synonym (e.g., *minister - pastor*) compared to the earlier occurrence of a nonsynonym (e.g., *lawyer*). Similarly, Camblin, Gordon, & Swaab (2007) found that the earlier occurrence of a word such as *arm* speeded reading of a highly associated word such as *leg* compared to, e.g., *nose*, but only when the discourse context was absent or incoherent. They concluded that spreading activation from associative priming does not contribute to natural reading in discourse contexts. Accepting this claim, we suggest that our Experiment 2 results most likely reflect the effect of givenness on discourse integration costs.

Experiment 3

Experiment 3 turns from the comparison of given and new information to the examination of what is commonly referred to as 'contrastive focus.' It examined the reading of phrases that were not given (and could be analyzed as being 'informationally focused') with phrases that contained information that may have occurred previously in the discourse but is presented in a way that contrasts with previous usage or other presuppositions. An example appears in Speaker B's answer to Speaker A's question in (5b). *John* is said to be contrastively

(correctively) focused here. The phrase *I told John* contrasts with the earlier question *Did you tell Mary...* (which, as suggested earlier, entails the givenness of *I told X* but not of *John* in *I told John*). In Schwarzschild's (1999) analysis, contrastive focus is not a distinct concept; it is simply an instance of non-givenness (which requires focus marking). However, in other analyses (e.g., Katz & Selkirk, 2011), contrastive focus is distinguished prosodically, semantically, and pragmatically from simple newness (cf. Breen et al., 2010).

We do not enter this debate here. From our perspective, the functional difference between simple newness ('informative focus') and corrective focus is just that, while the former requires additions to a discourse model (as represented in e.g., Heim's, 1983, file change theory), the latter requires a deletion as well as an addition. The larger discourse change required by contrastive focus supports the prediction that it will result in longer reading times than simple newness. Experiment 3 tests this prediction.

- (5) a. Background: John and Mary are working today./₁
 Speaker A:/₂ Did you tell someone to go home early? /₃
 Speaker B:/₄ I told/₅ John/₆ but I don't/₇ know if it was a good idea.
- b. Background: John and Mary are working today./₁
 Speaker A:/₂ Did you tell Mary to go home early? /₃
 Speaker B:/₄ I told/₅ John/₆ but I don't/₇ know if it was a good idea.

Methods

Materials—We employed a similar question and answer paradigm to Experiment 1 in order to distinguish newness and contrastive (corrective) focus. Critical stimuli (an example appears in (5), with analysis regions indicated) were eighteen proper names (3–7 letters long) embedded in a sentence attributed to 'Speaker B.' This sentence always followed two sentences: A background sentence that introduced two referents, and a question attributed to 'Speaker A.' In the new (non-contrastive) condition (5a), Speaker A always asked about "someone". In the contrastive condition (5b), Speaker A asked about the second referent mentioned in the background sentence. Speaker B mentioned the target word as the object of the first clause. This target word was always the first referent from the background sentence, and thus (in the analysis of yes-no questions presented earlier) contradicted the non-null interpretation of Speaker A's (5b) question.

Participants—Thirty-six students from the University of Massachusetts Amherst received course credit for participating in this experiment. These participants were the same participants as Experiment 1, as the experiment was run concurrently. Data from eight subjects were dropped due to eye-tracker calibration problems or issues with the tracker. Twenty-eight subjects were included in the analysis. All subjects got at least 85% of the questions correct.

Procedure—The procedure for Experiment 3 was identical to the other experiments. This experiment was run concurrently with Experiment 1.

Results

As in the other two experiments, all trials where a track loss occurred near the critical word were deleted (comprising 6% of the data). The means and standard errors of the eyetracking measures appear in Table 3. Data from the preceding region and the spillover region are also presented, but no measure had a significant effect (all $t_s < 1.7$). As in Experiment 2, effects were evaluated primarily by using a linear mixed model with random slopes and intercepts,

taking an absolute value of t greater than 2.0 to be significant, and falling back to a random intercepts model when model comparison yielded a $p > 0.40$. In the former case, the ChiSquares and associated p values resulting from comparing models with and without the fixed effect of contrastiveness are presented; in the latter case, pMCMC values are shown.

Reading times were longer when target words had contrastive focus than when they were simply new and not contrastive. This effect was fully significant in first fixation duration ($b=19.26$, $SE=8.73$, $t=2.21$; $\text{ChiSquare}(1) = 4.73$, $p < .03$), in gaze duration ($b = 19.43$, $SE = 8.42$, $t = 2.31$, $p\text{MCMC} < .03$, and in go past time ($b=67.47$, $SE=24.42$, $t=2.76$, $p\text{MCMC} < .01$, but marginal in total time ($b=24.9$, $SE=13.1$, $t=1.90$, $p\text{MCMC} < .06$). The difference in probability of regressing out of the target was high in both conditions, but did not differ between them ($t < 1.0$). No differences in either of the other region were significant. In particular, the reading time in Region 5 (preceding the target item) for the contrastive case was not significantly longer than the non-contrastive case ($b = 42.5$, $SE = 33.3$, $t = 1.28$).

Discussion

Words in contrastive (corrective) focus elicited longer fixation durations than words that were not contrastive but simply new (not given). With contrastive focus, a relation that is already in the discourse needs to be amended or changed, while the non-contrastive case involves addition of new information, without amending or changing anything. The added revision of the discourse model required by the contrastive items presumably slowed comprehension and thus reading. One caveat is in order: since Experiment 3 was run together with Experiment 1, the reported significant effects do not permit generalization from a new sample of subjects. However, one can conclude that the same subjects who showed slower processing of non-given items than given items (in Experiment 1) also showed slower processing of corrective items than merely non-given items (in Experiment 3), reflecting a graded effect of amount of change needed in a discourse representation.

General Discussion

The current series of experiments explored the effects of discourse updating on eye movements. Experiment 1 found that new information was read slowly compared to given information, even when the new information condition repeated the target word from the context. Sheer repetition had a modest, and rather delayed, effect. Experiment 2 showed faster reading times for words that were made given by the prior occurrence of a synonym or a hyponym compared to words that were not given. Finally, Experiment 3 found that words in corrective focus were read slower than words that were simply non-given (and hence, focus-marked).

We adopted a theoretically motivated analysis of focus (Schwarzschild, 1999), with givenness as the core concept and focus as derivative from it. In our materials (unlike the case in some previous reports, e.g., Birch & Rayner, 1997), the focused item was always a single word, rather than multiple words. We used questions to make some constituents given and thus to manipulate focus marking. This has the advantage of keeping the target words and carrier sentences constant across conditions, which is not the case with other manipulations of focus, such as clefting. Our simple conclusion is that given material is read faster than material that is not given, and that the effect is graded, with material that is contrastive (in particular, corrective) being read slower than material that is simply new. We interpret these findings as showing that revisions to a discourse model (such as Heim's, 1983, file card model) are costly in processing terms, and more costly to the extent that they require not only additions but also changes to the discourse model. We find it somewhat surprising that such discourse-integration effects show up in very early measures of reading

time, and submit that it would be of interest to determine the conditions under which such early measures are affected.

We suggest that this pattern of findings clears up the apparent inconsistency in the literature about the effects of focus on reading time. When material is not given, and hence must be focus-marked, it is read more slowly than when it is given. In that sense, focus slows reading. We do not claim that every instance of focused material will be read more slowly than non-focused material with which it is compared. Focusing a word or phrase by using a cleft construction or a focus particle can have complicated effects on the semantics and pragmatics of a sentence. For instance, these linguistic devices carry presuppositions that could very well change a reader's pattern of eye fixations. If one reads, e.g., *Only John...* one might strategically look ahead to see what John is being contrasted with, and similarly *It was John that...* might encourage a reader to look ahead to determine what satisfies the presupposition that John was involved in something that the reader presumably knows about. Similarly, we do not claim that every instance of more "prominent" material will be read more slowly than less prominent material (cf. Birch & Rayner, 2010). Some ways of manipulating prominence (defined, for instance, as Birch and Rayner, 2010, did, as greater memorability) may well result in more prominent material being read more rapidly.

Taken as a whole, our results tell a clear story. We manipulated givenness and the requirement for focus-marking by asking questions whose semantics do or do not entail a sharply-defined constituent. We found that when content is entailed by a preceding context it is read fast, but when content requires updating of a reader's discourse representation, fixation durations are longer. This is especially the case when information from the previous discourse needs to be amended or changed, as in the case of corrective focus. Using Heim's (1983) metaphor, adding a new file card for a new referent is costly in time, and changing the entry on a file card is even more costly. Viewed from another perspective, when other factors are held constant, a word that is obligatorily focus-marked is read more slowly than one that is not so marked, holding other factors constant.

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Appendices

Appendix A: Materials used in Experiment 1

1.
 - A. Speaker A: I'm confused, does Kyle care about Natalie? Speaker B: Kyle cares about Natalie but he doesn't show it.
 - B. Speaker A: Natalie is confused, does Kyle care about someone? Speaker B: Kyle cares about Natalie but he doesn't show it.
 - C. Speaker A: Isabella is confused, does Kyle care about someone? Speaker B: Kyle cares about Natalie but he doesn't show it.
2.
 - A. Speaker A: I'm curious, is Tiffany jealous of Matt? Speaker B: Tiffany's jealous of Matt but who isn't?
 - B. Speaker A: Matt's curious, is Tiffany jealous of anyone? Speaker B: Tiffany's jealous of Matt but who isn't?
 - C. Speaker A: Arnold's curious, is Tiffany jealous of anyone? Speaker B: Tiffany's jealous of Matt but who isn't?
3.
 - A. Speaker A: I'm intrigued, is Julie in love with John? Speaker B: Julie's in love with John but she's too shy to show it.
 - B. Speaker A: John's intrigued, is Julie in love with anyone? Speaker B: Julie's in love with John but she's too shy to show it.
 - C. Speaker A: Gary's intrigued, is Julie in love with anyone? Speaker B: Julie's in love with John but she's too shy to show it.
4.
 - A. Speaker A: I'm curious, does Anne care about Mary? Speaker B: Anne cares about Mary but I worry that the feeling's not mutual.
 - B. Speaker A: Mary's curious, does Anne care about anyone? Speaker B: Anne cares about Mary but I worry that the feeling's not mutual.
 - C. Speaker A: Brooke's curious, does Anne care about anyone? Speaker B: Anne cares about Mary but I worry that the feeling's not mutual.
5.
 - A. Speaker A: I'm concerned, does Jill despise Dan? Speaker B: Jill despises Dan but I think that he deserves it.
 - B. Speaker A: Dan is concerned, does Jill despise someone? Speaker B: Jill despises Dan but I think that he deserves it.

- C. Speaker A: Steve is concerned, does Jill despise someone? Speaker B: Jill despises Dan but I think that he deserves it.
6. A. Speaker A: I am curious, does Brian love Amy? Speaker B: Brian loves Amy and I don't blame him.
 B. Speaker A: Amy is curious, does Brian love anyone? Speaker B: Brian loves Amy and I don't blame him.
 C. Speaker A: Madison is curious, does Brian love anyone? Speaker B: Brian loves Amy and I don't blame him.
7. A. Speaker A: I want to know, does Jessica love James? Speaker B: Jessica loves James but he's too young for her.
 B. Speaker A: James wants to know, does Jessica love someone? Speaker B: Jessica loves James but he's too young for her.
 C. Speaker A: Kurt wants to know, does Jessica love someone? Speaker B: Jessica loves James but he's too young for her.
8. A. Speaker A: I am curious, does Chloe complain about Samuel? Speaker B: Chloe complains about Samuel but it's always about such minor things.
 B. Speaker A: Samuel is curious, does Chloe complain about anyone? Speaker B: Chloe complains about Samuel but it's always about such minor things.
 C. Speaker A: Peter is curious, does Chloe complain about anyone? Speaker B: Chloe complains about Samuel but it's always about such minor things.
9. A. Speaker A: I'm confused, did Timmy lie to Fred? Speaker B: Timmy lied to Fred but I'm not getting involved anymore.
 B. Speaker A: Fred's confused, did Timmy lie to someone? Speaker B: Timmy lied to Fred but I'm not getting involved anymore.
 C. Speaker A: George's confused, did Timmy lie to someone? Speaker B: Timmy lied to Fred but I'm not getting involved anymore.
10. A. Speaker A: I want to know, does Michelle gush about Lenny? Speaker B: Michelle gushes about Lenny all the time, and he gushes about her too.
 B. Speaker A: Lenny wants to know, does Michelle gush about anyone? Speaker B: Michelle gushes about Lenny all the time, and he gushes about her too.
 C. Speaker A: Raymond wants to know, does Michelle gush about anyone? Speaker B: Michelle gushes about Lenny all the time, and he gushes about her too.
11. A. Speaker A: I need to know, does Ming admire Aaron? Speaker B: Ming admires Aaron but she still questions some things he says.
 B. Speaker A: Aaron needs to know, does Ming admire someone? Speaker B: Ming admires Aaron but she still questions some things he says.
 C. Speaker A: Ian needs to know, does Ming admire someone? Speaker B: Ming admires Aaron but she still questions some things he says.
12. A. Speaker A: I'm curious, is Lori smitten with Ben? Speaker B: Lori's smitten with Ben and the two are inseparable.

- B.** Speaker A: Ben's curious, is Lori smitten with anyone? Speaker B: Lori's smitten with Ben and the two are inseparable.
- C.** Speaker A: Bruce's curious, is Lori smitten with anyone? Speaker B: Lori's smitten with Ben and the two are inseparable.
- 13.** **A.** Speaker A: I want to know, did Walter admit everything to Mildred? Speaker B: Walter admitted everything to Mildred but he told me that he regrets it.
- B.** Speaker A: Mildred wants to know, did Walter admit everything to someone? Speaker B: Walter admitted everything to Mildred but he told me that he regrets it.
- C.** Speaker A: Evelyn wants to know, did Walter admit everything to someone? Speaker B: Walter admitted everything to Mildred but he told me that he regrets it.
- 14.** **A.** Speaker A: I am curious, did Stephanie say that she trusted Stuart? Speaker B: Stephanie said that she trusted Stuart but she didn't sound very convincing.
- B.** Speaker A: Stuart is curious, did Stephanie say that she trusted anyone? Speaker B: Stephanie said that she trusted Stuart but she didn't sound very convincing.
- C.** Speaker A: Nicholas is curious, did Stephanie say that she trusted anyone? Speaker B: Stephanie said that she trusted Stuart but she didn't sound very convincing.
- 15.** **A.** Speaker A: I'm unclear about something, is Steven infatuated with Dana? Speaker B: Steven's infatuated with Dana but I don't think that it'll last.
- B.** Speaker A: Dana's unclear about something, is Steven infatuated with anyone? Speaker B: Steven's infatuated with Dana but I don't think that it'll last.
- C.** Speaker A: Hannah's unclear about something, is Steven infatuated with anyone? Speaker B: Steven's infatuated with Dana but I don't think that it'll last.
- 16.** **A.** Speaker A: I'm feeling antsy, did Clark respect Ron? Speaker B: Clark respected Ron, but after last night's events, I'm not so sure.
- B.** Speaker A: Ron's feeling antsy, did Clark respect anyone? Speaker B: Clark respected Ron, but after last night's events, I'm not so sure.
- C.** Speaker A: Logan's feeling antsy, did Clark respect anyone? Speaker B: Clark respected Ron, but after last night's events, I'm not so sure.
- 17.** **A.** Speaker A: I am curious, does Debbie care for Sacha? Speaker B: Debbie cares for Sacha, but she doesn't come right out and say it.
- B.** Speaker A: Sacha is curious, does Debbie care for anyone? Speaker B: Debbie cares for Sacha, but she doesn't come right out and say it.
- C.** Speaker A: Ella is curious, does Debbie care for anyone? Speaker B: Debbie cares for Sacha, but she doesn't come right out and say it.

18. A. Speaker A: I'm unsure about something, does Sal depend on Connor?
Speaker B: Sal depends on Connor for everything, to the point where I worry about them both.
- B. Speaker A: Connor's unsure about something, does Sal depend on anyone? Speaker B: Sal depends on Connor for everything, to the point where I worry about them both.
- C. Speaker A: Isaac's unsure about something, does Sal depend on anyone? Speaker B: Sal depends on Connor for everything, to the point where I worry about them both.
19. A. Speaker A: I'm curious, does Dominic love Dylan? Speaker B: Dominic loves Dylan in a brotherly way, but nothing beyond that.
- B. Speaker A: Dylan's curious, does Dominic love anyone? Speaker B: Dominic loves Dylan in a brotherly way, but nothing beyond that.
- C. Speaker A: Luke's curious, does Dominic love anyone? Speaker B: Dominic loves Dylan in a brotherly way, but nothing beyond that.
20. A. Speaker A: I'm curious, does Arianna obsess over Colleen? Speaker B: Arianna obsesses over Colleen but it's adorable.
- B. Speaker A: Colleen's curious, does Arianna obsess over anyone? Speaker B: Arianna obsesses over Colleen but it's adorable.
- C. Speaker A: Lily's curious, does Arianna obsess over anyone? Speaker B: Arianna obsesses over Colleen but it's adorable.
21. A. Speaker A: I am surprised, did Kathleen change her mind about Alec? Speaker B: Kathleen changed her mind about Alec but who knows whether she'll change it again.
- B. Speaker A: Alec is surprised, did Kathleen change her mind about someone? Speaker B: Kathleen changed her mind about Alec but who knows whether she'll change it again.
- C. Speaker A: Henry is surprised, did Kathleen change her mind about someone? Speaker B: Kathleen changed her mind about Alec but who knows whether she'll change it again.
22. A. Speaker A: I'm curious, does Elijah look up to Shane? Speaker B: Elijah looks up to Shane so much and I think that it's so cute.
- B. Speaker A: Shane's curious, does Elijah look up to anyone? Speaker B: Elijah looks up to Shane so much and I think that it's so cute.
- C. Speaker A: Jordan's curious, does Elijah look up to anyone? Speaker B: Elijah looks up to Shane so much and I think that it's so cute.
23. A. Speaker A: I'm concerned, does Marcy love Michael? Speaker B: Marcy loves Michael and she told me that she has big plans for his birthday.
- B. Speaker A: Michael's concerned, does Marcy love someone? Speaker B: Marcy loves Michael and she told me that she has big plans for his birthday.
- C. Speaker A: Owen's concerned, does Marcy love someone? Speaker B: Marcy loves Michael and she told me that she has big plans for his birthday.

24. A. Speaker A: I am confused, does Emily like Josh? Speaker B: Emily likes Josh, but she's not sure if she loves him.
 B. Speaker A: Josh is confused, does Emily like anyone? Speaker B: Emily likes Josh, but she's not sure if she loves him.
 C. Speaker A: Julian is confused, does Emily like anyone? Speaker B: Emily likes Josh, but she's not sure if she loves him.
25. A. Speaker A: I'm excited, does Patty trust Ariel? Speaker B: Patty trusts Ariel very much, and I think that she deserves it.
 B. Speaker A: Ariel's excited, does Patty trust someone? Speaker B: Patty trusts Ariel very much, and I think that she deserves it.
 C. Speaker A: Mariah's excited, does Patty trust someone? Speaker B: Patty trusts Ariel very much, and I think that she deserves it.
26. A. Speaker A: I am surprised, does David trust Jennifer? Speaker B: David trusts Jennifer but he worries about her strange moods.
 B. Speaker A: Jennifer is surprised, does David trust someone? Speaker B: David trusts Jennifer but he worries about her strange moods.
 C. Speaker A: Claire is surprised, does David trust someone? Speaker B: David trusts Jennifer but he worries about her strange moods.
27. A. Speaker A: I'm curious, does Maya worry about Peter? Speaker B: Maya worries about Peter, but I'm usually around to calm her down.
 B. Speaker A: Peter's curious, does Maya worry about anyone? Speaker B: Maya worries about Peter, but I'm usually around to calm her down.
 C. Speaker A: William's curious, does Maya worry about anyone? Speaker B: Maya worries about Peter, but I'm usually around to calm her down.

Appendix 2: Materials used in Experiment 2

1. A. SPEAKER A: Who delivered something to our house? SPEAKER B: The man in the truck delivered the mail to our house at the end of the afternoon.
 B. SPEAKER A: Who delivered a letter to our house? SPEAKER B: The man in the truck delivered the mail to our house at the end of the afternoon.
2. A. SPEAKER A: Who brought something to the picnic? SPEAKER B: I believe Melinda brought a steak to the picnic yesterday.
 B. SPEAKER A: Who brought a t-bone to the picnic? SPEAKER B: I believe Melinda brought a steak to the picnic yesterday.
3. A. SPEAKER A: I can't remember, when did Charles study something? SPEAKER B: I'm told that he studied math last year when he was in Amherst.
 B. SPEAKER A: I can't remember, when did Charles study mathematics? SPEAKER B: I'm told that he studied math last year when he was in Amherst.

4. A. SPEAKER A: Remind me, when did Sam visit someone? SPEAKER B: I think Sam visited the writer last year when he was traveling in New England.
B. SPEAKER A: Remind me, when did Sam visit the author? SPEAKER B: I think Sam visited the writer last year when he was traveling in New England.
5. A. SPEAKER A: Bill is uncertain, where did Rose go to get something? SPEAKER B: I'm told she went to Hadley to get a dog as a present for her children.
B. SPEAKER A: Bill is uncertain, where did Rose go to get a collie? SPEAKER B: I'm told she went to Hadley to get a dog as a present for her children.
6. A. SPEAKER A: I need to know, where did Mary eat something for lunch? SPEAKER B: I'm pretty sure she ate pasta in the food court at the mall.
B. SPEAKER A: I need to know, where did Mary eat spaghetti for lunch? SPEAKER B: I'm pretty sure she ate pasta in the food court at the mall.
7. A. SPEAKER A: Sam wondered, who went hunting for something? SPEAKER B: I think Chris might have gone hunting for fowl up north of the Quabbin Reservoir.
B. SPEAKER A: Sam wondered, who went hunting for turkey? SPEAKER B: I think Chris might have gone hunting for fowl up north of the Quabbin Reservoir.
8. A. SPEAKER A: Who listened to something last night? SPEAKER B: I think Miles listened to music before he went to bed last night.
B. SPEAKER A: Who listened to jazz last night? SPEAKER B: I think Miles listened to music before he went to bed last night.
9. A. SPEAKER A: I forget, when did Bill go into the kitchen for something? SPEAKER B: I believe he went into the kitchen for some food just a few minutes before dinner was served.
B. SPEAKER A: I forget, when did Bill go into the kitchen for a snack? SPEAKER B: I believe he went into the kitchen for some food just a few minutes before dinner was served.
10. A. SPEAKER A: I'm unsure, when did Julia train something to do tricks? SPEAKER B: I understand she actually trained an ape to do tricks last winter.
B. SPEAKER A: I'm unsure, when did Julia train a gorilla to do tricks? SPEAKER B: I understand she actually trained an ape to do tricks last winter.
11. A. SPEAKER A: Sam's concerned, where did Ryan get a ride to? SPEAKER B: My understanding is he took a taxi to his house after the evening in the bar.
B. SPEAKER A: Sam's concerned, where did Ryan take a cab to? SPEAKER B: My understanding is he took a taxi to his house after the evening in the bar.

12. A. SPEAKER A: Tom asked me, where did Ron ride on something last summer? SPEAKER B: I think he rode on a motorcycle on Cape Cod all of the last summer.
- B. SPEAKER A: Tom asked me, where did Ron ride on a Harley Davidson last summer? SPEAKER B: I think he rode on a motorcycle on Cape Cod all of the last summer.
13. A. SPEAKER A: Tell me, who drove somewhere to see his friend? SPEAKER B: I think Alex drove to the city to see his friend.
- B. SPEAKER A: Tell me, who drove to New York to see his friend? SPEAKER B: I think Alex drove to the city to see his friend.
14. A. SPEAKER A: I was wondering, who had a drink of something? SPEAKER B: I believe Leah had a drink of coke before running off to school.
- B. SPEAKER A: I was wondering, who had a drink of coca-cola? SPEAKER B: I believe Leah had a drink of coke before running off to school.
15. A. SPEAKER A: Ellen is curious, when is Brian hiking somewhere? SPEAKER B: I believe he is hiking to the summit next Saturday or Sunday.
- B. SPEAKER A: Ellen is curious, when is Brian hiking to the peak of Mount Tom? SPEAKER B: I believe he is hiking to the summit next Saturday or Sunday.
16. A. SPEAKER A: The reporter was wondering, when did the emergency team respond to something? SPEAKER B: I believe they responded to a fire sometime after midnight last night.
- B. SPEAKER A: The reporter was wondering, when did the emergency team respond to something burning down? SPEAKER B: I believe they responded to a fire sometime after midnight last night.
17. A. SPEAKER A: Her mother is curious, where did Ashley eat something? SPEAKER B: I'm pretty sure she ate a candy bar at the bus stop in front of the Newman Center.
- B. SPEAKER A: Her mother is curious, where did Ashley eat a Milky Way? SPEAKER B: I'm pretty sure she ate a candy bar at the bus stop in front of the Newman Center.
18. A. SPEAKER A: Tell me, where did Roger play something? SPEAKER B: I understand he played the drums at the show this weekend.
- B. SPEAKER A: Tell me, where did Roger play the bongos? SPEAKER B: I understand he played the drums at the show this weekend.
19. A. SPEAKER A: Tom was asking, who took his date somewhere recently? SPEAKER B: I understand Dan took his date to a movie sometime during the past week or two.
- B. SPEAKER A: Tom was asking, who took his date to a film recently? SPEAKER B: I understand Dan took his date to a movie sometime during the past week or two.
20. A. SPEAKER A: I'm really curious, who is going somewhere? SPEAKER B: I believe Charlotte is going on a plane and she's very excited about it.

- B.** SPEAKER A: I'm really curious, who is going on a jet tomorrow?
SPEAKER B: I believe Charlotte is going on a plane and she's very excited about it.
- 21.** **A.** SPEAKER A: Tell me, when did Caitlin leave to go somewhere?
SPEAKER B: I believe she left to go to the doctor just a little while before 11 this morning.
- B.** SPEAKER A: Tell me, when did Caitlin leave to go to the cardiologist?
SPEAKER B: I believe she left to go to the doctor just a little while before 11 this morning.
- 22.** **A.** SPEAKER A: When did Mike buy something yesterday? SPEAKER B: He bought a book yesterday at the Barnes and Noble store in the strip mall.
- B.** SPEAKER A: When did Mike buy a novel yesterday? SPEAKER B: He bought a book yesterday at the Barnes and Noble store in the strip mall.
- 23.** **A.** SPEAKER A: We were wondering, where did Sarah decide to plant something? SPEAKER B: I believe she decided to plant a tree just outside her dining room window.
- B.** SPEAKER A: We were wondering, where did Sarah decide to plant an oak? SPEAKER B: I believe she decided to plant a tree just outside her dining room window.
- 24.** **A.** SPEAKER A: Mary asked, where was Ellen when she used the binoculars to see something? SPEAKER B: I understand she used the binoculars to see the birds when she was on vacation in the Berkshires.
- B.** SPEAKER A: Mary asked, where was Ellen when she used the binoculars to see the hawks? SPEAKER B: I understand she used the binoculars to see the birds when she was on vacation in the Berkshires.

Appendix C: Materials used in Experiment 3

- 1.** **A.** Background: John and Mary are working today. Speaker A: Did you tell someone to go home early? Speaker B: I told John, but I don't know if it was a good idea.
- B.** Background: John and Mary are working today. Speaker A: Did you tell Mary to go home early? Speaker B: I told John, but I don't know if it was a good idea.
- 2.** **A.** Background: Paul and Adam are really strict about deadlines. Speaker A: Did you inform someone about your late submission? Speaker B: I informed Paul, and he wasn't happy about it.
- B.** Background: Paul and Adam are really strict about deadlines. Speaker A: Did you inform Adam about your late submission? Speaker B: I informed Paul, and he wasn't happy about it.
- 3.** **A.** Background: Phil and Amy love going skiing. Speaker A: Did you invite someone to come with us? Speaker B: I invited Phil, but I doubt that he'll agree to come.

- B.** Background: Phil and Amy love going skiing. Speaker A: Did you invite Amy to come with us? Speaker B: I invited Phil, but I doubt that he'll agree to come.
4. **A.** Background: Alyssa and Ian skipped class today. Speaker A: Did you email someone about the surprise quiz? Speaker B: I emailed Alyssa, because she emailed me first.
- B.** Background: Alyssa and Ian skipped class today. Speaker A: Did you email Ian about the surprise quiz? Speaker B: I emailed Alyssa, because she emailed me first.
5. **A.** Background: Jacob and Isabella are planning a huge party on Saturday. Speaker A: Did you tell someone about our cranky neighbors? Speaker B: I told Jacob, but he wasn't worried about it.
- B.** Background: Jacob and Isabella are planning a huge party on Saturday. Speaker A: Did you tell Isabella about our cranky neighbors? Speaker B: I told Jacob, but he wasn't worried about it.
6. **A.** Background: Mike and Noah are trying out for the football team this year. Speaker A: Did you ask someone to come train with us? Speaker B: I asked Mike, because he has a good chance of getting in.
- B.** Background: Mike and Noah are trying out for the football team this year. Speaker A: Did you ask Noah to come train with us? Speaker B: I asked Mike, because he has a good chance of getting in.
7. **A.** Background: Ava and Emily left our house in a hurry this morning. Speaker A: Did you tell someone to lock the door? Speaker B: I told Ava, because she was the last to leave.
- B.** Background: Ava and Emily left our house in a hurry this morning. Speaker A: Did you tell Emily to lock the door? Speaker B: I told Ava, because she was the last to leave.
8. **A.** Background: Jeff and Chloe are making a huge dinner tonight. Speaker A: Did Jennifer inform someone of your allergies? Speaker B: Jennifer informed Jeff, but I hope that he didn't forget.
- B.** Background: Jeff and Chloe are making a huge dinner tonight. Speaker A: Did Jennifer inform Chloe of your allergies? Speaker B: Jennifer informed Jeff, but I hope that he didn't forget.
9. **A.** Background: Heather and Stephanie are going food shopping. Speaker A: Did you ask someone to buy more bagels? Speaker B: I asked Heather, because she knows which ones I like.
- B.** Background: Heather and Stephanie are going food shopping. Speaker A: Did you ask Stephanie to buy more bagels? Speaker B: I asked Heather, because she knows which ones I like.
10. **A.** Background: Eric and Bill are good musicians. Speaker A: Did you invite someone to our show? Speaker B: I invited Eric, because he asked me about it.
- B.** Background: Eric and Bill are good musicians. Speaker A: Did you invite Bill to our show? Speaker B: I invited Eric, because he asked me about it.

11. A. Background: Faith and Will are moving off campus. Speaker A: Did you inform someone about your plans to move out too? Speaker B: I informed Faith, and we might all live together.
- B. Background: Faith and Will are moving off campus. Speaker A: Did you inform Will about your plans to move out too? Speaker B: I informed Faith, and we might all live together.
12. A. Background: Brian and Becky want to go to grad school. Speaker A: Did you tell someone that you want to go to grad school too? Speaker B: I told Brian, because it would be nice to go through the application process together.
- B. Background: Brian and Becky want to go to grad school. Speaker A: Did you tell Becky that you want to go to grad school too? Speaker B: I told Brian, because it would be nice to go through the application process together.
13. A. Background: Shawna and Danielle are studying abroad next year. Speaker A: Did you invite someone to the information session? Speaker B: I invited Shawna, but she already knew about it.
- B. Background: Shawna and Danielle are studying abroad next year. Speaker A: Did you invite Danielle to the information session? Speaker B: I invited Shawna, but she already knew about it.
14. A. Background: Robert and Beverly are home for the weekend. Speaker A: Did you persuade someone to come with you to your cooking class? Speaker B: I persuaded Robert, but he didn't need much convincing.
- B. Background: Robert and Beverly are home for the weekend. Speaker A: Did you persuade Beverly to come with you to your class? Speaker B: I persuaded Robert, but he didn't need much convincing.
15. A. Background: Ashley and David are having a party at their new house. Speaker A: Did you ask someone to give you directions? Speaker B: I asked Ashley, and she drew a map for me.
- B. Background: Ashley and David are having a party at their new house. Speaker A: Did you ask David to give you directions? Speaker B: I asked Ashley, and she drew a map for me.
16. A. Background: Richard and Susan are coming over tonight. Speaker A: Did you ask someone to bring snacks? Speaker B: I asked Richard, and I know that he'll bring good stuff.
- B. Background: Richard and Susan are coming over tonight. Speaker A: Did you ask Susan to bring snacks? Speaker B: I asked Richard, and I know that he'll bring good stuff.
17. A. Background: Kelly and Sarah go running together all the time. Speaker A: Did you ask someone to lend you running shoes? Speaker B: I asked Kelly, but she was using hers.
- B. Background: Kelly and Sarah go running together all the time. Speaker A: Did you ask Sarah to lend you running shoes? Speaker B: I asked Kelly, but she was using hers.
18. A. Background: Julie and Brett are having a yard sale Sunday. Speaker A: Do you expect someone to have told Jane about it already? Speaker B: I

expect Julie to have told Jane, because they had class together this morning.

- B.** Background: Julie and Brett are having a yard sale Sunday. Speaker A: Do you expect Brett to have told Jane about it already? Speaker B: I expect Julie to have told Jane, because they had class together this morning.

Appendix D: Descriptions and examples of filler sentences used in the experiments

In addition to providing fillers for each other (see Appendices A and C), Experiments 1 and 3 contained:

- a.** 24 2-person dialogs from an experiment on complement deletion, e.g.: Speaker A: What are you deeply ashamed of? Speaker B: (That) I ignored you. It never should have happened.
- b.** 20 2-person dialogs from an experiment on the discourse consequences on *and* vs. *or*, e. g. Speaker A: Jeff or Brayden objected to the new policy. Speaker B: Dan did too, but it didn't do any good.
- c.** 10 fillers for the previous experiment, e.g., Speaker A: Cindy or Meg made two ice cream sundaes. Speaker B: It was probably Cindy, who makes two and eats two.
- d.** 12 2-person dialogs with leadins similar to the dialogs of Experiment 1, but with continuations that did not introduce new proper names, e.g.: Speaker A: I'm confused, does Abby want Elisa to come to dinner? Speaker B: No, Abby didn't feel like having a big crowd.
- e.** 8 2-person, 3-sentence dialogs similar to the dialogs of Experiment 3, but with continuations that introduced a new but noncontrastive proper name, e.g. Background: Ethan and Sophia seemed to have hit it off. Speaker A: Do you know if someone told Marc? Speaker B: Mary told Marc, and he wasn't pleased.

Experiment 2 contained:

- a.** 36 single-sentence items examining subject-extracted vs. object-extracted relative clauses, e.g. The bus driver that the kids followed wondered about the location of a hotel.
- b.** 40 single-sentence items examining the reading of homonyms in focused or non-focused positions, e.g. The students agreed that it was the races that made them decide to leave the city.

Highlights

- Material that is contextually given is read faster than material that is new.
- Reading speed is slowed when text requires changes in a discourse representation.
- Effects of givenness appear in the absence of lexical repetition.
- Discourse updating can take place very quickly in reading.

Table 1

Mean fixation times, ms, and proportion regressions out (and SEs) on target word (e.g., “Natalie” in 3) and the preceding and following (‘spillover’) regions. Means that differ significantly from the New/Rep condition are **boldfaced**.

Condition	First Fixation Duration	Gaze Duration	Go Past Time	Total Time	Reg Out (%)
Preceding Region (3)					
Given	212 (4.9)	495 (12.1)	524 (14.0)	596 (17.1)	.04 (.01)
New/Rep	204 (4.9)	494 (14.3)	559 (20.6)	659 (24.1)	.07 (.02)
New/NoRep	213 (5.3)	488 (14.8)	559 (24.4)	638 (27.5)	.07 (.02)
Target Region (4)					
Given	186 (4.4)	194 (5.7)	237 (13.3)	221 (8.8)	.11 (.03)
New/Rep	215 (4.7)	234 (7.1)	271 (12.3)	280 (13.5)	.11 (.03)
New/NoRep	222 (5.5)	247 (7.3)	324 (16.0)	298 (15.8)	.21 (.03)
Spillover Region (5)					
Given	212 (4.2)	372 (13.1)	410 (17.8)	465 (17.1)	.05 (.01)
New/Rep	214 (4.7)	382 (13.3)	526 (30.5)	515 (19.8)	.16 (.02)
New/NoRep	215 (4.2)	405 (15.0)	516 (29.1)	532 (19.4)	.13 (.02)

Mean fixation times, ms, and probability of regression out (and SEs) on target phrase (e.g. *the doctor* in (4)), Experiment 2, together the preceding and following regions (Regions 3, 4 and 6 in (4)). Significant and near-significant differences are boldfaced.

Table 2

Condition	First Fix Duration	Gaze Duration	Go-past Time	Total Time	Regression Probability
			Sentence 2 Start (Region 3)		
Given	206 (3.1)	566 (13.1)	604 (16.4)	617 (15.6)	.025 (.007)
New	215 (3.4)	549 (12.4)	610 (18.5)	615 (15.3)	.040 (.009)
			Previous (Region 4)		
Given	202 (2.8)	236 (4.8)	266 (8.1)	283 (6.8)	.059 (.011)
New	206 (2.8)	242 (4.5)	283 (8.9)	283 (6.2)	.088 (.013)
			Target Word (Region 5)		
Given	215 (3.1)	255(5.1)	294 (8.1)	301 (7.4)	.091 (.013)
New	225 (3.4)	274 (5.2)	308 (8.3)	307 (7.6)	.088 (0.13)
			Spillover (Region 6)		
Given	218 (3.0)	385 (7.7)	385 (7.7)	487 (10.6)	.139 (.015)
New	219 (3.2)	379 (7.9)	379 (7.9)	460 (9.8)	.131 (.014)

Table 3

Mean fixation times, ms (and standard errors) on target word (e.g., *John*). Significant and marginal differences are boldfaced.

Condition	First Fix Duration	Gaze Duration	Go-past Time	Total Time	Regression Probability
	Previous (Region 5)				
Non-Contrast	236 (6.9)	369 (16.2)	391 (17.6)	402 (15.6)	.047 (.015)
Contrastive	235 (7.0)	384 (18.2)	415 (23.7)	460 (26.3)	.040 (.015)
	Target Word (Region 6)				
Non-Contrast	188 (4.3)	201 (6.3)	279 (13.8)	238 (10.0)	.259 (.034)
Contrastive	204 (6.3)	219 (7.3)	348 (21.4)	265 (11.1)	.310 (.036)
	Spillover (Region 7)				
Non-Contrast	205 (4.7)	307 (10.7)	359 (16.7)	438 (18.1)	.073 (.018)
Contrastive	214 (5.0)	328 (13.8)	370 (18.9)	434 (18.2)	.049 (.015)