Abstract

Across three experiments, we investigated how different markers of contrastive focus affect text encoding and retention. Prior work suggests that some contrastive focus markers (e.g., contrastive pitch accents) can enhance long-term memory for discourse; we tested whether this arises from contrast alone or the realization of linguistic focus in particular. Participants read texts containing true propositions for which a salient alternative was previously mentioned (e.g., *The British scientists found the monkey* when the *French* were previously mentioned) and took a memory test. Contrast markers alone (adversative connectives) did not facilitate retention whereas contrastive focus markers (*it*-clefts) did. However, contrary to what has been observed for other contrastive focus markers (contrastive pitch accents and font emphasis), it-clefts facilitated retention of focused words rather than salient alternatives. We suggest that, consistent with recent linguistic accounts, cognitive and mnemonic effects vary across contrastive focus markers as a function of properties such as exhaustivity.

Keywords: [focus; memory; reading; text integration]

Language comprehension relies on multiple levels of integration. Comprehenders must integrate the most recent proposition with previous statements, with prior knowledge, and with contextual information. Through the integration process, the comprehender constructs a *situation model*, or mental representation of the discourse (van Dijk & Kintsch, 1983). Discourse cues can facilitate this integration process by reactivating concepts that are no longer in working memory so that they can be more easily integrated with the current text (Myers & O'Brien, 1998; van den Broek, Beker, & Oudega, 2015).

One linguistic mechanism which may facilitate integration and retention of discourse is contrastive focus. A linguistically focused item is particularly salient to comprehension, and additional attentional resources may be devoted to processing it (Birch & Garnsey, 1995; Cutler & Fodor, 1979). *Contrastive* focus indicates that alternatives to the focused object are additionally relevant to comprehension (Rooth, 1992; Krifka, 2008). As such, in comprehending a word marked by contrastive focus, the comprehender may interpret both the word and its alternatives as salient (Krifka, 2008; Zimmerman & Onea, 2011). For example, (1) below sets up a story which initially involves a bear and a rabbit, but as the story continues in (2a), only behavior of the bear is specified, leaving open the question of what, if any, information about the rabbit should be integrated into the situation model. Focus, in this case, is ambiguous. The reader could interpret either *bear* or *eating our food* as the focus of the sentence. In (2b), on the other hand, the *it*-cleft marks *bear* as being *in focus* and this creates a role for *rabbit* such that it becomes an alternative against which *bear* is evaluated (Zimmerman & Onea, 2011). The implication becomes that what is most salient to comprehension is that is the bear and not the rabbit that is eating the food (cf. Büring & Kriz, 2013; Destruel & DeVeaugh-Geiss, 2018; Horn, 1981; Kiss, 1998; Rooth, 1999; Velleman et al., 2012; DeVeaugh-Geiss, Zimmerman, Onea, &

Boell, 2015; Zimmerman & Onea, 2011). The *it*-cleft has marked the rabbit's behavior as contrastively related to that of the bear. But does the use of the *it*-cleft have cognitive implications for what is encoded and retained now that *rabbit* and *bear* are contrastively linked?

(1) When we arrived back from our hike, a bear and a rabbit were near our picnic.

(2a) The bear was eating our food.

(2b) It was the bear that was eating our food.

Growing evidence, reviewed in detail below, suggests that several markers of contrastive focus can indeed enhance long-term memory for a discourse (Birch, Albrecht, & Myers, 2000; Fraundorf, Benjamin, & Watson, 2013; Fraundorf, Watson, & Benjamin, 2010; Gotzner & Spalek, 2019; Husband & Ferreira, 2016; Sanford, Sanford, Molle, & Emmott, 2006; Singer, 1976; Spalek, Gotzner, & Wartenburger, 2014; Sturt, Sanford, Stewart, Dawydiak, 2004). However, contrastive focus markers span a range of linguistic devices and each may carry different implications for interpretation of the discourse (Delin, 1995; Destruel & DeVeaugh-Geiss, 2018; Zimmerman & Onea, 2011). Further, it is not even clear that contrastive focus is critical to generating the enhanced representation, since contrast can be created without placing any particular item in focus through the presence of adversative connectives (e.g., *but*; Umbach, 2005). Thus, in the present study, we extend prior research by testing (a) *what* specific text characteristics related to contrast are necessary to produce a mnemonic benefit, and (b) *how* memory representations are altered by contrastive text characteristics.

The Variability and Exhaustivity of Contrastive Focus

Before considering the cognitive effects of contrastive focus on memory for a discourse, we first review what linguistic theories have established about contrastive focus. Although precise theories differ in ways that we discuss below, virtually all linguistic accounts agree that *contrastive focus* is a semantic property that relates an utterance to a larger set of possible, contrasting alternatives (Destruel & DeVeaugh-Geiss, 2018; Kiss, 1998; Krifka, 2006, 2008; Rooth, 1985; 1992; 1996). For example, returning to the example from (2c; *It was the bear that was eating our food*), the cleft highlights the fact that it was specifically *the bear,* and not *the rabbit* introduced earlier, that was eating the food. Contrastive focus can be marked through exclusive focus particles (e.g., *only*), clefts and pseudo-clefts, contrastive pitch accents (L+H* in the ToBI system for intonational transcription of English; Beckman & Elam, 1997; Silverman et al., 1992), reduplication (Huang, 2015), or any other marker which suggests a proposition is true for a subset to the exclusion of a larger contextually relevant set of alternatives.

Critically, some recent accounts of focus (e.g., Zimmerman & Onea, 2011) suggest that the core meaning of focus may simply be to introduce alternatives against which the utterance is to be evaluated, with the specific interpretation of those alternatives determined by context. As a result, different markers or realizations of contrastive focus may be interpreted differently.

For instance, one particular property that has been suggested to vary across realizations of contrastive focus is *exhaustivity*; that is, whether the focused item is a complete (exhaustive) subset of the larger set of possible alternatives. Some realizations of contrastive focus imply exhaustivity less absolutely than others. Returning to the example from (2c; *It was the bear that was eating our food*), the cleft marks *the bear* as an exhaustive subset from the larger group *a bear and a rabbit*; that is, the bear was the *only* animal eating the food, and therefore, the rabbit was not eating the food. However, the exhaustivity created in (2c) can be canceled (Destruel & DeVeaugh-Geiss, 2018; Kiss, 1998; Zimmerman & Onea, 2011), as in (3a).

By comparison, an exclusive focus particle (e.g., *only*; Destruel & DeVeaugh-Geiss, 2018; Zimmerman & Onea, 2011)[1] carries a stronger implication of exhaustivity that *cannot* be negated. For example, (3b) does not make sense because the focus particle *only* carries a more definitive implication of exhaustivity than the cleft. Thus, the focus particle makes an exhaustive meaning explicit whereas a cleft merely implies exhaustiveness (Büring & Kriz, 2013; Velleman et al., 2012) such that the implied exhaustiveness of the cleft may be negated in later text (Destruel & DeVeaugh-Geiss, 2018; Zimmerman & Onea, 2011).

(3a) It was the bear that was eating our food. The rabbit was eating the food, too.

(3b) Only the bear was eating our food. The rabbit was eating the food, too.

Focus and Salience in Discourse Memory

Does contrastive focus—and differences in its realization—have consequences for how people encode and remember discourses? There is reason to think so. Words and syntactic structures do not only convey meaning in the moment; they can also serve as "processing instructions" (Givón, 1992) for what should be attended to and remembered for the future. Consistent with this principle, several studies have demonstrated that memory for particular details in a discourse is enhanced by devices that place those details in *contrastive focus*; these devices include contrastive pitch accents (Fraundorf et al., 2010; Morett & Fraundorf, 2019; Sanford et al., 2006), font emphasis (Fraundorf et al., 2013; Sanford et al., 2006), clefting (Almor & Eimas, 2008), and focus particles, such as *only* (Spalek et al., 2014).

We review the paradigm introduced by Fraundorf et al. (2010) in detail because it motivated the design of the present experiment. Fraundorf et al. had participants listen to spoken

[1] A complete overview of this debate is beyond the scope of the current study. However, we note that whether or not the realization of contrastive focus is prompted from the focus marker itself or the marker in combination with its context is a current, open debate (see Krifka, 2008 for an overview).

discourses, such as (4), in which two pairs of contrasting alternatives (e.g., *British*/*French* and *Indonesia*/*Malaysia*) were introduced over the course of one or more context sentences. A critical sentence followed the context sentence in which one word of each contrast set (target words marked in all capital letters here) received either a contrastive pitch accent or a standard presentational accent (H* in ToBI). After listening to all of the passages, participants took a memory test in which they were asked to respond *True* or *False* to probes about the critical sentence. The memory test included three types of probes: false statements about the salient alternative (5a), false statements about an unmentioned item (5b), or true statements about the target word (5c).

(4) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys. Finally, the BRITISH spotted one of the monkeys in INDONESIA and planted a radio tag on it.

(5a) The French biologists spotted one of the monkeys and planted a radio tag on it.

(5b) The Dutch biologists spotted one of the monkeys and planted a radio tag on it.

(5c) The British biologists spotted one of the monkeys and planted a radio tag on it.

Critically, if the effect of contrastive pitch accents relative to presentational pitch accents was to enhance memory of the target word itself, it should have improved participants' ability to reject all false items by virtue of being able to better identify that they are not the target word. However, if contrastive pitch accents facilitated memory for a specific salient alternative, then correct rejection of that alternative, such as (5a), would benefit from contrastive pitch accents, but other false statements, such as (5b) would not. The latter result is exactly what Fraundorf et al. found. It follows, then, that correct rejection of the salient alternatives was not due to improved memory for *British* but instead to forming a memory representation for *not French.*

The realization of contrastive focus through pitch accents led comprehenders to remember a particular salient alternative to the true proposition. Such evidence suggests that markers of contrastive focus prompt the comprehender to encode the entirety of the contrastive relationship—both what is true and what is not.

These and similar results have been taken as evidence that the realization of contrastive focus improves retention of salient alternatives through reactivating those alternatives as part of evaluating the focused item (Fraundorf & Benjamin, 2015; Fraundorf et al., 2010, 2013, Fraundorf, Watson, & Benjamin, 2012; Gotzner & Spalek, 2019; Gotzner, Spalek, & Wartenburger, 2013; Husband & Ferreira, 2016; Lee & Fraundorf, 2017; Spalek, Gotzner, & Wartenburger, 2014). However, as we noted above, different markers of contrastive focus may be interpreted differently, so it is important to test a wider range of contrastive focus devices which will help to isolate the features of contrastive focus which promote comprehenders to encode alternatives. In English[2], *it*-clefts are well suited to this task. As detailed in the previous section, they differ from previously tested contrastive markers (contrastive prosody and exclusive focus particles) in that they do not mandate exhaustivity (DeVeaugh-Geiss et al., 2015; Zimmerman & Onea, 2011), and they further have a broader range of use which does not always necessitate the presence of alternatives (e.g., Delin, 1995). If the previously observed mnemonic effects are effects of contrastive focus per se, we should observe similar effects from *it*-clefts, whereas if they are effects specifically of exhaustiveness, *it*-clefts may have different effects on comprehension.

[2] The extent to which clefts may be realized as contrastive varies across languages (Destruel & DeVeaugh-Geiss, 2018). In the current study, we test the cognitive effects of clefts as a marker of contrast in English. We do not comment on the cognitive effects of clefts in languages in which clefts may be realized differently.

A third possibility is that, if better memory is promoted via evaluating a true item against its salient alternatives, apparent memory benefits of contrastive focus may not be incumbent on focus at all but in fact result from anything that suggests contrast. We use the term *contrast markers* to refer to any device that alerts comprehenders to a contrastive relationship between entities or propositions. As previously discussed, contrastive focus markers are one method to establish contrast across a set of constituents; however, other devices also mark contrast without marking a single concept as important and focused (Birch & Garnsey, 1995; Birch, Albrecht, & Myers, 2000; Kaiser, 2010). It is plausible that any marker of contrast connectives, could facilitate memory for discourse regardless of focus if they indicate that it is important for comprehension to represent alternatives or increase the specificity of the encoding of true information to distinguish it from alternatives. For instance, *adversative connectives* (e.g., *but* or *however*) mark contrast insofar as using adversative connectives in non-contrastive sentences prolongs reading times and leads to lower ratings of coherence (Murray, 1997). But, adversative connectives do not mark a particular portion of a sentence as focused; they only suggest two propositions are negatively related and that the second proposition negates the first (Jasinskaja, 2012)[3]. Indeed, in a pilot study discussed below, we found that adversative connectives communicated the presence of a contrast without localizing or focusing this contrast. Nevertheless, adversative connectives involve a search for mismatching information in the prior text, which may prompt reactivation of salient alternatives to the contrasted clause (Lee & Lee,

[3] Although there is little argument that *but* indicates some type of contrast, the exact nature of that contrast in English (and other languages) is an open debate. On one end, the meaning of *but* is believed to be ambiguous and to require information from context or other elements of syntax for interpretation (e.g., Izutsu, 2008). On the other end, *but* can communicate a number of meanings including semantic opposition, denial-of-expectations, topic change, or concession (Umbach, 2005). In the middle are attempts to find a unified core meaning (e.g., Winterstein, 2012). As with clefts, a complete analysis of the core meaning of *but* is beyond the scope of this study though a brief overview of the current positions can be found in Winterstein (2012). For the purposes of this paper, we consider only that *but* and other adversative connectives carry a contrastive meaning that is not focused on a particular constituent within the sentence.

2005). If adversative connectives promoted memory for salient alternatives, it would suggest that contrast is sufficient to promote tandem encoding of two contrasted entities.

Do adversative connectives benefit memory? Although causal connectives reliably enhance memory (e.g., Cevasco & van den Broek, 2008; Trabasso & van den Broek, 1985), adversative connectives have not been found to consistently do so (cf. Caron, Micko, & Thüring, 1988; Cevasco, 2009; Cevasco & van den Broek, 2013; Lee & Lee, 2005; Miller & Just, 1994; Murray, 1995, 1997). One possibility for these mixed findings may be that the research has focused on the constituent immediately following the connective. It may be that adversative connectives increase memory for entities mentioned previously in the discourse. *But*, in particular, may suggest a confirm/deny relationship (Jasinskaja & Zeevat, 2008; Umbach, 2004; Zeevat, 2012) and as such make the information about the confirmation relevant only against the backdrop of what has been denied. Under this line of thought, adversative connectives and all other contrastive devices may enhance memory for salient alternatives regardless of focus.

Thus, at least three different properties could account for putative memory benefits of contrastive focus: (a) only those forms of contrastive focus that mandate exhaustivity, (b) any form of contrastive focus, or (c) contrast more broadly, without the implication of focus. To address this, in the present study, we tested the effects of two manipulations—*it*-clefts and adversative connectives—that both mark contrast but vary in whether they establish focus.

Memory for Contrastive Relationships

Above, we have considered what properties may determine *whether* the memory benefits of contrastive focus occur. A separate—but related—question is *how* a comprehender's situation model changes as a result of these markers. The granularity hypothesis proposes that the realization of focus benefits memory because the focused item is retained at an increased level of *granularit*y, or the degree of specificity of its semantic representation (Hobbs, 1985; Sanford et al., 2006; Sturt et al., 2004). For example, in (2a) *bear* can be thought of and retained at the coarse-grained level of *animal* since it is important to the story that an animal ate all of the food, but it is not as important which animal ate all of the food. However, in (2b), *bear* is in contrast to an alternative in which the rabbit ate the food. In this case, a more finely grained semantic representation is warranted to differentiate the focused *bear* from the alternative *rabbit*. As a result, the specifics are more finely encoded and remembered more precisely.

But which constituent, the true item or its alternative, receives the benefit from the finer-grained encoding? Under one hypothesis, evaluating the true item against the backdrop of the alternative leads to the true item being encoded with greater specificity whereas under a separate hypothesis, this evaluation process results in the alternative becoming encoded in greater detail and linked to the representation of the true item.

Evidence from experiments manipulating contrastive focus have thus far supported the latter possibility: It is the alternativethat receives the finer-grained encoding (e.g., *French* in example 4). When contrastive pitch accents are applied to a target word, salient alternatives become active and this activation persists longer than for non-contrastive semantic associates (Braun & Tagliapietra, 2010; Husband & Ferreira, 2016). Further, this sustained activation extends to subsequent memory. When contrastive pitch is applied to a target word or the target word is preceded by a focus particle (e.g., *only*), comprehenders better retain a previously mentioned salient alternative (Fraundorf et al., 2010; Spalek et al., 2014).

However, as we discuss above, different realizations of contrastive focus may be interpreted differently. Indeed, contrary to effects of contrastive pitch accenting, Gotzner et al. (2013) found that the combination of focus particles and contrastive accenting did not target previously mentioned (salient) alternatives and instead activated a larger set of alternatives (as assessed in a probe recognition task) than either device on its own. This result implies that, although several different devices have been previously viewed as establishing contrastive focus, they may in fact have different effects on memory. This suggests a need to compare the effects of specific markers of contrast to determine what—if any—principles may generalize across them.

In particular, given that contrastive pitch accents and focus particles suggest complete exhaustivity (Chevallier et al., 2008; Gotzner & Spalek, 2014), the encoding of salient alternatives in prior studies was driven by the stronger implication of exhaustivity provided by those devices. But because a weaker implication of exhaustivity could later be canceled, comprehenders may be less likely to search for the alternative antecedent upon encountering other, different realizations of contrastive focus that only weakly imply exhaustivity—such as clefts. Under this account, comprehenders do not encode alternatives for *all* markers of contrastive focus but rather are sensitive to the probability that the contrast can be negated, making the inference regarding the alternatives only when they are certain that alternative information is indeed in contrast with the focused items.

Thus, in this study, we test whether the finding that some contrastive focus markers lead to a finer-grained encoding of salient alternatives can extend to markers which convey less exhaustivity (i.e., *it*-clefts instead of focus particles), or if variance in the way readers realizes contrastive focus changes *what* is encoded (the alternatives or the true item).

Effects of Focus on Non-Focused Words

A third question of interest in the prior work was how contrastive focus would affect integration and retention of other, non-focused entities. The realization of contrastive focus may in part require increased attentional resources being placed on the focused entity (Birch & Garnsey, 1995; Cutler & Fodor, 1979; Sedivy, 2002). Placing increased attention on one entity within a sentence could have consequences for other entities in the sentence that are not in focus and that may be perceived as less important by comparison (Birch et al., 2000; Birch & Garnsey, 1995; Delin, 1995). For example, in comparison to (7), sentence (6) not only focuses *bird* but *de*focuses *ate the fruit* (Birch et al., 2000). The presence of the focus on one entity in the sentence reduces the comparative focus on other parts of the sentence. This raises the question of whether such non-focused entities in sentences with cleft constructions receive less attention due to increased attention being dedicated to the focused entity—as compared to (7) which leaves focus ambiguous in that bird, fruit, or the entire event may be given focus by the reader.

(6) It was the bird that ate the fruit.

(7) The bird ate the fruit.

Indeed, this concern marks the early literature on clefting, in which reading time and memory effects for focused entities were often compared to a *de*focused entity (Almor, 1999; Almor & Eimas, 2008; Bredart & Modolo, 1988; Cowles & Garnham, 2005; Singer, 1976) or to other non-focused words in syntactically different positions of the sentence from the focused word (Birch & Garnsey, 1995; Birch & Rayner, 1997). These comparisons make it unclear whether reading time and retention effects were driven by facilitation of the focused word, a cost to the defocused or non-focused word, or both (Birch et al., 2000; Birch & Rayner, 2010; Lowder & Gordon, 2015). Birch et al. (2000) addressed this concern by asking participants to make speeded recognition judgments following a sentence in which a target word received contrastive focus, as in (6), or following a neutral version where the same sentence was presented without contrast markers, as in (7). They found that placing the probed word in focus facilitated response times given a sufficiently long stimulus onset asynchrony. This finding suggested that the memory trace for a focused word was stronger than for the same word in a neutral context.

Thus, studies comparing contrastive focus to focus-neutral sentences suggest that at least part of the focus effects reflect a *benefit* of focus relative to a neutral context. However, it remains unclear if the presence of focus also imposes a cost on non-focused concepts. If increased memory for focused entities reflects increased attention to them, there may be a reciprocal effect of diminished attention to other, non-focused details within the same sentence. On the other hand, focusing one contrast set may not detract from retention of non-focused entities. Here, we test these competing possibilities by comparing retention of non-focused words in focus and focus-neutral conditions.

Online Processing of Contrast

Lastly, we consider the effect of contrast markers on reading times. If contrast markers make it easier for comprehenders to create relationships across sentences, reading times for the target word may decrease for a word in a cleft or following a connective (Birch & Rayner, 2010). On the other hand, conditions that facilitate long-term memory often require more difficult or effortful processing initially (McNamara, Kintsch, Songer, & Kintsch, 1996; Schmidt & Bjork, 1992), and contrast markers may facilitate memory precisely because they lead to longer, more effortful processing. Finally, of course, a third possibility is that these cues do not affect initial reading time: One view of online reading is that reading time is primarily controlled by word identification (Reichle, Rayner, & Pollatsek, 2003), and from that perspective, variance in online reading times largely reflects the time needed to reach an adequate level of word identification, not how deeply the sentence is being processed.

To date, evidence addressing this question is mixed, with connectives and clefts showing diverging results. Although adversative connectives have been linked to decreased reading times (Millis & Just, 1994), reading times for words in a cleft have been generally shown to increase (Almor, 1999; Birch & Rayner, 1997; Lowder & Gordon, 2015). For instance, Lowder and Gordon (2015) found that reading times for words focused by a pseudocleft, as in (8), increased when compared to reading times for the same word in a focus-neutral condition. They speculated that the increased processing time is what facilitates memory for the focused words. However, phoneme detection was *faster* when an item was focused (Cutler & Fodor, 1979), and changes made to a focused word during reading were more likely detected despite participants not spending a significantly longer time reading these words (Ward & Sturt, 2007). Further, Birch and Rayner (2010, Experiment 3) found the opposite results of Lowder and Gordon: Reading times for critical words following *it*-clefts were generally faster than in focus neutral conditions.

(8) What the secretary typed was the official memo about the new office policy.

At least two confounding factors might account for these differing results across studies. The first is word position within the sentence: Lowder and Gordon (2015) point out that in the Birch and Rayner (2010) materials, the cleft pushed the target word further into the passage. Since reading times have been shown to be longer for words at the beginning of a sentence (Ferreira & Henderson, 1993; Haberlandt, 1984), this might account for the speeded processing of the clefted items in that study. Lowder and Gordon therefore moved the location of the target word (e.g., *memo*) deeper into the sentence, as in (8), and compared this both to a *de*focused condition in which the pseudocleft was replaced by an *it*-cleft and to a focus neutral condition which omitted a cleft but included an adverb (e.g., *Yesterday*) at the start of the sentence in order to hold constant the position of the target word within the sentence. When the target word was held in a constant position across conditions, reading times increased in the focus (i.e., pseudocleft) condition.

A second key difference between studies finding faster processing of focused words (Birch & Rayner, 2010; Cutler & Fodor, 1979) and the Lowder and Gordon (2015) study is context. The former studies provided a contextual sentence prior to the one containing focused entity whereas the Lowder and Gordon study used a single sentence, providing only the focused information and not the context. This could have resulted in processing disruptions because clefts do not typically appear as the first entity in a discourse (Almor, 1999) and do typically refer to previously mentioned entities (Delin, 1995; Destruel & DeVeaugh-Geiss, 2018; Kiss, 1998). Therefore, beginning an isolated sentence with a cleft may increase reading times because processing is disrupted by the absence of expected contextual information.

In the current study, we included context sentences prior to the cleft. Further, we included whether or not the word was at the beginning of the sentence as a predictor in our statistical models with the aim of controlling for sentence-position effects that may be confounded with the presence of a cleft. These controls allow us to test for differences in reading time across condition. In order to test Lowder and Gordon's (2015) claim that *longer* reading times within a cleft lead to enhanced memory performance, we also examined the relationship between reading time and memory *at the level of individual trials*. If increased time spent encoding the focused information is responsible for the increased retention, we might expect to see a relationship between reading time and memory such that longer reading times predict better memory.

Current Study

To investigate the topics outlined in the previous paragraphs, we conducted three experiments that tested participants' memory for texts that contained a contrast between a referent (e.g., *Indonesia* in (9) below) and its salient alternative (e.g., *Malaysia*). We examined the effect of contrastive focus and adversative connectives on retention of focused and non-focused entities. If focus drives the memory benefits of contrastive focus found in prior studies using other markers of contrastive focus, we should expect to see that clefts, which provide contrastive focus, increase retention of salient alternatives, but that adversative connectives, which indicate contrast without focusing a specific element of the text, do not. If, on the other hand, it is the contrastive nature of contrastive focus that drives encoding of the salient alternatives, we should expect to find that both clefts and adversative connectives facilitate memory for salient alternatives.

Further, if contrastive focus diverts attention away from non-focused entities, we should expect to see diminished retention of non-focused target words in clefted sentences as compared to non-focused targets in sentences without a cleft. We thus included two contrasts in each passage. In cleft conditions, the first contrast was *in focus* but the second contrast was not. For all other conditions, neither contrast set was focus marked. This additional manipulation allowed us to determine if effects of contrastive focus were due to facilitatory effects on the focused word, deleterious effects to the non-focused word, or both. It had the additional benefit of allowing us to test if effects of contrast alone can apply broadly across multiple contrasts in a sentence.

In Experiment 1, we orthogonally manipulated the presence of *it*-clefts (contrastive focus) and adversative connectives (contrast without focus) and assessed their effects on the retention of the target words. To preview, we found some preliminary evidence that each of these devices contributes to recognition memory. We thus conducted two further experiments to individually examine clefts (Experiment 2A) and adversative connectives (Experiment 2B) to determine *how* they might contribute to recognition memory: by driving encoding and retention of salient alternatives or of the focused item itself.

In all three experiments, we also measured reading times to determine if the conditions that enhance retention are initially processed more quickly, more slowly, or no differently—and, indeed, if any differences in reading times at the trial level predicted retention of those trials.

We supplement null-hypothesis significance testing with Bayes Factors analyses, which (unlike conventional, frequentist methods) can provide evidence for the absence of an effect; e.g., that focusing one item does *not* affect memory for other, non-focused items. A Bayes Factor (BF) is a ratio of the likelihood of one model compared to the likelihood of another and can be used to support the null (BF_{01}) or the alternative (BF_{10}) hypothesis (Jarosz & Wiley, 2014). Further, unlike *p* values, the *BF* obtained for a given hypothesis can be used to determine how much relative support there is for each model. For example, $BF_{01} = 3$ indicates that the null hypothesis is 3 times more likely than the alternative. We adopt the language of Jeffreys (1961) and describe $BF > 3$ as substantial evidence for one model over another, $BF > 10$ as strong evidence, and $BF > 100$ as decisive evidence. We computed a *BF* for all variables of theoretical interest. In addition to allowing us to provide support for the null, use of *BF* for the alternative hypothesis allowed us to avoid relying solely on a binary threshold for significance and to examine the degree of support for each hypothesis.

Experiment 1

In Experiment 1, we tested whether each of two contrast markers—*it*-clefts and adversative connectives—contribute to long-term memory for a text. Although both of these devices suggest contrast, only clefts focus a particular element. The intuition that adversative connectives do not focus a particular element of a sentence was supported by a pilot study. We presented a separate group of participants ($N = 29$) with the passages from Experiment 1 that either included an adversative connective or no contrast marker, as outlined in (9) and (10) below. Participants were asked to identify which of a set of three contrasts they believed were most important to the purpose of the texts. Two of the answers specified the contrast between one of the two target words and its salient alternative (e.g., *The British, not the French, found the monkey in one of the countries.*). A third answer was more general and did not specifically mention either target word (e.g., *only one group of researchers found the monkey in one location*). In texts with adversative connectives, the odds of participants selecting the third general option were 1.39 times (96% CI:[1.04, 1.87]) greater than in no connective conditions, $z = 2.24$, $p = .03$. This suggests that, as would be expected based on recent linguistic analysis of the implicatures of *but* (Umbach, 2005; Jasinskaja, 2012), the adversative connectives contrast the clause as a whole with the preceding clause rather than placing focus on any specific details.

The fact that connectives do not focus a particular constituent raises the possibility that they might benefit memory only in *combination* with a focusing device that highlights a particular contrast. Further, we speculate that adding an adversative connective to an already clefted constituent may increase the extent to which the cleft is realized as contrasting an earlier alternative. We thus orthogonally manipulated the presence of clefts and adversative connectives so that we could assess the effects of each device individually as well as any possible effect of the combination.

Method

Participants. To determine an appropriate sample size, we conducted a power analysis for a within-factor repeated measures ANOVA (using G*Power version 3.1.9.3; Faul, Erdfelder, Lang, & Buchner, 2007); our planned mixed-effects model with subject and item random effects should if anything have greater power than the corresponding by-subjects ANOVA (Baayen, Davidson, & Bates, 2008, p. 404; Quené & Van den Bergh, 2004). Given an estimated effect size of Cohen's $d = 0.15$ from the first 8 participants, the power analysis indicated that 80% power required a minimum N=59. Students (N=63, 35 female, M age = 19.2 years) at the University of Pittsburgh participated online in partial fulfillment of a course requirement. All participants were required to be native American English speakers. Four participants were excluded because their mean reading times (RTs) were less than 100 ms per word, which we considered too fast for meaningful processing in a moving window paradigm; supporting this interpretation, these participants' subsequent memory performance was at or below chance. This left 59 participants for analysis.

Materials. Eighty (60 critical, 18 filler, 2 practice) texts and 120 memory probes were created or modified from Fraundorf et al. (2013). Each critical text began with one to four *context sentences* that presented two sets of paired words in the context of a short, fictitious story, such as the pair *British* and *French* and the pair *Malaysia* and *Indonesia* in (9). Each text then continued with a *critical sentence*, which referred to one word from each pair, such as *British* and *Indonesia* in (9), which we term the *target words*. By contrast, we term the other words in each set (i.e., *French* and *Malaysia*) the *salient alternatives* because these words represent plausible alternatives to the target word in the discourse. Some texts concluded with an additional sentence.

(9) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys. The British spotted one of the monkeys in Indonesia and placed a radio tag on it. (neutral)

(10) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys. However, the British spotted one of the monkeys in Indonesia and placed a radio tag on it. (adversative connective)

(11) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys. It was the British who spotted one of the monkeys in Indonesia and placed a radio tag on it. (*it*-cleft)

(12) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys. However, it was the British who spotted one of the monkeys in Indonesia and placed a radio tag on it. (adversative connective and *it*-cleft)

We created four versions of each text by orthogonally varying the presence or absence of an adversative connective and the presence or absence of an *it*-cleft at the start of the critical sentence, as demonstrated in examples (9) through (12) above. We refer to the absence of a connective and *it*-cleft as the *neutral condition*. Because we wanted our conclusions to generalize across the set of adversative connectives and our text to be as natural as possible, the adversative connectives varied across texts and included *but*, *however*, *yet*, *nevertheless*, and *instead* in equal numbers. (We revisit this point in the Discussion.) No other connectives or clefts were present in any of the critical texts. No clefts or adversative connectives were used in the filler texts, but filler texts did contain other types of connectives, such as causal or temporal connectives.

As noted above, one of our research questions was whether focusing one part of the discourse would decrease memory for non-focused elements. To test this, each critical sentence included two target words such that, when a cleft was present, the first target word would be focused (e.g., *British* in [11] and [12] above) and the second target word would be outside of focus[4] (e.g., *Indonesia*).

For the memory test, we constructed 120 recognition memory probes, one testing each target word, as in (13) and (14). Each probe was presented in a two-alternative forced choice format, where the answer choices were the target word and its salient alternative. The order of the two choices was randomized for each item and each participant. A full list of items and memory probes is available in Appendix B of the Online Supplement.

(13) The _______ scientists spotted the endangered monkey and tagged it.

1. British 2. French

(14) The endangered monkey was finally spotted in _________.

1. Malaysia 2. Indonesia

This resulted in a 2 x 2 x 2 design (cleft x connective x location) with the first two variables varying within participants and within items, and location of the target word in the sentence varying within participants but between memory probes. There were two probes for each passage, and each probe asked about one word from the passage, either the focused or non-focused target word. All materials were presented using IBEX version 2.6.5 (Drummond, 2014).

[4] For nine items, the non-focus target word followed soon after the focus target word and could be considered part of the focused phrase (e.g., *specials* in "The Mexican restaurant's specials …"). For six other items, the non-focus target word came before the word "that" in the sentence and was therefore part of the extended subject phrase (e.g., *kitchen* in "The pests in the kitchen..."). Nevertheless, excluding these 15 items did not change the significance of any of the results reported here.

Procedure. Participants read instructions that told them they would read 80 texts and take a subsequent memory test based on what they read. To discourage participants from adopting a task-specific reading strategy, the instructions did not indicate the exact format of the test or type of information that participants would be expected to remember.

The experiment began with a study phase in which participants read each text one at a time. To collect reading times (RTs), the texts were presented via a self-paced moving-window task (Just, Carpenter, & Woolley, 1982), in which each word in the text was replaced with a horizontal line of the same length as the word. Participants pressed the space bar to display the next word in the passage and hide the previous word. Two practice texts were presented first to familiarize participants with the task.

After participants had read all 80 texts (M = 29.54 minutes), the test phase began. Participants were presented with a set of 60 probes, each testing only one of the two target words from a text. Half of the probes concerned the focused target word and half the non-focused. Each probe was presented on its own screen. Participants selected their answer by clicking on their choice or pressing a corresponding number on their keyboard. After completing the first 60 probes, they were then presented with an additional 60 probes, each about the other target word. Each set of probes were presented in the same order as in the study phase, which held the time between study and test roughly constant; since the items were presented in the same order to all participants, any remaining differences between items in their retention interval would be captured in our statistical analysis by the item-level random effects.

Analytic Strategy. We analyzed the data using mixed-effect models. Fixed effects for all models in Experiment 1 included the presence of adversative connectives or clefts, the location of the probed target word within the critical sentence (e.g., *British* occurs before

Indonesia), and their interactions. We contrast-coded all fixed effects to obtain estimates of main effects analogous to those from an ANOVA. The exception was in the models of reading time, where the three levels of location (1st target, 2nd target, or non-target) were treatment-coded so as to compare each target word to the mean RT for all non-target words. This comparison allowed us to test whether the effects of our manipulations were specific to the target words or affected reading more generally.

All models included random intercepts for participants and items. (For models of recognition memory, each memory probe constituted an item; for models of reading time, each item was a text.) Models with the maximal random effects structure did not converge; thus, we sought a random-effects structure supported by the data (Matuschek, Kliegl, Vasishth, Baayen, & Bates, 2017). For memory models, no random slopes by participants or by items significantly improved the fit of the model, all *p*s > .20, so we report results from a model that included only random intercepts. For reading time models, models with random slopes by subject and items for location or for cleft and connective presence converged. We report results from the latter because it had a lower AIC value and included the variables of primary interest, clefting and connective presence; nevertheless, model choice did not affect the significance of the variables.

All models used across experiments were fit in the R Project for Statistical Computing with the packages *lme4* (Bates, Maechler, Bolker, Walker, 2015) and *lmerTest* (Kuznetsova, Brockhoff, & Christensen, 2017). Simple effects were analyzed using the emmeans package (Lenth, 2019). Bayes Factors were obtained using *brms* package (Bürkner, 2018) with improper flat priors over the real numbers. We used flat priors rather than an informative prior because, although similar studies have been conducted using clefts and connectives, those studies are either not similar enough to this one or the results across studies are not uniform enough to warrant a strong informative prior[5]. Sampling iterations for the Bayesian model were increased until they yielded a stable Bayes Factor. We settled on 4,000 iterations with 1000 used during warm-up for each of 4 chains, resulting in 12,000 samples used to calculate the BF. The bayes_factor() function was run five times for each outcome and accepted as stable when the difference among the *BF*s was relatively small (< 0.1 in most cases); we report the mean of the five results from the function in all cases. As further confirmation of the stability of the resulting values, we computed BF_{10} separately and confirmed that it was (as it should be) the inverse of BF_{01} in all cases. *BF*s are provided for all variables and interactions of a priori experimental interest.

Results

Reading time. Reading times (RT) longer than 2000 ms on an individual word were removed (0.4% of words) because they were not likely to be related to reading processes. Reading times less than 100 ms (4.1% of words) were also removed because this was insufficient time for the word to be read (Just et al., 1982). RTs were positively skewed (skewness = 2.00), so we log-transformed RTs (skewness = 0.53) to create a more normal distribution.[6]

We then calculated residual reading times (RRT) to control for eight variables known to affect reading time by fitting a mixed-effects model to the log RTs on the words in the filler

[5] Because *BF*s can be sensitive to priors (Lee & Wagenmakers, 2014), we conducted a sensitivity analysis to determine how a range of increasingly informative priors affected the *BF*s. In Experiment 1,we set the priors to *Normal*(0, *SD*) with *SD* = 0.10, 0.50, or 1.00; in Experiments 2A and 2B, we did the same but also tested *M*s and *SDs* obtained from Fraundorf et al. (2013, Table 5) which used a similar paradigm and experimental materials. Nicenboim, Vasishth, and Roesler (2020) found that as priors become stronger (e.g., *SD* = 0.10), *BF*s approached 0. We found this same pattern in our results, though at times an effect persisted even with a strong prior. However, at higher *SD*s, *BF*s were either equivalent to those obtained with the default priors set by the *brms* function. We thus report the *BF*s obtained under the default priors.

[6] Because log RTs can in some cases skew results with interactions (Balota, Aschenbrenner, & Yap, 2013; Lo & Andrews, 2015), we also ran an independent model using residual reading times without the log transformation. Model choice did not affect the significances of the primary outcomes. However, the model without the log transformation had additional marginal effects. We report the more conservative log-transformed model.

texts. First, we included the length of the word, as per the traditional residual reading time analysis (Ferreira & Clifton, 1986), $t(57.09) = 5.32$, $p < .001$. Second, we included the log-transformed number of texts the participant had read to that point because reading times tend to decrease in self-paced moving window paradigms as participants become familiar with the task (e.g., Fine & Jaeger, 2016), $t(53.56) = -9.24$, $p < .001$. Third and fourth, to account for longer reader times at the start (Ferreira & Henderson, 1993) and end (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989) of a sentence we included whether or not the word was the first, $t(58.33) = 7.30$, $p < .001$, or final, $t(57.13) = 1.88$, $p = .07$, content word in the sentence. Fifth, we included the log transformed serial position of the sentence within the passage, $t(57.62) = -7.23$, $p < .001$. Sixth and seventh, because our texts spanned several lines and reading times are affected by line breaks at both the beginning and end of a line (e.g., Kuperman, Dambacher, Nuthmann, & Kliegl, 2010), we included whether the word was the first, $t(57.94) = 7.65$, $p < .001$, or last, $t(58.28) = 2.73$, $p = .008$, word on a line. Although the critical words never appeared at the beginning or end of the line, we controlled for line breaks in constructing the model in order to more precisely estimate the other regression coefficients. The eighth variable indicated whether a word was the final word of the *text* (over and above effects of the last word of a sentence). Reading times for these words were significantly longer and may have captured pauses unrelated to reading processing, such as resting, $t(56.77) = 7.45$, $p < .001$. Each of these eight variables was also added as a random slope by participants.

Having fit the above model to the filler items, the resulting regression equation was used to predict log RTs for the critical texts; residual reading times were then calculated as the difference between the observed log RT and the predicted log RT. A comparison of the raw means (see Figure A1 in Appendix A of the Online Supplement) against the residual means (see

Figure 1) showed that the residualization process factored out any increase in reading times that might have resulted from the critical word being the first word in the sentence. Log RRTs greater than 3 standard deviations from the mean were removed (1.84% of words). This left 170,757 reading times in critical texts (6,621 of which were target words) still available for analysis.

Our primary interest was in reading of the target words[7] (e.g., *British* and *Indonesia*) and how they were affected by the presence of a cleft or connective. Figure 1 displays the mean RRTs for the target words which we compared to the aggregate of the non-target words as a function of clefting and connective presence.

Table 1 presents estimates of the fixed effects in terms of log RRTs; in the text, we back-transform effects in terms of RRTs (in ms) to facilitate interpretation[8]. Of primary interest were the effects of clefting and connectives on reading times. Across the sentences, there were no main effects of clefting or connective presence, all ps > .60. However, the presence of both a cleft and a connective in the same sentence decreased overall reading times by 0.99 times (95% CI:[0.98, 0.99]), $t(170{,}600) = -4.68$, $p < .001$. There were additional effects stemming from the interaction between the cleft and word location. That is, the combination of a cleft and an adversative connective did not affect reading times over and beyond the effect of a cleft alone. Specifically, when a cleft was present in the sentence, reading time on the first, focused target word decreased by 0.96 times (95% CI: [0.95, 0.98]), $t(170{,}400) = -4.80$, $p < .001$; by comparison, cleft presence did not significantly affect reading time on the second, non-focused

[7] Because effects on reading times are sometimes observed on the word following the critical region of interest (i.e., spillover effects), we also conducted additional analyses of the RRTs for the words following each critical word. There were no significant effects for any of the variables in the spillover regions, all ps > .05.
[8] Because we modeled log RRTs, effects are multiplicative rather than additive once back-transformed out of log space.

critical word, p = .16. That is, in the clefted sentence "It was the British who spotted the monkey in Indonesia," RRTs for the clefted target *British* were shorter than when the cleft was omitted. The Bayes Factor indicates decisive evidence for this effect, BF_{10} = 1,497.

Neither connective presence nor the interactions between word location and cleft and connective presence had a significant effect on RRTs, all ps > .05, BF_{01} > 8. Here, the Bayes Factors substantially support accepting the null hypothesis.

In sum, we found that the reading times for target words in the cleft *de*creased, but no other major differences in RTs between conditions emerged.

INSERT FIGURE 1 HERE

INSERT TABLE 1 HERE

Memory. Figure 2 displays mean recognition accuracy for each condition, separated by the location of the target word in the critical sentence. Table 2 displays parameter estimates from the mixed-effects model in terms of the log odds; to facilitate interpretation, in the text we discuss back-transformed estimates of effects on the odds.

Effects of clefting. Averaging across word position, clefting had only a marginal effect on recognition memory accuracy, z = 1.72, p = .09. Rather, clefting interacted with word position: The benefit of clefting for the focused target word (i.e., the word *focused* by the cleft) was 1.38 times (95% CI: [1.09, 1.74]) greater than for the second, non-focused word , z = 2.70, p = .007, BF_{10} = 1.34. However, the Bayes Factor analysis only provides anecdotal evidence in support of the interaction. To better understand this interaction, we conducted a simple-effects analysis to determine the effects of cleft presence on the focused and non-focused target word separately. When the target word was in the cleft, the odds of a correct response increased 1.30 times (95% CI: [1.10, 1.53]), z = 3.14, p = .002, BF_{10} = 25.17, with the Bayes Factor indicating strong support for the effect. Cleft presence did not, however, have a significant effect on the odds of correct memory for the non-focused target word, $p = .49$, $BF_{01} = 5.08$; indeed, the Bayes Factor indicates substantial support for the null hypothesis that cleft presence did *not* have an effect on recognition memory of the non-focused item. Further, the addition of an adversative connective to a sentence containing a clefted entity did not enhance recognition memory performance beyond the presence of a cleft alone, ps > .30. We can therefore conclude that a cleft increased recognition memory for the *focused* entity without harming memory for a later *non-focused* entity, and that this effect was driven by the realization of contrastive focus without additional benefit from the presence of an adversative connective.

Effects of adversative connectives. Adversative connective presence did not significantly increase the odds of a correct memory response overall, nor did it interact with any other variables, all ps > .10, $BF_{01} < 3$. However, the Bayes Factors for all values indicated only anecdotal support for the null hypothesis. One reason the evidence regarding connectives was weak may be that there was significant heterogeneity across connectives. Five different adversative connectives were used across texts, and although all the connectives represent some type of contrast, they each have slightly different meanings (Izutsu, 2007). The connectives also vary in their frequency (English Lexicon Project; Balota, Yap, Cortese, Hutchison, Kessler, Loftis, & Treiman, 2007): *but* (Log HAL frequency: 14.571), *however* (12.35), *yet* (11.98), *instead* (11.57), *nevertheless* (8.92). Indeed, examining memory performance as a function of the specific connective used (Figure 3) suggests some variance across connectives; recognition accuracy appeared higher than the control neutral condition, but only for the most frequent connectives: *but* and *however*.

To formally test this possibility, we conducted a post-hoc analysis of recognition memory but restricted our data to only the 24 texts for which *but* or *however* was used as the adversative connective[9]. For texts that could receive the *but* or *however* condition, connectives significantly enhanced recognition memory; these adversative connectives increased the odds of a correct response by 1.25 times (95% CI: [1.04, 1.51]), $z = 2.33$, $p = .02$, $BF_{10} = 3.34$. Unlike for clefts, this benefit was consistent for both critical words, and we did not find evidence for an interaction with word location, $p = .30$, $BF_{01} = 1.50$.

Summary. We found that clefting improved recognition memory specifically for the target clefted word; clefting neither improved nor diminished retention of a later non-focused word within the same sentence. We further found that retention improved for both target words following *but* or *however,* but that this effect was absent for other adversative connectives. Finally, we found that inclusion of an adversative connective at the start of a sentence containing a cleft did not affect subsequent retention beyond the presence of a cleft alone.

INSERT FIGURE 2 HERE

INSERT TABLE 2 HERE

INSERT FIGURE 3 HERE

Relation of Reading Times to Accuracy

Did the mnemonic benefits of clefts come about because (as suggested by Lowder & Gordon, 2015) participants spent longer reading focused words? This seems unlikely given that, on average, focused words were read *faster*, not slower. Nevertheless, to more directly test if time spent reading a target word during the study phase related to subsequent recognition

[9] We also tried restricting the analysis to *but* and *however* for our models of reading times and of accuracy as a function of reading time. In both cases, limiting the cases to only *but* and *however* did not significantly change the pattern of results.

memory accuracy, we updated the model of recognition accuracy to include as additional predictors the log RRT on the corresponding target word during the original study phase, as well as its interactions with the other critical variables of interest.

Table 3 reports fixed effects from this model. Reading time on the target word during the study phase did not predict subsequent recognition memory accuracy in general, p = .80, BF_{01} = 3.12, nor did it interact with cleft or connective presence, all ps > .50. Further, even when controlling for reading time, cleft presence significantly predicted higher memory accuracy for the first critical word, p = .02, BF_{10} = 6.32.

We did find one unexpected pattern. Log RRT interacted with connective presence and location such that as reading time of the focused target word increased, the odds of subsequent recognition accuracy decreased by 0.31 times (95% CI: [0.11, 0.87]), z = -2.21, p = .03, BF_{10} = 15.68. The addition of a cleft to the interaction further decreased the odds of a correct response by 0.12 times (95% CI: [0.02, 0.94]), z = -2.02, p = .04, BF_{10} = 14.02. In other words, the association of RRTs to subsequent memory differed depending on the location of the target word and the experimental condition: In the conditions where a connective was present, longer RRTs were associated with *de*creased odds of a correct response for an initial target word but *in*creased accuracy when the target word occurred later in the sentence. However, to preview, these effects did not replicate in subsequent experiments. We revisit this finding in the General Discussion.

Discussion

In Experiment 1, we orthogonally manipulated two devices associated with contrast—clefting and adversative connectives— to assess their effects on memory for short texts, as well as the initial reading of those texts.

The use of an *it*-cleft improved long-term recognition memory for the contents of a discourse. This clefting effect was obtained regardless of the presence or absence of an adversative connective before the clefted phrase. Together, these results indicate that the realization of contrastive focus via the *it*-cleft can improve retention of a focused word even though the cleft may imply less exhaustivity than previously tested markers of contrastive focus (e.g., contrastive pitch in Fraundorf et al., 2010, and focus particles in Spalek & Gotzner, 2014).

Further, the clefting benefit was isolated to the word focused by the cleft (e.g., *British* in "It was the British who…"); *it*-clefts did not enhance memory for a later, non-focused entity (e.g., *Indonesia*). Nevertheless, a Bayes Factor analysis provided strong evidence that the presence of an *it*-cleft did not *diminish* retention for these non-focused entities. The presence of an *it*-cleft then had long-term benefits for memory of items placed in focus by the cleft without any subsequent loss of memory for material not in focus.

Was this also true for adversative connectives, which do not establish focus at all? We found mixed evidence. Although connectives on the whole did not benefit memory, a post-hoc analysis restricted to just the connectives *however* and *but* did find such an effect. One possibility is that this reflects a genuine difference between connectives; i.e., *but* and *however* may have contributed more to memory because they are higher frequency words (requiring fewer processing resources) or because other connectives, such as *yet*, had a more precise meaning that may not have been fully supported by the text. However, because the connectives *but* and *however* were selected post-hoc based on the empirical data, it is also possible that this is simply capitalization on chance because the number of trials the effect was based on were relatively small (only 12 memory probes per participant). In Experiment 2B, we target these connectives for analysis *a priori* and more rigorously test whether they enhance text memory.

In Experiment 1, we also considered whether the potential mnemonic benefits of these two devices related in part to how they were initially read. We found that cleft presence decreased reading times for the clefted constituent. This facilitatory effect of clefting on reading is consistent with the findings of Birch and Rayner (2010) but in conflict with those of Lowder and Gordon (2015). We will revisit possible reasons for these discrepancies in the General Discussion. However, we note here that reduction in reading times for clefted entities likely was not due to the position of the word within the sentence because of the residualization steps taken to separate the effect of the position of the target word within the sentence from the condition. We did not find evidence that this facilitation of reading times extended to adversative connectives, regardless of whether we restricted our analysis to just *but* and *however*. This was surprising given prior studies that have found decreased reading times following a connective (Millis & Just, 1994; van Silfhout, Evers-Vermeul, & Sanders, 2015). It is not immediately clear why reading times did not decrease following a connective in this study.

Did clefts contribute to memory in part because—as suggested by Lowder and Gordon (2015)—they lead to slower, more careful reading? This seems unlikely given that clefting overall lead to faster reading of the focus word. Indeed, clefting alone did not interact with reading times in predicting memory outcomes, and the effect of clefting remained even after controlling for reading times. However, reading times did interact with the connective and location variables such that faster reading time predicted better memory performance for the focused target word when a connective was present. To preview, these effects did not replicate, so we hold off on interpretation here and instead return to this point in the General Discussion.

In sum, the results of Experiment 1 suggest that clefts enhance memory specifically for a focused entity and at no cost to a non-focused entity. However, at least one potential confound clouds this conclusion. The focused target word, which was focused when a cleft was present, and the non-focused target word, which was not focused by a cleft, were also different lexical items that referred to different parts of the discourse. For example, in (15), *British* never occurs in the non-focus position, and *Indonesia* never occurs in the focus position. It is possible that the apparent differences between the focus and non-focus positions are spuriously driven by the individual lexical items rather the location within the sentence. To remove this confound in the remaining experiments, we counterbalanced the order of words within the sentence such that, across lists, the same lexical items appeared in both the focus and non-focus position of the critical sentence.

(15) It was the British who spotted the monkey in Indonesia and planted a radio tag on it.

Another major question left unanswered in Experiment 1 is *how* clefts enhanced memory. One possibility is that clefts introduce a representation of the salient alternative and thus enhance memory for alternatives in line with effects found for other markers of contrastive focus. However, it may be that clefts, by virtue of being less definitively exhaustive, promote memory only for the word in focus. These two possibilities cannot be distinguished by the two-alternative forced choice task in Experiment 1, which could be solved by affirming the correct target word, rejecting the salient alternative, or both. In Experiments 2A and 2B, we teased apart these possibilities by separately testing memory for the salient alternative versus a different false statement.

Experiments 2A and 2B

To determine how contrast markers may enhance memory, we adopted a different form of memory test in Experiments 2A and 2B. Specifically, we used the true/false task from Experiment 3 of Fraundorf et al. (2010), in which participants separately affirmed or rejected three types of statements (repeated below): true statements about the target (16a), false statements about the salient alternative (16b), or false statements about an unmentioned item (16c). If the effect of the contrast markers in Experiment 1 was to enhance memory for the target word, it should help participants identify that neither the unmentioned probe nor the salient alternative was correct. However, if the contrast marker improved participants' memory specifically for the salient alternative, it should improve rejection only of that salient alternative, not an unmentioned item.

(16a) The British scientists spotted one of the monkeys and planted a radio tag on it.

(16b) The French scientists spotted one of the monkeys and planted a radio tag on it.

(16c) The Dutch scientists spotted one of the monkeys and planted a radio tag on it.

To add this manipulation of probe type without creating a combinatorial explosion of conditions, and given that we observed no evidence of a cleft x connective interaction in Experiment 1, we separated the cleft and connective conditions into two experiments: Experiment 2A tested clefts and Experiments 2B tested connectives. In a further change from Experiment 1, Experiment 2B included only the connectives *but* and *however*, the two connectives for which we had a significant memory benefit in our post-hoc analysis. This allows us to assess whether their memory benefits replicate when they are targeted *a priori* or whether the effects in Experiment 1 were merely a result of choosing these connectives post-hoc after observing participants' performance.

Method

Participants. The power analysis was conducted in the same manner as Experiment 1 using effect sizes from the first 12 participants. Given the observed effect size of Cohen's *d* =

0.13, 119 participants were required to achieve power greater than 80%. Thus, we targeted 120 participants to balance each of the 12 stimulus lists.

Experiment 2A: Clefts. Amazon Mechanical Turk workers (*N* = 124, 53 female, *M* age = 37.85) were paid $7.25 for their participation. Three participants were excluded due to mean RTs less than 100 ms per word and one due to overall accuracy less than 50%. All participants were native English speakers who were born in the USA. Participants varied in terms of the highest level of education achieved (high school diploma *n* = 23, associate degree or some college *n* = 42, bachelor's degree *n* = 41, post-graduate training *n* = 14).

Experiment 2B: Adversative Connectives. A second set of participants were used in Experiment 2B (*N* = 129, 58 female, 1 undisclosed gender, *M* age = 36.81). Recruitment and compensation followed the same protocol as in Experiment 2A. Six of these participants were excluded due to mean RTs less than 100 ms per word. One further participant was eliminated for less than 50% accuracy on the memory probes. Again, participants varied in terms of education (high school diploma *n* = 18; associate degree or some college *n* = 41, bachelor's degree *n* = 50, post-graduate training *n* = 13).

Design and Materials. The location of each word was counterbalanced such that, across lists, every lexical item could occur in both the first (focused for cleft conditions) and second (non-focused) locations. Materials were the same between Experiments 2A and 2B except that in Experiment 2A, only cleft and contrast marker absent structures were used, while in Experiment 2B, clefts were replaced with adversative connectives (*but* or *however*). Assignment of *but* or *however* in Experiment 2B occurred pseudo-randomly with the intent of balancing their use across passages. However, due to a technical error, twenty-nine of the texts received *but* and the other 31 received *however*. The complete list of texts and probes can be found in Appendix B of the Online Supplement.

We constructed three types of memory probes to present during the test phase. One third of probes referred to the correct target word (as in example 16c), one third were false statements referring to the salient alternative from the original discourse (16b), and one third were false statements referring to an unmentioned item from the semantic category (16c). For each Experiment, this resulted in a 2x2x3 design with contrast marker presence, location (1st or 2nd in the critical sentence), and probe type all varying within participants and items. One memory probe was presented for each target item in each text; thus, participants saw a total of 120 probes.

The texts from Experiment 1 were substantially revised to allow for all target words to appear as either the focused or non-focused target word. The revised texts reflected three constraints. First, all target words followed an article or a preposition so that no target word was ever the first word in the sentence. This meant that the focused target word within the critical sentence was either the second word (in the neutral conditions), the fourth word (cleft conditions), or the third word (connective conditions) of the sentence. This constraint offered further control over word position effects on reading time beyond using word position as a control variable in calculating RRT. Second, the non-focused target word in the critical sentence occurred at least three words after the focused target word, was always in the predicate, and was always followed by at least two words. This ensured that the non-focused target word (a) was never in the spillover region for the focused target word, (b) was never in focus or part of the same phrase as the focused word, and (c) was not the last word in the sentence, helping to separate reading times on this word from any sentence wrap-up effects. Lastly, one concern is that the original version of each story might sound more natural than the version created by counterbalancing the word order. To address this concern, each presentation list contained half of the texts in the originally-written order and half in the counterbalanced order; this counterbalancing variable was orthogonal to the experimental conditions. Text (17) and its alternative critical sentence (18) reflect this counterbalancing; target words are in bold.

(17) The insurance company sent an investigator to look into a property damage claim. They suspected arson or vandalism had occurred. They also believed the policy holder had committed identity or financial theft. [It was/But] the **identity** theft [that] turned out to be linked to the **vandalism** according to the investigator, and the insurance company did not have to make a payout.

(18) [It was/But] the **vandalism** [that] turned out to be linked to the **identity** theft according to the investigator, and the insurance company did not have to make a payout.

We further counterbalanced which words from the context sentences were chosen as the target word. There were four possible combinations: (a) the first word mentioned from both contrast sets (e.g., *arson* and *identity*), (b) the second word mentioned from both contrast sets (e.g., *vandalism* and *financial*), (c) the first word mentioned from the first contrast set and the second word from the second contrast set (e.g., *arson* and *financial*), (d) the reverse of (c). These were counterbalanced across sets so that each combination showed up in tandem one quarter of the time. The complete list of texts and probes is available in Appendix B of the Online Supplement.

Procedure. Participants were given the same instructions and read through the texts in the same manner as in Experiment 1. After they finished reading (M = 23.94 min in Experiment 2A; M = 20.04 in Experiment 2B), participants saw each memory probe one at a time and responded by selecting the *True* or *False* link presented under the probe. Each participant received only one of the three probe conditions for each target word.

Analytic Strategy. Due to technical error, one text in Experiment 2A was never presented to participants, leaving 59 texts and 118 memory probes available for analysis.

To directly compare the effects of clefts (Experiment 2A) and connectives (Experiment 2B), we added experiment as an additional between-subjects, fixed-effect variable (since the experiments were otherwise identical). We then collapsed the use of clefts and connectives into a single fixed effect of contrast marker. If the condition included either a cleft or a connective, this variable was set to *True;* otherwise, it was set to *False*. Thus, a differential effect of one contrast maker over the other would be reflected in a contrast marker x experiment interaction.

Fixed effects for reading time models included contrast marker, experiment, location of the target word, and their interactions. Fixed effects for recognition memory accuracy included the additional effect of probe type (e.g., *True*, *False*-salient alternative, *False*-unmentioned item) and its interactions. In both experiments, contrast marker and experiment were contrast-coded. Location of the target words was treatment-coded as in Experiment 1 for reading models and contrast coded for memory models.

The new true/false memory task employed in Experiments 2A and 2B necessitated the use of a signal-detection framework for analysis (Fraundorf et al., 2010, 2013; Freeman et al., 2010; Green & Swets, 1966; Macmillan & Creelman, 2005; Wright, Gabbert, Memon, & London, 2008). Specifically, because the correct answer was *True* in some conditions but *False* in others, differences in raw accuracy across conditions confound the ability to identify the truth value of particular probes with a general bias towards responding *True* or *False* in the face of uncertainty. These factors can be teased apart conceptually and theoretically by using the type of response the participant gave (*True* or *False*) as the dependent variable. Probe type was then coded so as to compare (a) the unmentioned item and (b) the salient alternative to the mean rate of rejections. Under this system, the intercept represents *response bias* (i.e., the tendency of participants to respond *True*) whereas the effect of probe type represents *sensitivity* to the correct response (i.e., a decreased likelihood of responding *True* when the probe statement is false). Effects that do not interact with probe type indicate effects on response bias and those that do reflect sensitivity.

As in Experiment 1, we included subjects and items as random effects. Maximal mixed effects structures did not converge for memory or reading time models. For all models, only a random-intercepts structure, without random slopes, was supported by the data. However, choice of model did not affect the significance of the results.

Results

Reading times. For the reading time data, reading times longer than 2000 ms or less than 100 ms on an individual word (2.39% of words) were removed. RTs were positively skewed (skewness = 1.80). Following Experiment 1, log RTs[10] were used instead, (skewness = 0.83). Log RRTs were calculated in the same manner as Experiment 1. Log RRTs greater than 3 standard deviations from the mean were then removed (1.78% of reading times), leaving 716,217 reading times on critical texts for both Experiments 2A and 2B (27,633 of which were target words). As in Experiment 1, we compared the two target words against the aggregate of all other words from the context and critical sentences (Figure 4). Table 4 reports model results.[11]

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[10] Use of log RRTs versus RRTs in the model did not affect the significance of the results.
[11] We also conducted additional analyses of the RRTs for the words following each critical word. There were again no significant effects of cleft or connective presence in the spillover regions, all *p*s > .20.

We focus here on describing effects that interacted with experiment because our primary interest was in differences between clefts and connectives. Across all locations, the effect of the contrast markers differed between experiments (experiment x contrast marker interaction) with reading times being slightly faster in sentences with a cleft as opposed to a connective, $t(716{,}000{,}000) = -2.85$, $p = .004$. A three-way interaction between experiment, contrast marker presence, and location indicated that this effect was magnified for the first target word, $t(715{,}900{,}000) = 3.84$, $p < .001$

In order to better understand the interactive effect of the experiment, contrast marker, and location of the target word, we turn to the simple effects. A direct comparison between the effect of cleft presence (Experiment 2A x contrast marker presence x focus target) and the absence of a cleft (Experiment 2A x contrast marker absence x focus target) showed that cleft presence reduced the reading time of focused target word by 0.98 times (95% CI:[0.96,0.99]), $z = -4.44$, $p < .001$. Conversely, there was no effect for adversative connectives (Experiment 2B x contrast marker presence x focus target) as compared to the absence of a connective (Experiment 2B x contrast marker absence x focus target), $p > .99$. That is, clefts—and *only* clefts—decreased reading time for the focused word in a cleft, with the BF_{10} for the three-way interaction (26.99) providing strong evidence.

The difference in reading times between the non-focused target word and the aggregate of all other words was not significantly affected by the presence of a contrast marker in either experiment, *p*s > .20, $BF_{01} = 25.92$. Here, the Bayes Factor provides strong evidence for the null hypothesis that cleft and connective presence neither increase nor decrease reading times for the non-focused target word.

To summarize, replicating results from Experiment 1, RTs were faster for clefted target words. RTs did not significantly differ across other conditions.

INSERT FIGURE 4 HERE

INSERT TABLE 4 HERE

Memory. Recall that to separate the effects of bias towards *True* or *False* responses, we used as our dependent variable to the response given (*True* or *False*) rather than accuracy and included as an independent variable the type of probe (*True, False-Salient, False-Unmentioned)*. This technique allows us to determine if participants' tendency to respond *True* is greater in when the probe is *True* versus when it is *False-Salient* or when it is *False-Unmentioned* and whether or not this sensitivity changes across conditions. Table 5 reports results of the model, and Figure 5 the mean rates of *True* responses. Again, we back transform effects on the log odds from Table 5 to odds within the text to facilitate interpretation.

Baseline effects. The odds of a *True* response were greater than for *False* across both experiments, $z = 5.49$, $p < .001$, indicating some overall bias to respond *True*. Nevertheless, participants responded *True* significantly less to the two types of false probes, demonstrating that they were sensitive to the correct response and able to correctly reject *False* probes.

Clefts vs. Connectives. The critical question was whether the use of a contrast marker in the text improved participants' later ability to remember the discourse. We considered the ability the discriminate the correct information from both (a) the salient alternative from the original text and (b) a wholly unmentioned item.

For both salient alternatives and unmentioned probes, when collapsing across location, there were no significant effects of contrast markers generally nor type of contrast marker, *p*s > .12. Further, in a simple-effects comparison within each Experiment, when collapsing across word location, the rate of rejections for the salient alternative did not significantly differ between cleft and no-cleft conditions, $p = .12$, nor adversative connective and no adversative connective conditions, $p = .27$. Instead, effects appeared as interactions based on the location (1st or 2nd in the sentence).

For rejections of the salient alternative, the rate of correct rejection was higher in Experiment 2a as compared to 2b for the first versus second target word in the sentence, $p = .003$, $BF_{10} = 3.79$. Indeed, simple effects showed that for Experiment 2A, the odds of correct rejection were 1.31 times (95% CI: [1.12, 1.53]) higher for the focus versus the non-focus target, $z = 3.88$, $p = .006$, whereas in Experiment 2B there were no significant differences based on the location of the target word, $p > .99$. In other words, participants were more accurate in rejecting salient alternatives for the first (focus) target than for the second (non-focus) target only in Experiment 2A. However, the presence of a contrast marker did not significantly alter this effect, $p = .65$, $BF_{01} = 7.47$; in fact, the Bayes Factor indicates substantial evidence for the absence of such an effect.

By comparison, for the unmentioned probe, word location did not significantly interact with Experiment to affect rejections of the unmentioned items, $p = .39$, $BF_{01} = 12.89$; indeed, the BF reflects strong support for an absence of such an effect. Rather, for the unmentioned probe to the first (focus) target word, there was an interaction with contrast marker presence and Experiment such that the odds of correct rejection were 1.79 times (95% CI: [1.01,3.15]) more likely when a cleft was in the sentence, $z = 1.96$, $p = .05$, $BF_{10} = 5.43$. The BF for this 3-way interaction indicates substantial support that cleft presence improved rejections of unmentioned probes relative to the presence of connectives[12] and relative to the absence of contrast markers

[12] As in Experiment 1, we also considered the additional variable of connective type (*but, however,* or none), but we found no differences based on the type of connective used.

entirely. This conclusion was further supported by a simple-effects analysis: In Experiment 2A, the odds of correctly rejecting the unmentioned alternative to the focus target word were 1.19 times (95% CI:[1.01, 1.42]) higher when a cleft was present as opposed to when it was absent, $z = 2.07$, $p = .04$. That is, rejections of unmentioned probes were facilitated only by clefts and only for the clefted target.

Summary. Clefts, but not connectives, facilitated memory performance. The memory benefit of clefts was not driven by rejections of salient alternatives to the clefted item, but by rejections of items entirely unmentioned in the earlier discourse.

INSTERT FIGURE 5 HERE
INSERT TABLE 5 HERE

Relation of reading times to memory. As in Experiment 1, log RRTs were added to the memory model to determine if reading time predicted accuracy. However, reading times did not predict memory outcomes in either Experiment 2A or 2B, all *p*s > .20.

Discussion

In Experiment 2A, we replicated the finding from Experiment 1 that retention of material focused by a cleft was greater than when the same material was not focused. As in Experiment 1, this benefit did not come at a cost to other, non-focused words in the sentence, for which retention did not change across conditions. Indeed, Bayes Factors provided in Experiment 2 strongly support the null hypothesis that focus does not negatively affect retention of non-focused items.

We also replicated the finding from Experiment 1 that contrast alone was not sufficient to drive these effects: We did not see a memory benefit for words which followed a contrast marker that did *not* establish focus; i.e., an adversative connective. In Experiment 1, we had found some evidence for a memory benefit among particular adversative connectives (*but* and *however*) selected post-hoc on the basis of their performance. When we targeted these specific comparisons a priori in Experiment 2B, however, we did not replicate this effect, which suggests this relationship in Experiment 1 was spurious.

The main contribution of Experiment 2 is that it allowed us to test more specifically how clefting improved memory. We separately presented true probes about the target word, false probes that replaced the target word with its salient alternative, and false probes about an unmentioned item. If clefts led participants to encode specific information about a specific salient alternative, as has been the case for other contrastive focus devices (e.g., contrastive pitch accents, Fraundorf et al., 2010; focus particles, Spalek & Gotzner, 2014), they should have facilitated rejections only of probes containing that salient alternative, but not probes containing unmentioned items. By comparison, if the clefts facilitated rejections of the unmentioned items, it would suggest that participants had improved their retention for the target word and were therefore able to reject probes with unmentioned and salient items because they recognized that these were not the target word.

Our results provided more support for the latter possibility in the form of an experiment x contrast marker x location interaction: Clefts facilitated correct rejection only of unmentioned items. By comparison, we found no evidence for improvement in correct rejection of salient alternatives based on the presence of either contrast marker. In fact, the Bayes Factors provided substantial evidence that clefts did *not* benefit correct rejection of salient alternatives. These results support an interpretation that the realization of contrastive focus via an *it*-cleft encourages the comprehender to encode the focused concept in more fine-grained detail so that later they are able to remember what was true with greater specificity. Later rejection is stronger because the comprehender can identify that it is not the true proposition, rather than because the comprehender has any specific memory for a particular alternative. This finding suggests that the common linguistic categorization of *it*-clefts, contrastive pitch accents, and focus particles as markers of contrastive focus is not always reflected in common cognitive effects among them. It may be that features of particular markers of contrastive focus (e.g., the extent of exhaustivity) are critical to the cognitive effects on the comprehender.

If the effect of the cleft is that readers encode the focused item in finer detail, we would have also predicted improvements both in acceptance of the *True* probes and in correct rejection of the salient alternatives. However, a direct analysis of only the rate of *True* responses cannot be carried out because such an analysis is confounded with participants' overall bias or tendency to respond *True* in the face of uncertainty; i.e., they will have a tendency to get more *True* probes correct by chance. As regards the salient alternatives, although the effect was numerically in the hypothesized direction, it was not statistically reliable (although the effect on salient alternatives may have been diminished by a general feeling of familiarity towards these words; Yonelinas, 2002). Nevertheless, the most plausible explanation of the memory benefit found in this study is increased memory for the item in focus. It is implausible that the cleft could have led readers to encode something about the unmentioned item in particular because that item—by definition—was not mentioned in the text.

With respect to reading times, Experiment 2 replicated the finding from Experiment 1 that reading was faster for the focused target word (i.e., the focused word) in cleft conditions. However, contrary to Experiment 1, reading times did not predict later memory accuracy in this experiment. It is important to note that in Experiment 1, reading times only predicted accuracy when an adversative connective was present (with or without a cleft). In Experiment 2, we did not find any effects of connective presence on memory or reading times, suggesting that the original finding was either spurious or an effect of combining the two contrast markers.

General Discussion

In three experiments, we investigated the effect of contrast markers—clefts and adversative connectives—on online processing and memory outcomes. We sought to determine whether putative memory benefits resulting from the realization of contrastive focus via focus particles and contrastive pitch truly reflect contrastive focus or can instead be found with any marker of contrast. We also considered whether clefts, like other markers of contrastive focus, enhance encoding of representations for salient alternatives to focused items or enhance encoding of representations for the focused item itself. We additionally considered if memory benefits from contrastive focus come at a cost to non-focused items, and how clefts and adversative connectives are initially processed online.

To briefly summarize, in Experiments 1 and 2A, we found that clefts enhance memory for the word they focused. By comparison, in Experiment 2B, adversative connectives did not similarly benefit memory, suggesting that the memory effects are effects of the realization of contrastive focus and not of contrast markers more broadly. Further, Experiment 2A suggested that the memory benefit of clefts comes about by strengthening the representation of the focused item itself, rather than of alternatives present in the discourse: Specifically, clefts only facilitated the ability between correct probes and unmentioned items that were never part of the original discourse. Since the reader had not encountered this unmentioned item and could not possibly have encoded it as part of the discourse, this pattern is most likely explained by the reader encoding the focused items with greater specificity, which would enhance rejection of these false probes. We also found that this greater specificity did not come at a cost to remembering non-focused words. Lastly, we found faster reading times for target words immediately following clefts but not adversative connectives, but this was not predictive of subsequent memory. We review each of these findings below.

Discourse Memory

Our results provide evidence that the presence of a cleft increases the level of the encoding of the target word. The additional encoding serves to ensure that the comprehender recalls the fine-grained detail (e.g., *British*) rather than some coarse-grained category (e.g., *people* or *country*). It is plausible that focus could lead to such fine-grained encoding because focus establishes a contrast, and the focused item needs to be encoded with greater specificity to ensure it is not confused with some other plausible alternative. Thus, consistent with Zimmerman & Onea (2011), the process of evaluating the focused constituent against the backdrop of the salient alternative is what prompts the reader to engage in greater specificity and subsequently heightens memory.

This result diverges from prior work with contrastive pitch accents (Fraundorf et al., 2010), font emphasis (Fraundorf et al., 2013), and focus particles (Spalek et al., 2013), which suggested that what is encoded in response to focus is a specific salient alternative to the true proposition. How can we reconcile these differing results? We speculate that, although several devices have been viewed as establishing contrastive focus, they may have subtly different effects. One critical difference may be the level of exhaustivity implied by the particular realization of contrastive focus. For focus particles, the exhaustivity is absolute (Destruel & DeVeaugh-Geiss, 2018; Kiss, 1998). It cannot be canceled afterwards (Zimmerman & Onea, 2011). However, exhaustivity implied by cleft can be cancelled afterward (Destruel & DeVaugh-Geiss, 2018). Although at first the clefted information (e.g., *identity theft*) appears to exclude alternatives (e.g., *financial theft*), this can be changed without causing significant issues for the reader (Destruel & DeVaugh-Geiss,2018). The non-definitive implication of exhaustivity for clefts may lead to cognitive differences in processing of the focused item as compared to the use of exclusive focus particles. When a cleft is present, the salient alternatives may be active to a lesser degree because the reader knows that there is still some possibility that the alternative (e.g., *financial theft*) was involved, too. In this case, the processing instructions that trigger activation of the salient alternative during other types of contrastive focus constructions may be less extensive within a cleft. Thus, definitive implications of exhaustivity may be necessary to promote the encoding of salient alternatives. From this we would predict that the odds of a reader remembering salient alternatives increases as a function of the exhaustivity implied by contrastive focus marker. Cases in which exhaustivity is definitive (e.g., *only*) would have greater odds of prompting retention of salient alternatives than cases in which exhaustivity is less definitive (e.g., *it-clefts*).

Although clefts did not lead comprehenders to encode a specific salient alternative, they did still enhance the memory representation for the focused constituent. Critically, we found that markers which suggest *focus* were necessary to produce this enhance memory; contrast alone was not enough. Specifically, adversative connectives, which suggest a contrast but do not isolate that contrast to a single entity or set of entities, did not facilitate memory for the target item or its salient alternatives. We speculate that adversative connectives do not yield memory effects related to a particular word because the contrast is at the sentence level between propositions (e.g., *John is tall, but Bill is small*; Zeevat, 2012) as opposed to individual words within the proposition (*John-Bill* or *tall-small*). Instead, focusing a specific discourse entity is necessary to promote memory for that item or for its salient alternatives. This finding complements prior work showing that non-contrastive focus (e.g., presentational pitch accents; Fraundorf et al., 2010) was not as effective as contrastive focus (e.g., contrastive pitch accenting) at facilitating memory for target items or their salient alternatives. Here, we show that contrast alone is also not as effective as contrastive focus. Rather, it is the combined effects of focus *and* contrast that drive the more detailed representations.

Finally, we found that the effect of clefting was driven by a benefit to focused information rather than a penalty to non-focused information—two variables that had often been confounded in past studies. Here, we established through the use of Bayes Factors that focusing one word with a cleft did not impair retention for a later, non-focused word. At a methodological level, this supports the validity of comparisons in prior studies of memory outcomes between non-focused and focused information. More broadly, it is striking that clefts conferred a memory benefit for focused information without impairing memory for other, non-focused information. This is consistent with the notion that effects of linguistic focus are at least part driven by the (semantic or pragmatic) interpretation of focus as a linguistic feature rather than by attention because directing attention to the focused information might be expected to impinge memory for unattended information (but see Fraundorf, Watson, & Benjamin, 2012, for differing results from older adults and from younger adults with lower working memory).

Our findings regarding memory performance are thus three-fold: (a) Encoding of a salient alternative required more than contrastive focus alone. We speculate that a more definitive exhaustive implicature may also be necessary, (b) Effects of contrastive focus indeed require focus, not contrast more broadly, and (c) Cleft presence did not affect memory for non-focused entities.

Online Processing of Contrastive Relationships

Although our primary interest was in how clefts and connectives affected long-term text representations and memory, we also considered how they affected initial processing. Across both experiments, reading times were faster for the target word in the cleft; Bayes Factors suggested that the evidence for this effect was decisive. By comparison, we did not find an analogous effect for connectives.

Why didn't connectives decrease reading time? It was surprising that adversative connects did not affect reading times given prior findings of decreased reading times following a connective (Millis & Just, 1994; Traxler, Bybee, & Pickering, 1997; van Silfhout et al., 2015). However, very few of these prior experiments concerned adversative connectives in particular; instead, they concerned causal or temporal connectives. It is possible that generating a contrastive link between clauses does not facilitate processing in the same way as creating a causal or temporal link. Indeed, Murray (1995, 1997) found that the effects of adversative connectives on reading times and memory diverged from the effects of other types of connectives. Further, given that connectives did not ultimately affect memory representation, it is perhaps not surprising that they would also fail to result in a difference in reading time for that word. The connective does not isolate a single word as an object of potential focus; rather, it may set up an expectation for a contrast without targeting what might be contrasted. This may make it less likely that the adversative connective would facilitate reading times for the next subsequent word.

Why did clefts decrease reading time? Conversely, clefts in both experiments *did* benefit memory, and this was paired with a facilitation of reading times as well. Clefts have produced mixed effects on reading times in prior literature. Birch and Rayner (2010) found that reading times were shorter for words in a cleft whereas Lowder and Gordon (2015) found longer reading times. Lowder and Gordon suggested that the facilitation effect observed by Birch and Rayner was due to the position of the target word within the sentence: Adding a cleft to the beginning of the sentence moves all words two positions deeper, and because reading times speed up over the course of the first several words of the sentence, a later word position within the sentence could account for the decreased reading times in the Birch and Rayner study. However, in our study, we took into account the status as the first content word of a sentence when calculating residual reading times, and we still found that reading times were faster for a target word when it was in the cleft (i.e., in focus). We believe that, instead, these discrepant results reflect the manner in which the clefted details were presented. In our experiment, we included of a context sentence which makes it easier to integrate information following the cleft. When readers reached the cleft, they may have expected the next word to refer back to a previously mentioned entity and were therefore primed to read the focused word. The priming then led to faster activation and quicker reading times. Consistent with this speculation, prior studies (Birch & Rayner, 1997; Lower & Gordon, 2015) that found increased reading times for target words in the cleft did not include a context sentence. However, the Birch and Rayner (2010) study, which found the faster reading times for the focused target words, *did* use context sentences. Thus, we suggest that time spent reading a word is not determined by whether or not it is in focus or follows a cleft but rather reading times are affected by how easy it is to integrate the entity with the rest of the passage.

We speculate that were the context sentences to be removed from our stimuli, we would find increased reading times in cleft conditions similar to prior studies. The expectation that a clefted sentence should contain new information about a presupposed concept would be disrupted if there is no context from which the reader can expect the presupposed information to be drawn (Delin, 1995). Critically, we suggest that such divergent results in studies with and without context sentences indicate that reading times in clefted sentences are not driven by effects of focus so much as the extent to which words in the cleft are preactivated and easier to integrate with a previous concept.

Do Reading Times Predict Memory?

Lastly, we considered the relationship between initial reading and subsequent memory. Some accounts (e.g., Lowder & Gordon, 2015) suggest that increased memory for focused items occurs because of increased reading times spent on the focused items. However, in both Experiments 1 and 2A, we found clefts led focused entities to be read *faster*. Further, there was no evidence to suggest that reading times on target words interacted with cleft presence to predict recognition memory. Cleft presence may affect both reading times and recognition memory, but these effects are independent; the mnemonic benefit of cleft presence is not moderated by reading time.

Adversative connectives showed diverging results across experiments. In Experiment 1, the reading times interacted with adversative connective conditions such that memory was more accurate for the focus target when an adversative connective was present *and* readers read more quickly. Experiment 2B did not replicate this effect. The key difference between the experiments is the inclusion in Experiment 1 of a condition including both a cleft and a connective, which produced the larger effect size and appeared to be driving the relation of RRTs to memory outcomes. As this effect was isolated and did not replicate, we report on it but do not speculate on why it might have occurred.

Presuppositions as a Mechanism

We have suggested that contrastive focus enhances the granularity of the focused item or its alternative by prompting comprehenders to evaluate the focused item against its alternatives. However, it is not clear what aspect of contrastive focus prompts this evaluation. Velleman et al. (2012) propose that contrastive focus, particularly *it*-clefts and exclusive focus particles, presuppose a question; for instance, *It was the British who found the monkey* presupposes the question *Who found the monkey?* Given the presence of the salient alternative *French*, the answer to the question can be encoded in comprehenders' situation model in one of three ways: *The British*, *not the French,* or *The British* and *not the French*. Which of these becomes encoded as the answer may relate to what the comprehender perceives to be *at issue* or the addition to the common ground (Velleman et al., 2012). According to Velleman et al., exclusive focus particles focus the item as the maximum of what may be learned (*e.g., only the British*). Clefts, on the other hand, focus the item as the minimum of what may learned (*e.g., definitely the British*). The presupposed questions may then reflect the scope of what is at-issue. In the first case, the question presupposed by the exclusive focus particle may be *Who did and who did not find the monkey?* whereas the question presupposed by the clefted phrase may be *Who found the monkey?*. We speculatively hypothesize that it may be that prompting the reader to presuppose a question is what promotes retention in the case of contrastive focus and that specifically which material is better retained is governed by the specific question the comprehender is prompted to ask. This possibility also accords with the notion that prereading questions often improve text retention (e.g., St. Hilaire & Carpenter, 2020; McCrudden, Schraw, & Kambe, 2005). Nevertheless, this hypothesis requires future empirical testing.

Limitations

One limitation of our reading-time results is that reading times were all collected through a moving window paradigm. Although this method allowed us to capture progressive reading times for all words, it does not fully replicate natural reading. For example, if given the opportunity, readers might regress to a target word or its salient alternative and thereby increase time spent reading a word. Eye-tracking of free reading would allow us to capture regressions or second pass reading times and how those might contribute to the encoding of salient alternatives in ways we were unable to observe in this paradigm.

Another limitation of the study is that the effects of focus and first mention were not fully deconfounded. An advantage for first mention has been found such that words that are mentioned first in a sentence are accessed more quickly during probe recognition tasks—regardless of their role in the sentence—than subsequently mentioned words (Carreiras, Gernsbacher, & Villa, 1995; Gernsbacher & Hargreaves, 1988). This would suggest that first mentioned words are active for longer periods of time than subsequent words and this may affect later retention. In the present experiments, because focused entities always occur at the start of the sentence, the first-mention effect may have diminished the difference between focused and non-focused words. Contrast that with the experiments by Fraundorf et al. (2010, 2013), in which either an initial target word and/or a later target word could be in focus, making the manipulation of focus orthogonal to the location of the focused word in the sentence. For example, in (19), *Indonesia* received contrastive focus even though it is the non-focus target. It is possible that the effect of contrastive focus versus a focus neutral condition would be more apparent if the non-focused target word were the one in focus, such as through the use of a focus particle or pseudocleft.

(19) The British spotted one of the monkeys in INDONESIA and placed a radio tag on it.

Conclusion

Understanding how we update and integrate prior representations with incoming information is of critical importance to understanding language processing. The role of realizations of contrastive focus in encoding and retaining a relationship among entities offers one window into understanding how and on what timeline relationships are encoded. Here, we have shown that readers use *it*-clefts to selectively retain details from a text, and that this effect was driven specifically by contrastive focus rather than contrast alone. *It*-clefts improve retention specifically for what is focused by the cleft, creating a more precise representation of the word and the concept to which it attaches. This finding sets *it*-clefts apart from other realizations of contrastive focus (e.g., focus particles), which have been found to benefit memory by leading readers to remember a specific salient alternative. As a critical difference between *it*-clefts and focus particles is the extent to which they imply exhaustivity, this finding suggests that exhaustivity is critical for increasing the encoding granularity of salient alternatives. Without definitive exhaustivity that cannot be negated, the focus is on the clefted constituent and thus the memory benefits are for this item. Further, the level of specificity involved in encoding the focused word did not come at a cost to non-focused material, nor did it require additional processing time; indeed, focus sped up reading. Creation of a more finely grained representation, then, comes at an insignificant cost to the representation of the passages as a whole. Instead, contrastive focus as realized by *it*-clefts acts to enrich the representation.

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