Pragmatic Influences on Sentence Integration: Evidence from Eye Movements

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Pragmatic Influences on Sentence Integration: Evidence from Eye Movements

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Abstract

To understand a discourse, readers must rapidly process semantic and syntactic information and extract the pragmatic information these sources imply. An important question concerns how this pragmatic information influences discourse processing in return. We address this issue in two eye movement experiments that investigate the influence of pragmatic inferences on the processing of inter-sentence integration. In Experiments 1a and 1b, participants read two-sentence discourses in Chinese in which the first sentence introduced an event and the second described its consequence, where the sentences were linked using either the causal connective "suoyi" (meaning "so" or "therefore") or not. The second sentence included a target word that was unmarked or marked using the focus particle "zhiyou" (meaning "only") in Experiment 1a or "shi" (equivalent to an *it*-cleft) in Experiment 1b. These particles have the pragmatic function of implying a contrast between a target element and its alternatives. The results showed that while the causal connective facilitated the processing of unmarked words in causal contexts (a connective facilitation effect), this effect was eliminated by the presence of the focus particle. This implies that contrastive information is inferred sufficiently rapidly during reading that it can influence semantic processes involved in sentence integration. Experiment 2 showed that disruption due to conflict between the processing requirements of focus and inter-sentence integration occurred only in causal and not adversative connective contexts, confirming that processing difficulty occurred when a contrastive relationship was not possible.

Keywords: pragmatic processing, inter-sentence integration, contrastive focus, causality, eye movements during reading

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Readers use syntax and semantics to establish the literal or propositional meaning of sentences in a discourse (Kintsch & Van Dijk, 1978). They also use pragmatics to draw inferences about the intentions of the writer that are implied by this information (Grice, 1975). An important source of this pragmatic information comes from the use of focus (Halliday, 1967; Umbach, 2004). Focus refers to the most emphasized and prominent element in a sentence and carries the implicature that this should be contrasted with its alternatives. This is marked by various linguistic devices, including the particle "only" (equivalent to "zhiyou", "只有", in Chinese), and *it*-cleft structures (equivalent to "shi", "是"). For example, "Liru" in sentence (1) is marked by "only" and so focused. Similarly, "Liru" is focused in sentence (2), but not sentence (3) (Chen, Li, & Yang, 2012).

(1) Only Liru felt tired.

(2) It was Liru who felt tired.

(3) Liru felt tired.

Sentence (1) means that Liru felt tired as indicated by the sentence syntax and semantics. However, "only" additionally implicates that other people were not tired. This is because "only" implies a contrast between a focused element ("Liru") and some alternatives, which is the pragmatic meaning of the sentence. Studies show readers are sensitive to this information and that it is processed rapidly during comprehension (e.g., Nieuwland, Ditman, & Kuperberg,

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2010).

On-line resolution of this pragmatic information has also been shown to influence syntactic and semantic processing (for a review, see Filik, Paterson, & Sauermann, 2011). For instance, numerous studies reveal an influence on the syntactic analysis of garden-path sentences (Filik, Paterson, & Liversedge, 2005; Liversedge, Paterson, & Clayes, 2002; Ni, Crain, & Shankweiler, 1996; Paterson, Liversedge, & Underwood, 1999; Sedivy, 2002). The sentence "The horse raced past the barn fell" is temporarily ambiguous between two syntactic analyses: a simple active analysis and a reduced relative clause analysis. In the simple active reading, "raced" is the main verb of the sentence, whereas in the reduced relative clause reading, the phrase "raced past the barn" modifies the subject noun ("the horse"). Readers usually adopt the simple active analysis of the ambiguity and experience processing difficulty when, ultimately, it is disambiguated as a relative clause at the verb "fell" (see, e.g., Bever, 1970). However, if "only" is placed before the initial noun in this sentence, as in "Only the horse raced past the barn fell", this difficulty is reduced or even eliminated (Filik et al., 2005; Liversedge et al., 2002; Ni et al., 1996; Paterson et al., 1999; Sedivy, 2002). This is attributed to "only" implying a contrast between the focused element ("the horse") and some alternatives (other horses). This induces an expectation for modifying information specifying this contrast, which can facilitate ambiguity processing as the dispreferred analysis provides such information (see, e.g., Crain & Steedman,

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1985; Ni et al., 1996). Pragmatic information can also affect semantic analysis during sentence processing. In the sentence "At dinner, Jane passed only the salt to her mother but not the pepper", "only" causes "the pepper" to be contrasted with "the salt". However, in "At dinner, Jane passed only the salt to her mother but not her father", "her father" should not be contrasted with "her mother" because "only" implies a contrast between "the salt" and its alternatives. This inappropriate contrast produces longer reading times compared to when the contrast is appropriate, suggesting contrastive information is extracted sufficiently rapidly that it can affect the semantic processing of sentential information (Filik, Paterson, & Liversedge, 2009; Paterson et al., 2007; Sauermann, Filik, & Paterson, 2013).

Most such studies have used particles like "only". However, violation of the contrast implied between the clefted element of a cleft-structure (i.e., an "it was x" construction) and its alternatives can also disrupt processing (Drenhaus, Zimmermann, & Vasishth, 2011). Similarly, characters marked by "shi" are processed easily in discourses that contain a contrast but with difficulty in discourses without one (Chen & Yang, 2015; Chen, 2018). Contrasts can even be established by extra-linguistic factors such as using underlining or a change in font to indicate the prominence of a word (Fraundorf, Benjamin, & Watson, 2013). Finally, many studies show that focus modulates attention, such that focused words receive greater attention and have shorter processing times compared to unfocused words (Birch & Rayner, 2010; Chen, Li, & Yang, 2012;

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Morris & Folk, 1998; Sanford, 2002; but see Lowder & Gordon, 2015). This "focus facilitation effect" predicts shorter reading times for "Liru" when focused in (2) than when unfocused in (3).

The integration of information across sentences is a further key feature of discourse comprehension that is computed on-line during reading. Generally, a reader's understanding of the discourse context has a rapid influence on the processing and integration of textual information (e.g., van Berkum, Hagoort, & Brown, 1999). An important element of this process involves establishing the logical relations between successive sentences in a text. Substantial evidence shows that causal relations (i.e., an interpretation in which one sentence provides the cause for events described in another) are analysed and integrated on-line during reading (Keenan, Baillet, & Brown, 1984; Kuperberg, Paczynski, & Ditman, 2011; Mason & Just, 2004; Myers, Shinjo, & Duffy, 1987; Traxler, Bybee, & Pickering, 1997). Causal integration is easy when this is supported by causal inferences based on a reader's knowledge of the world (Myers et al., 1987). For example, the text in (4) contains two sentences that are intrinsically causally related such that "climbed up the mountain" is the cause of "felt tired". Readers can integrate these sentences based on their knowledge that climbing mountains is likely to be the cause of feeling tired, so that the processing time for sentences like (4) is shorter, and memory for text enhanced, compared to sentences like (5) where the underlying causal relationship is unclear (e.g., Keenan et al., 1984; Myers et al., 1987).

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(4) Liru climbed up the mountain yesterday. Today she felt tired.

(5) Liru received a beautiful card yesterday. Today she felt tired.

Causal relations can also be cued using linguistic devices, such as causal connectives like "because", "so", and "therefore", which serve to make explicit the causal relationship between sentences (see, e.g., Givón, 1992; Kintsch, 1992). Numerous studies show that causal connectives can facilitate the integration of sentences that already have a clear causal relationship (the connective facilitation effect; Golding, Millis, Hauselt, & Sego, 1995; Millis & Just, 1994; Traxler et al., 1997). However, when sentences are not intrinsically causally related, the inclusion of a causal connective may not facilitate integration and may even induce processing difficulty (Golding et al., 1995). For instance, sentence (7) is likely to be harder to process than (6) because the connective "so" facilitates the integration of sentences that have an intrinsic causal relationship in (6) but not when this relationship is absent in (7). Moreover, while most research has focused on the processing of causal relations, similar effects are observed for connectives, such as "but" and "although", that indicate an adversative relationship (Jasinskaja, 2012; Murray, 1994, 1997; Umbach, 2004).

(6) Liru climbed up the mountain yesterday. So today she felt tired.

(7) Liru received a beautiful card yesterday. So today she felt tired.

Finally, numerous investigations of causal processing show that measures of eye

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movements, which provide an moment-by-moment index of linguistic processing during reading (see, e.g., Rayner, 2009), are highly sensitive to the incremental nature of causal integration processing during reading (e.g., Cozij, Noordman, & Vonk, 2011; Mak & Sanders, 2013; Traxler et al., 1997; van den Bosch, Segers, & Verhoeven, 2018; van Silfhout, Evers-Vermuel, & Sanders, 2015). We therefore used this method to investigate the interaction between focus and causal integration processing in the present experiment.

Our aim was to determine whether pragmatic processes associated with contrastive focus is processed sufficiently rapidly to influence the processing of inter-sentence integration. This is potentially important, as it will shed further light on the fundamental role played by pragmatic processes in discourse processing by revealing whether contrastive focus can influence on-line inter-sentence integration, just as it influences syntactic and semantic processes during sentence processing (see, e.g., Filik et al., 2011). This was achieved in Experiments 1 and 2 by examining whether focus influences the connective facilitation effect. Consider how easily the sentences in (9) to (12) might integrate with the sentence in (8). For (9) and (10), this may be easy, as (8) provides a cause for the events described in these sentences. Moreover, for (10), integration is further supported by presence of a causal connective and so may be even easier. Sentences (11) also may be integrated relatively easily even though (8) does not provide a cause for the event it describes (i.e., Liru and Jiangang climbed the mountain does not explain why only Liru felt tired).

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However, as “Liru” is marked by “only” in this sentence, the processing of this word should be facilitated. Finally, (12) includes both a focus particle and causal connective. For this example, “only” requires a contrast between the two characters. However, the connective indicates a causal relationship between the sentences that does not relate to this contrast, and so there is no answer for “why only Liru felt tired”. Conflict between these focus and connective requirements may therefore trigger processing difficulty.

(8) Yesterday, Liru and Jiangang climbed up the mountain.

(9) Today Liru felt tired.

(10) So today Liru felt tired.

(11) Today only Liru felt tired.

(12) So today only Liru felt tired.

We investigated if such difficulty is observed on-line, such that pragmatic inferences related to focus are processed sufficiently rapidly to influence inter-sentence integration. Experiments 1 used two-sentence stimuli (Table 1), in which an event in one sentence was the cause of an event in a second. The second sentence began with or without the causal connective “suoyi”, and included a focus particle (“zhiyou”, meaning “only”, in Experiment 1a, and “shi”, meaning “it was… who…”, in Experiment 1b) or not.

In line with previous research, we expected that the presence of a causal connective

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should facilitate sentence integration (as the sentences always had an intrinsic causal relation), and the presence of the focus particle should facilitate processing of focused words. However, for readers to process a focused word successfully, they must establish a contrast between that word and other elements. This may conflict with causal integration, with two possible outcomes. If contrast establishment does not affect inter-sentence integration, we may observe connective and focus facilitation effects independently. Consequently, processing will be quicker for sentences with a connective than not, and for focused than non-focused words. However, if contrast establishment disrupts inter-sentence integration when the two are potentially in conflict, we may observe an interaction in eye movement measures sensitive to on-line sentence processing, such that the connective facilitation effect is observed normally in the absence of a focus particle and disrupted when one is present.

Experiment 1

Experiments 1 investigated the influence of focus on sentence integration by examining effects for “zhiyou” (Experiment 1a) and “shi” (Experiment 1b).

Method

Participants. Participants in Experiment 1a were 24 students aged 20-26 years (M = 23 years; 12 males), and in Experiment 1b were a different 30 students aged 19-29 years (M = 22 years; 15 males), all from universities near the Institute of Psychology at the Chinese Academy

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of Sciences in Beijing.

Stimuli & Design. Forty sets of two-sentence Chinese discourses were constructed (see Table 1). The first sentence of each discourse introduced a causal event and the second described a consequent event. Two different-gender characters were introduced in the first sentence using two gender-typical Chinese names, each composed of two Chinese characters so that the names were always the same length (e.g., "建刚", or "Jiangang", is a typical Chinese male name, and "丽茹", or "Liru", is a typical female name). The first-mentioned character was female for half the discourses and male for the other half. In the second sentence, one character (e.g., "Liru") was repeated as the target name. The target name always referred to the first-mentioned character to avoid effects due to order of antecedents. In Experiment 1a, the second sentence began with the connective "suoyi" or not and the target name was marked by "zhiyou" or not. In Experiment 1b, "zhiyou" was replaced with "shi". For both experiments, an additional 56 two-sentence discourses served as filler items, and a further 10 discourses served as practice items. To encourage comprehension, one third of experimental and filler items were followed by a two-alternative forced-choice comprehension question about an aspect of the discourse other than the target name.

The experiment used a within-participants design with the factors Connective (present, absent) and Focus (present, absent). The experimental items were presented in one of four

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counterbalanced lists so that each participant read each passage in only one condition.

Insert Table 1 about here

Apparatus & Procedure. Monocular eye movements were recorded from the dominant eye (right eye for 20 participants, left eye for 4 participants in Experiment 1a; right eye for 26 participants, left eye for 4 participants in Experiment 1b) during binocular reading using an EyeLink 1000 eye-tracker (SR Research). Chin and forehead rests were used to minimize head movements. Stimuli were displayed on a high-definition monitor, at 60 cm viewing distance, as white text on a dark background in 24-point Chinese Songti font.

At the start of the experiment, participants were seated at the eye-tracker and instructed to read normally and for comprehension. A 9-point procedure was used to calibrate eye movements (with spatial accuracy > .3°). At the beginning of each trial, a small square appeared on the left side of the screen. Once a participant fixated this square, a passage was displayed with the first character replacing the square. When the participant finished reading, they pressed a response key. The passage then disappeared, replaced by a comprehension question on 1/3 of trials, to which participants responded. Fixation accuracy was checked prior to each trial and the eye-tracker recalibrated as necessary. The experiment lasted 30 minutes for each participant.

Results

Accuracy responding to comprehension questions in Experiment 1a averaged 97% (>

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80% for all participants). Data from one participant were excluded from analyses in Experiment 1b due to comprehension accuracy < 80%. For the remaining participants in Experiment 1b, accuracy averaged 96%. Following standard procedures, fixations shorter than 80ms or longer than 800ms were deleted, affecting 1.9% of fixations in Experiment 1a and 2% of fixations in Experiment 1b. A further 9 trials in Experiment 1a, and 4 trials in Experiment 1b, were removed due to excessive blinks or recording error. Data are reported for a region containing the focused (or not) word (e.g., "Liru"). Trials with zero fixation times in this region were excluded. Data analysis focused on eye movement measures sensitive to early and late processing (see Table 2).

Data were analyzed by linear mixed-effects models (Baayen, Davidson, & Bates, 2008) using R (R Development Core Team, 2016) and the lme4 package (Bates, Maechler, & Bolker, 2011). For binomial variables, generalized LMEMs were conducted with the Laplace approximation. A maximal random effects structure was used (Barr, Levy, Scheepers, & Tily, 2013), with participants and items as crossed random effects. Focus, Connective, and their interaction were fixed factors. Contrasts of main effects and to examine interactions were defined using sliding contrasts (the contr.sdif function) in the MASS package (Venables & Ripley, 2002). Following convention, $t/z > 1.96$ were considered significant. Data for continuous variables were log-transformed. Table 2 shows descriptive statistics and Table 3 statistical effects.

Insert Table 2 about here

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In Experiment 1a, main effects of Focus (in FFD, GD, RPRT, TRT) were due to shorter reading times for focused than non-focused names (i.e., a focus facilitation effect). A main effect of Connective in GD was due to shorter reading times when the connective was present than absent (i.e., a connective facilitation effect). An interaction between these variables (in GD, RPRT, TRT) was due to shorter reading times (GD, $b = .19$, $SE = .04$, $t = 4.97$; RPRT, $b = .22$, $SE = .05$, $t = 4.30$; TRT, $b = .16$, $SE = .05$, $t = 3.50$) for non-focused names when the connective was present than absent, with no effect for focused names (ts < 1.9). In Experiment 1b, main effects of Focus (in FFD, GD, RI) were due to shorter reading times and fewer regressions for focused than non-focused names (i.e., a focus facilitation effect). There was no main effect of Connective. An interaction in RI was due to fewer regressions to the target names when the connective was present than absent ($b = .64$, $SE = .19$, $t = 3.32$) for the non-focused condition, with no effect for the focused condition ($t < 1$).

Insert Table 3 about here

Discussion

Both experiments produced a standard focus facilitation effect, such that reading times for the target name were shorter when this was focused (using either “zhiyou” or “shi”) than unfocused. Experiment 1a additionally showed that, in passages without “zhiyou”, the causal connective facilitated processing, replicating the standard connective facilitation effect. However,

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when "zhiyou" was present, this effect was disrupted so that reading time differences due to the connective no longer were observed, consistent with conflict between focus and connective requirements. In Experiment 1b, an interaction in regressions was observed such that a connective facilitation effect (fewer regressions) was observed when "shi" was absent but not when it was present. The pattern (but not time-course) of this effect was consistent with Experiment 1a. The findings from both Experiments 1a and 1b therefore show standard focus and connective facilitation effects and also that conflict between focus and connective requirements can disrupt discourse processing. This suggests that focus is processed sufficiently rapidly during reading that it can disrupt semantic processes underlying on-line inter-sentence integration when focus and connective requirements are in conflict.

Experiment 2

Experiment 1 showed conflict between focus and connective requirements can disrupt discourse processing. Therefore, pragmatic information (namely, contrastive focus) influenced on-line sentence integration. One issue with this claim is whether disruption was selectively due to conflict between focus and causal integration, as we have claimed but not yet demonstrated. To investigate this, we examined focus effects when inter-sentence relations were causal or adversative. The results from Experiment showed that readers experience difficulty when the causal relations between the sentences in "Yesterday, Liru and Jiangang climbed up the

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mountain. So today only Liru feels tired" does not provide an answer for why only Liru felt tired. Replacing the causal connective with an adversative (e.g., "however") in "Yesterday, Liru and Jiangang climbed up the mountain. However today only Liru feels tired" appears to eliminate this problem by licensing a contrast between Liru and Jiangang. However, this needs to be tested empirically. We therefore investigated eye movements for the same set of stimuli used in Experiment 1 but where the sentences in these stimuli were linked using either a causal or adversative connective. Given the number of stimuli in this set, we were unable to assess whether the connective facilitation effect was disrupted by focus (as we did not include a condition in which neither a causal nor adversative connective was used). However, we reasoned that conflict between focus and casual integration might disrupt the focus facilitation effect (as well as the connective facilitation effect, as shown in Experiment 1). We therefore examined the processing of focused and unfocused words in causal compared to adversative contexts. We hypothesised that if focus selectively conflicts with causal inter-sentence integration, the normal focus facilitation effect may be disrupted in causal contexts, where the two are in conflict, but not in connective contexts where focus is no longer incongruent with the inter-sentence relation.

Method

Participants. Participants were 24 students aged 18-32 years (M = 24 years; 12 males) from universities near Institute of Psychology at the Chinese Academy of Sciences in Beijing,

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who did not take part in Experiments 1.

Materials & Design. Stimuli were constructed by modifying Experiment 1a stimuli by linking sentences using causal ("souyi") or adversative ("danshi") connectives (Table 4). Target words referred to the first-mentioned name for half of stimuli and the second-mentioned name for the others. Filler items and comprehension questions were the same as in Experiment 1.

Apparatus & Procedure. The apparatus and procedure were the same as in Experiment 1. Eye movements were recorded from each participant's right eye.

Results

Accuracy responding to comprehension questions averaged 97% (> 90% for all participants). Data were processed following the same procedure as in Experiment 1, resulting in exclusion of 1.6% of fixations. Effects are reported for the target word. Table 5 shows descriptive statistics and Table 3 the statistical effects for this region.

Insert Table 4 & 5 about here

An effect of Focus (in TRT and RI) was due to shorter reading times and fewer regressions for focused than non-focused names (a focus facilitation effect). No main effect of Connective was observed. An interaction in RPRT was due to shorter reading times for focused than non-focused target names when an adversative (b = .15, SE = .06, t = 2.44) but not causal connective ($t < 1$) was used.

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Discussion

In Experiment 2, an interaction in regression-path reading times showed a focus facilitation effect for sentences linked by an adversative but not causal connective. We take this to show that the focus particle established a contrast and sentence integration was not disrupted when contexts included an adversative connective that also indicated a contrastive relation. By comparison, disruption occurred when the connective specified a causal relationship with the result that no focus facilitation effect was observed. We take this finding to support the view that disruption effects in Experiment 1a (and, by extension, 1b) were selectively due to conflict between focus and casual integration.

General Discussion

We have reported two experiments in Chinese that examined the interaction between contrastive focus and causal integration during the comprehension of short discourses like "Yesterday, Liru and Jiangang climbed up the mountain, so today only Liru felt tired". In this example, the focus particle "only" serves to emphasise the name "Luri", and implying that this person should be contrasted with someone else (i.e., "Jiangang"), while the causal connective "so" indicates that the first sentence provides a cause for the events described in the second sentence. Crucially, the processing requirements of the focus particle and causal connective are in conflict in this example, as the first sentence does not provide the reason why only Liru is tired. The

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purpose of our experiments was to determine if this conflict causes processing difficulty during reading, as this would show whether pragmatic processes associated with contrastive focus can influence semantic processes involved in inter-sentence integration during discourse comprehension.

There were several key findings. First, in passages without a causal connective, focused words were processed faster than non-focused words, consistent with a focus facilitation effect (Birch & Rayner, 2010; Chen et al., 2012; Morris & Folk, 1998). Second, in passages without a focus particle, causal connectives facilitated the integration of causally-linked sentences, consistent with a connective facilitation effect (Millis & Just, 1994; Traxler et al., 1997). Whereas such effects were reported previously for English, the present research reveals a similar effect for Chinese, demonstrating the generality of inter-sentence integration processes across different writing systems. Third, the co-presence of a focus particle and causal connective disrupted sentence integration. We argued this was a consequence of conflict between pragmatic information implied by focus, namely, a contrast between the focused element and some other elements, and the relationship specified by the causal connective. Consequently, when sentences included “zhiyou” or “shi”, a causal relationship could no longer be processed easily, resulting in processing difficulty (Experiments 1a & 1b). Experiment 2 investigated if contrastive focus selectively disrupted processing in causal contexts, as we had assumed, and so not when an

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adversative connective specified a contrastive relationship that was not incongruent with focus requirements. The standard focus facilitation effect was observed when the relationship was contrastive but disrupted when causal, which we interpreted as confirming that disruption effects in Experiment 1's effects were due to conflict between focus and causal integration.

Our findings demonstrate that pragmatic processing (specifically contrastive focus) occurs rapidly during discourse comprehension, and sufficiently so to influence semantic processes underlying inter-sentence integration. Such findings add to other evidence that contrastive focus can rapidly influence on-line processing (e.g., Filik et al., 2011). Crucially, however, where previous studies examined focus effects within-sentences, the present findings reveal an influence on the integration of information across sentences. We showed this effect using sentences in which the presence of a causal connective implied that the information in the first sentence was the cause of the events in the sentence. We argued that readers have difficulty with discourses such as "Yesterday Liru and Jiangang climbed the mountain for a whole day, so today only Liru felt tired", because a causal relation between the two sentences does not answer the question why only Liru felt tired. We also showed that this difficulty is eliminated when the causal connective is replaced by an adversative connective that licenses a contrast between the two characters in the first sentence. However, it is important to note that we are not argued that focus and causal inter-sentence integration will always conflict. Whether they conflict depends

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on whether the prior context provides the information required to satisfy the requirements of focus and the causal connective. For example, if the context provides information such as "Liru doesn't exercise after work while Jiangang goes to the gym every day", this can explain why only Liru felt tired when the following sentence states "so today only Liru felt tired", satisfying the requirements of both the causal connective and focus. We would therefore expect readers to have no difficulty processing this sentence. This has not been tested empirically, however, and further work clearly is required to more fully understand factors affecting the influence of focus on inter-sentence integration. The present findings nevertheless show that such an influence occurs naturally during reading and therefore that pragmatic inferences underlying focus can affect discourse processing.

However, while we clearly showed that processing is disrupted when focus and casual integration are in conflict, the time course of these effects varied across experiments. In Experiment 1a, focus had an immediate and strong influence on sentence integration, whereas in Experiment 1b, the effect was weaker and observed only later in the eye movement record (in regressions to target words). Similarly, the effect in Experiment 2 emerged relatively late during processing (in regression-path reading times). Thus, while the findings confirm that pragmatic information is processed incrementally during reading, variation in the strength and timing of effects suggests this processing is flexible. This flexibility might arise from differences in the

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precise function of different focus devices, such as particles like "only" and "zhiyou" compared to it-clefts or "shi". Indeed, the contrastive implication of only-focus appears to differ from that of cleft-focus (see Drenhaus et al., 2011; Umbach, 2004). Drenhaus et al. (2011) showed that whereas violations in the contrastive implications of only-focus and cleft-focus elicit larger effects in the EEG / ERP waveform during reading, the locus of the two effects appears to differ (i.e., violation of cleft-focus is associated with a larger N400-like effect, whereas violation of only-focus produces a larger P600 effect). Umbach (2004) suggests this may relate to differences in assumptions underlying the computation of contrast sets. Cleft-focus carries the presupposition that someone other than the focused person possesses some attribute. For instance, a sentence like "it was Liru who felt tired" presupposes that someone other than Liru would feel tired and that Liru feeling tired violated this expectation. By comparison, only-focus carries the presupposition that the focused person and also some others possess an attribute. Therefore, a sentence like "only Liru felt tired" presupposes that both Liru and some others might feel tired but that this is violated as only Liru felt tired. Thus, while in both cases the focus domain implies a contrast between the focused element and its alternatives, there are subtle but differences in the presuppositions associated with only-focus and cleft-focus (and therefore Chinese zhiyou-focus and shi-focus). These may cause the sentences to be processed differently and this in turn may explain the differences in the timing of effects observed in Experiments 1a and 1b. By

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comparison, variation in the timing of effects in Experiment 2 compared to Experiment 1 seem most likely to be due to differences in the design of these two experiments. In Experiment 1, we examined the connective facilitation effects (i.e., facilitated inter-sentence integration by the presence of a causal connective) in discourses with and without a focus particle. However, in Experiment 2 we examined the focus facilitation effect (facilitated processing of a focused element) in discourses containing a causal or adversative connective. These differences in experimental design might have influenced how easily disruption effects might be detected, potentially accounting for the differences in the timing of these effects in the two experiments.

Theoretical accounts of focus have argued that focus processing depends on two separate pragmatic processes: attention allocation and contrast establishment (Chen & Yang, 2015; Chen, 2018), and the present results provide evidence for both processes. First, as discussed above, Experiments 1 and 2 show disruption to processing when the requirements of causal integration and contrastive focus conflict. These studies therefore provide clear evidence for contrast establishment. However, the findings also show that focus can modulate attention. In Experiment 1, focus affected the duration of the first fixation on target words, and a similar effect was observed in total reading times in Experiment 2. This was due to faster processing of focused than non-focused words, consistent with other indications that processing of focused information is facilitated due to greater allocation of attention (Birch & Rayner, 2010; Chen et al., 2012;

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Morris & Folk, 1998). Again, these effects varied in their time course, appearing early during processing in Experiments 1 but only later in Experiment 2. Similar variation in time-course is observed in previous studies. Birch and Rayner (2010) reported a strong effect in both early and late eye movement measures. By comparison, Morris and Folk (1998) reported a late effect only. The influence of focus on attention therefore may also be flexible, too, occurring either rapidly to immediately influence sentence processing or more slowly to influence later integration processes. Consequently, while our findings add to evidence that the on-line resolution of pragmatic information can influence discourse processing, an important task for future research will to understand the reasons for this flexibility in the timing of pragmatic influences on the processing of other linguistic information and the allocation of attention during reading.

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Supplementary Material

The Supplementary Material is available at: qjep.sagepub.com

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Table 1. Example Stimuli in Experiment 1

Condition	*Passages*
Non-focused / No Connective	丽茹和建刚昨天爬了一天山，今天丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. Today Liru felt ache at every pore.
Non-focused / Connective	丽茹和建刚昨天爬了一天山，所以今天丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. So today Liru felt ache at every pore.
Focused / No Connective	丽茹和建刚昨天爬了一天山，今天*只有*丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. Today *only* Liru felt ache at every pore.
Focused / Connective	丽茹和建刚昨天爬了一天山，所以今天*只有*丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. So today *only* Liru felt ache at every pore.

Note: Target words are underlined. The connective "suoyi" (所以) is written in a different font. The focus particle "zhiyou" (只有) is in italics. All characters were shown normally in the experiment. The two sentences were separated by a comma in the Chinese text. This is replaced by a period in the English translation. In Experiment 1b, "zhiyou" was replaced by "shi" (是).

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Table 2. Eye Movement Measures for the Target Region in Experiment 1

	Experiment 1a				Experiment 1b			
	Non-focused		Focused		Non-focused		Focused	
Measures	Without-connective	With-connective	Without–connective	With-connective	Without-connective	With-connective	Without-connective	With-connective
FFD	285 (8)	269 (7)	256 (6)	265 (7)	262 (6)	265 (7)	250 (5)	250 (5)
GD	364 (12)	329 (13)	301(10)	297 (9)	312 (11)	321 (11)	293 (8)	289 (8)
TRT	523 (20)	471 (19)	453 (19)	460 (17)	485 (18)	472 (18)	492 (19)	459 (15)
RI (%)	34 (3)	28 (3)	26 (3)	26 (3)	45 (3)	34 (3)	32 (3)	34 (3)
RPRT	464 (20)	404 (18)	381 (20)	404 (22)	392 (17)	406 (18)	395 (17)	377 (18)

FDD (first-fixation duration) is the duration of the first fixation in a region prior to a fixation to its right; GD (gaze duration) is the sum of all fixations from the first fixation in a region until a saccade crosses its right or left boundary; TRT (total reading time) is the sum of all fixations in a region; RI (regressions-in) is the probability of a regression into a region; and RPRT (regression-path reading time) is the sum of all fixations, including re-reading, from the first fixation in a region until a saccade crosses its right boundary. FFD and GD are informative about early stages of word processing, and TRT, RI, and RPRT are informative about the later integration of linguistic information (Rayner, 1998). All measures are in ms except for RI. The standard error of the mean is shown in parentheses.

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Table 3. Statistical Effects for Experiments 1 and 2

		FFD	*GD*	*TRT*	*RI*	*RPRT*
Experiment 1a						
Intercept	*b*	5.54	5.67	6.00	0.97	5.85
	SE	0.02	0.03	0.06	0.21	0.04
	t/z	248.79	168.87	98.43	4.68	145.38
Focus	*b*	0.05	0.13	0.08	0.19	0.13
	SE	0.02	0.03	0.03	0.16	0.04
	t/z	2.39*	4.87*	2.48*	1.22	3.63*
Connective	*b*	0.02	0.06	0.02	0.18	0.07
	SE	0.03	0.03	0.04	0.16	0.38
	t/z	0.64	2.38*	0.66	1.15	1.95+
Focus × Connective	*b*	0.08	0.12	0.16	0.31	0.18
	SE	0.04	0.05	0.06	0.32	0.07
	t/z	1.78	2.24*	2.49*	0.98	2.51*
Experiment 1b						
Intercept	*b*	5.50	5.61	5.98	0.54	5.79
	SE	0.02	0.03	0.06	0.16	0.05
	t/z	274.92	169.48	101.92	3.27	110.75
Focus	*b*	0.04	0.06	0.01	0.34	0.03
	SE	0.02	0.02	0.03	0.14	0.03
	t/z	2.16*	2.46*	0.03	2.48*	1.04
Connective	*b*	0.01	0.01	0.03	0.24	0.02
	SE	0.02	0.03	0.03	0.14	0.04
	t/z	0.08	0.16	0.96	1.76	0.51

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Focus × Connective	*b*	0.01	0.02	0.01	0.60	0.06
	SE	0.04	0.05	0.06	0.27	0.06
	t/z	0.10	0.48	0.07	2.20*	0.93
Experiment 2						
Intercept	*b*	5.53	5.66	6.09	0.60	5.83
	SE	0.02	0.04	0.07	0.16	0.05
	t/z	232.85	146.66	87.32	3.71	118.82
Focus	*b*	0.01	0.02	0.09	0.36	0.06
	SE	0.03	0.03	0.04	0.14	0.05
	t/z	0.24	0.67	2.13*	2.55*	1.26
Connective	*b*	0.02	0.04	0.01	0.19	0.06
	SE	0.02	0.03	0.03	0.14	0.04
	t/z	0.96	1.37	0.27	1.33	1.63
Focus × Connective	*b*	0.04	0.08	0.10	0.51	0.17
	SE	0.05	0.06	0.07	0.28	0.07
	t/z	0.90	1.36	1.44	1.78	2.47*

Note. * $p < .05$

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Table 4 Example of the Experimental Materials in Experiment 2

Condition	*Passages*
Focused / Adversative	丽茹和建刚昨天爬了一天山，但是今天*只有*丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. But today *only* Liru felt ache at every pore.
Non-focused / Adversative	丽茹和建刚昨天爬了一天山，但是今天丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. But today Liru felt ache at every pore.
Focused / Causal	丽茹和建刚昨天爬了一天山，所以今天*只有*丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. So today *only* Liru felt ache at every pore.
Non-focused / Causal	丽茹和建刚昨天爬了一天山，所以今天丽茹感觉浑身酸痛。 Yesterday Liru and Jiangang climbed the mountain for the whole day. So today Liru felt ache at every pore.

Note: Target words are underlined. The connectives “danshi” (但是） and “suoyi” (所以） are written in a different font. The focus particle “zhiyou” (只有） is in italics. All characters were shown normally in the experiment. The two sentences were separated by a comma in the Chinese text. This is replaced by a period in the English translation.

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Table 5. Eye Movement Measures for the Target Region in Experiment 2

Measures	Adversative Connective		Causal Connective	
	Focused	Non- focused	Focused	Non- focused
FFD	261 (6)	264 (6)	273 (6)	270 (7)
GD	298 (9)	322 (11)	326 (11)	330 (12)
TRT	498 (20)	592 (26)	526 (22)	538 (20)
RI (%)	38 (3)	40 (3)	29 (3)	42 (3)
RPRT	358 (17)	439 (22)	428 (22)	413 (20)

Note. All measures in ms except RI. The standard error of the mean is shown in parentheses.

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