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Processing Plausibility in Concessive and Causal Relations: Evidence from Self-Paced Reading and Eye-Tracking

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ABSTRACT

In this study participants read plausible and implausible sentences containing concessive and causal relations in Chinese, for instance, *[Although/ Because] he has a talent for language, he [doesn't like/likes] learning English*. In two self-paced reading experiments (Experiments 1 and 2), we consistently found the plausibility effect at the postcritical region in both concession and causality. When a second postcritical region was added (Experiment 2), implausibility induced a sustained effect in causality but became temporarily acceptable in concession. In an eye-tracking study, plausibility induced a larger effect in concession on the second-pass and the total reading time of the precritical regions than in causality. The results suggest that verifying sentence plausibility in a negated cause–effect relation (i.e., concession) can be as fast as in a direct cause–effect relation (i.e., causality), as negation is expected in processing concession. At a later stage, different strategies are adopted in resolving the implausibility of the two relations. We suggest that a perspective shift is involved in resolving the implausibility in concession, which induces greater cost compared with causality.

Introduction

Most texts consist of two or more clauses that are related in some way. As language unfolds online, we draw on our real-world knowledge to process the relations between events and states and establish coherence in the discourse (Keenan, Baillet, & Brown, 1984; Kuperberg, Paczynski, & Ditman, 2011; Nieuwland, 2015; Singer & Halldorson, 1996; van Dijk & Kintsch, 1983). Of all the interclausal relations, concession and causality are closely related notions: Concession has often been considered the negative or contradictory counterpart of causality (König, 1991; König & Siemund, 2000; Sanders, Spooren, & Noordman, 1992, 1993). Whereas causal connectives signal that the described events are causally related, concessive connectives indicate that the expected causal links between the described events are violated (Louwerse, 2001). Consider the following examples:

- (1) Because the pupil studied a lot, he passed the exam.
- (2) Although the pupil studied a lot, he did not pass the exam.

In sentences like (1), the two events *study a lot* and *pass the exam* form a causal relation as indicated by the connective *because*. By contrast, the causal link between the events is rejected in a concessive relation like (2) where the concessive connective *although* leads to a negated consequential event *not pass the exam*. Though grounded in the same conditional *if p then q* (i.e., $p \rightarrow q$), concession involves

a violation of the conditional relation and has been found harder to comprehend than causality (Caron, Micko, & Thüring, 1988; Köhne & Demberg, 2012, 2013; Townsend, 1983; Xu, Chen, Panther, & Wu, 2018). For instance, whereas the initial *because* clause is processed faster than its following main clause, the initial *although* clause is processed slower, suggesting that in contrast to initial causal clauses that are immediately processed, initial *although* clauses that indicate a denial of a causal relation are processed with greater uncertainty as comprehenders do not know which event is to be rejected until the subsequent clause has been fully interpreted (Townsend & Bever, 1978, 1982, 1991).

Whereas causality as one of the most fundamental logical operations in human cognition directly describes a causal relation between events, concession can be taken as a proposition that deviates from the common logical relations, a subjective invitation to consider a less common logical possibility (Verhagen, 2005). In a concessive relation like (2), although the speaker acknowledges that *the pupil has studied a lot*, the expected consequence that *he will pass the exam* is countered by *he didn't pass the exam*. Comprehenders have to take into account the speaker's point of view and accept the reversed expectation (i.e., *didn't pass*) rather than interpret the sentence directly based on their own world knowledge (i.e., *study a lot* → *pass exams*) as they do for (1).

The violation of the causal expectation in a concessive relation is often associated with negative sentiment, which can be marked syntactically by an overt negator (e.g., *not*) or a semantic antonym (e.g., *fail* as an antonym of *pass*). Although negation is usually harder to process than its affirmative counterpart in simple sentences (Carpenter & Just, 1975; Just & Carpenter, 1971) and clauses with causal relations (Lyu, 2019), self-paced reading results showed no differences between negative expressions (e.g., *not save*) and positive expressions (e.g., *delete*) for processing concessive sentences like (3), suggesting that overt negators are preferred in a concessive relation as the surface linguistic form spells out each element of the logical form, for example, *although p, not q* (Lyu, 2019). Similar results were reported by Morera, León, Escudero, and de Vega (2017), who found negative emotional icons following concession were much easier to process.

- | | | | | | |
|------------|----------|-------------------------------|--|----------------|-------------|
| (3) suiran | Xiaoying | bianji | | baibanxiaoxin, | |
| although | Xiaoying | edit | | very careful | |
| danshi | haishi | <u>mei baocun/shanchu -le</u> | | wenjian, | zhenkexi |
| but | still | not save/delete ASP. | | file | such a pity |
- “Although Xiaoying was very careful in editing, she still didn't save/deleted the file. It was such a pity.”

During the comprehension of common events in discourse, people immediately use their world knowledge (Cook & O'Brien, 2014; Gerrig & O'Brien, 2005; Kuperberg et al., 2011; McRae & Matsuki, 2009; Nieuwland, 2015). When the events and their relations are incongruent with real-world knowledge, processing is difficult (Filik & Leuthold, 2008; Hagoort, Hald, Bastiaansen, & Petersson, 2004; Keenan et al., 1984; Myers, Shinjo, & Duffy, 1987; Rayner, Warren, Juhasz, & Liversedge, 2004; van de Meerendonk, Kolk, Vissers, & Chwilla, 2010; Warren & McConnell, 2007). For example, the concessive interpretation of (4) builds on the causal condition that if a person studies a lot, s/he should *not* pass the exam, which is contrary to one's real-world knowledge about the causal relation between studying and passing an exam. Concessive sentences like (4), building on implausible causal relations, are expected to be more difficult to understand. The contrast between (2) and (4) is referred to as the effect of plausibility in the present study.

- (4) Although the pupil studied a lot, he passed/did not fail the exam.

Verifying the plausibility of sentences containing negation is found to be harder than that of positive sentences (e.g., Fischler, Bloom, Childers, Roucos, & Perry, 1983; Lüdtke, Friedrich, de Filippis, & Kaup, 2008). In processing a sentence like (5), for example, the true condition *A robin is*

not a tree elicited a larger N400 than the false condition *A robin is not a bird*. According to the two-step theory, people suppose the false inner proposition (i.e., *A robin is a tree*) before integrating the negation to verify the sentence truth value (Clark & Chase, 1972; Kaup, Lüdtke, & Zwaan, 2006). A competing incremental account, however, suggests that no additional processing costs are inherently associated with negation (Nieuwland & Kuperberg, 2008; Tian, Ferguson, & Breheny, 2016). When pragmatically licensed by a sufficient context, as in (6), negation is incrementally processed rather than take an extra step to be integrated, as suggested by the larger N400 in the false *safe* case.

- (5) A robin is not a tree/*bird.
 (6) With proper equipment, scuba-diving isn't very dangerous/*safe.

Concession denotes a negated causal assumption. Several experimental studies have revealed that the plausibility effect elicits different neural responses in concession and causality (Drenhaus, Demberg, Köhne, & Delogu, 2014; Xiang & Kuperberg, 2015; Xu, Jiang, & Zhou, 2015), but this effect did not show up in concessive sentences using behavioral measures (Köhne & Demberg, 2013; Xu et al., 2018). Whether verifying the plausibility of a sentence that contains a negated cause–effect relation (i.e., concession) takes greater costs than in a sentence that contains a direct cause–effect relation (i.e., causality) remains unclear.

Event-related potential (ERP) studies showed an N400 effect (i.e., a negative-going ERP component that peaks between 300 and 500 ms after word onset; Kutas & Hillyard, 1980, 1984) in implausible conditions compared with plausible conditions for both causal and concessive conditions (Drenhaus et al., 2014; Xiang & Kuperberg, 2015; Xu et al., 2015). Whereas a P600 effect (i.e., a late positive-going ERP component that peaks between 500 and 800 ms after stimulus onset; Kuperberg, 2007; Osterhout & Holcomb, 1992, 1993) has been observed in causally related sentences; concession elicited a late anterior negativity effect (Xiang & Kuperberg, 2015; Xu et al., 2015). This late anterior negativity effect was attributed to the extra cost of suppressing an incongruent connective so that one can interpret a concessive sentence as a causal relation. For example, when connectives such as *even so* create an inconsistency as in (7), participants may choose to ignore the connective and interpret it in the most logical way as *Elizabeth aced the exam and (therefore) celebrated wildly*.

- (7) Elizabeth had a history exam on Monday. She took the test and aced it. Even so, she went home and celebrated wildly.

By contrast, in behavioral experiments, the plausibility effect does not always show up in concession. In an eye-tracking experiment on German concessive and causal relations like (8), significantly longer times (e.g., first-pass, total reading, regression) were spent in reading the pretarget region of *causal* relations for implausible conditions whereas only a marginal difference was found in the pretarget regions of *concession* (Köhne & Demberg, 2013, Experiment 2).

- (8) ... Her head feels cold. Therefore/However, she looks for [a nicely warm]_{gender-marked pre-target} [hat/scarf that does not look too colorful]_{target}.

In a recent study, Xu et al. (2018) adopted eye-tracking and self-paced reading tasks to investigate the influence of connectives on the processing of Chinese causal and concessive relations. They manipulated the conjunction type (*yinwei* “because,” *jinguan* “although,” and no conjunction) and sentence congruency (congruent vs. incongruent). See (9) for an example of *incongruent* concession in Xu et al. (2018). The congruency effect was not observed in concessive sentences but was found in both the causal condition and the condition with no conjunctions. Xu et al. (2018) concluded that

since processing concessive relations was already cognitively demanding, the effect of pragmatic anomaly was not observed due to a ceiling effect.

- (9) waipo cong Shenyang qiandaole Hainan
 grandma from Shenyang move to Hainan
 jinguan ta xihuan nali dongtian nuanhuo
 although she like there winter warm

“Grandma moved from Shenyang to Hainan, although she liked the warm winter there.”¹

In closer examination of Xu et al. (2018), the lack of plausibility effect could be attributed to a few other factors. One possible factor is that the materials they used all involved backward relations where the main clauses are followed by clauses with connectives rather than the other way around. In terms of subjectivity, postposed concessive and causal clauses like (9) are considered more subjective than preposed ones like (10).

- (10) Although/*Because she liked the warm winter in Hainan, grandma moved to Shenyang.

Whereas sentence-initial clauses in (10) provide a logical framework or orientation for interpreting the event described in the subsequent clause, backward relations like (9) function as a follow-up justification to address potential enquiries, disagreement, suspicion, or general unexpectedness (Li, 2014; Lyu, 2014; Song & Tao, 2008; Verhagen, 2005; Wei, 2018). Different from a backward causality that still explicitly indicates a causal relation (as marked by the causal connective), backward concession does not form a strong reversed cause–effect relation against the preceding main clause, but rather it allows speakers to weaken the original claim and is thus taken to be supplementary (Lyu, 2014; Verhagen, 2005). Another possible factor is that the locative pronoun *nali* “there” in the second clause is ambiguous, as it can refer to either city in the first clause, thus making interpretation and reanalysis difficult. That confusion may have diffused the differences between the plausible and implausible conditions.

One last possible factor we find critical in Xu et al. (2018) is that the location of the critical word was in the sentence-final position. In moving-window reading paradigms, if the critical region is placed at the sentence-final position, effects may be delayed and thus not observed (Danks, 1986). Although the eye-tracking method adopted in Xu et al. (2018) provides unrestricted access to the preceding text, studies show that implausibility would also lead to delayed effects in tasks where eye movements are measured (Ferguson & Jayes, 2018; see also Joseph et al., 2008; Liversedge, Paterson, & Pickering, 1998).

As has been introduced, although it may be more costly to interpret a concessive relation than a causal relation (e.g., Caron et al., 1988), it remains unclear how the plausibility of the invoked event knowledge may interact with concession and causality. Whereas ERP studies have shown the N400 effect for the implausibility between events in both concessive and causal relations (Xiang & Kuperberg, 2015; Xu et al., 2015), behavioral measures show the effect only in causality but not in concession (Köhne & Demberg, 2013; Xu et al., 2018). The fact that the only existing experiments on Chinese concession adopt a postposed position for *jinguan* “although” and that the critical regions were sentence-final may be the reason why no plausibility effect was observed. To further explore how the plausibility between events affects comprehenders’ understanding of the concessive and causal relations, we conducted the current study.

Present study

The present study aims at examining the plausibility effect in concession and causality. Although built on the same world knowledge *causal event p* → *consequential event q*, concession differs from

1. Hainan is a southern city in China with warm weather all year round, and Shenyang is a northern city known for its cold winter.

causality in that it denotes a reversed causal assumption and involves speaker subjectivity. In this study, we investigate whether and how the processing of plausibility differs in a direct cause–effect relation $p \rightarrow q$, i.e., causality, and in a reversed cause–effect relation $p \rightarrow \neg q$, i.e., concession.

Experiment 1 contains two self-paced reading experiments, where we used the negative form in the consequence clause of concession (e.g., *bu xihuan* “does not like”) and the affirmative form in the consequence clause of causality (e.g., *hen xihuan* “likes very much”). These two forms are each the more natural continuation of the two relations, respectively (Morera et al., 2017). Experiment 2 is a self-paced reading experiment where we contrasted the sentence plausibility and discourse relation using a 2 by 2 factorial design. In Experiment 3, an eye-tracking study, we used the same negative form in both concession and causality so that the negation preference in concession, if exists, could be observed.

To examine how plausibility is manifested in the two closely related discourse relations, we used the most straightforward (i.e., unmarked) concessive/causal relation in our study, where two events were connected in a linear cause–consequence order (Noordman & de Blijzer, 2000). There are three important modifications of the materials used by Xu et al. (2018). First, we added one region after the critical region to obtain the potential carry-over effect. Second, we adopted the logical sequence *suiran ... danshi ...* “although ... but ...” and *yinwei ... suoyi ...* “because ... so ...” using paired connectives, which present an iconic relationship between the causal and consequential clauses. As reviewed, Xu et al. (2018) placed the concessive/causal clause after the main clause as in (9), which reads more like an afterthought (Verhagen, 2005). Third, we used the concessive adverbial *suiran* instead of *jinguan* because the former is more commonly used than the latter based on the Beijing Language and Culture University Chinese Corpus (with a frequency 26 vs. 8.36 per million for *suiran* and *jinguan*, respectively) (BCC; Xun, Rao, Xiao, & Zang, 2016, retrieved on 13 September 2017). With the linear cause–consequence order, participants may be able to better establish the iconic relation and thus be more sensitive to the difference between plausible and implausible conditions. With the additional postcritical region in the present design, we may be able to observe the carry-over effects if the effect is delayed.

Experiment 1

We study the plausibility effect in concessive (Experiment 1a) and causal (Experiment 1b) relations respectively by using their most natural logical forms, that is, spelling out negation in concession and retaining affirmativeness in causality. Based on subjective ratings of the underlying causal relation between the events in the pretests, three levels of plausibility were distinguished in each experiment: plausible, less plausible, and implausible conditions. Compared with the previous study by Xu et al. (2018), we added an additional postcritical region so that the effect, if delayed or carried over, can still be observed. The effect of plausibility, if observed, would show up with longer reading times in the critical regions and/or the postcritical region of the implausible conditions in both causal and concessive sentences.

Pretests

The plausibility in Experiment 1 was manipulated by using different noun phrases (NPs) as objects in the second clause of a concessive or a causal relation, for example, *xue yingyu/raoshe/kaiche* “learn English/hip-hop/driving”, as illustrated below.

- (11) Ta yuyan tianfu hen qiang,
 he language talent very good
 suoyi hen xihuan [xue]v [yingyu/raoshe/kaiche]_{NP}.
 so very like learn English/hip-hop/driving
 “He has a talent for language, so he very much likes learning English/hip-hop/driving.”

Two pretests were administered. The goal of the first pretest was to make sure the critical verb phrases (VPs) are equally acceptable at the local phrasal level, for example, *learn English*, *learn hip-hop*, and *learn driving*. The second pretest was to determine the plausibility of the concessive or causal sentence where these VPs appeared.

In the first pretest, 37 verbs including 24 monosyllabic verbs like *xue* “to learn” and 13 disyllabic verbs like *guan cha* “to observe” were initially selected. Each verb was paired with six object NPs to form verb phrases. Twenty native speakers of Mandarin Chinese (5 men, 15 women) rated the acceptability of each verb phrase on a 10-point Likert scale (1 for unacceptable and 10 for perfectly acceptable). Thirty verbs were selected based on the criterion that each verb have at least three object NPs that showed no significant differences in acceptability rating ($ps > .10$) and that the ratings were all above a score of 7. The selected verbs, together with their object NPs, were used in the second pretest.

Since both concession and causality are built on causal relations, the second pretest was administered to collect the plausibility of the causal relations between events by comparing the plausible (e.g., *xue yingyu* “learn English”) and less plausible (e.g., *xue raoshe* “learn hip-hop”) and the plausible and implausible (e.g., *xue kaiche* “learn driving”) VPs in the consequence clause, as illustrated in (11). The sentences were causally connected by either *yinwei* “because” or *suoyi* “so”, where the NP in the consequence clause (i.e., *yingyu/raoshe/kaiche*) was left blank. Five completions, including the three target NPs and two filler items (e.g., *deyu* “German”, *huahua* “painting”), were provided for each sentence in a randomized order. Thirty-six native speakers of Mandarin (17 men, 19 women) rated each of the completions on a five-point Likert scale for each sentence (1 for unacceptable and 5 for perfectly acceptable). Twenty-four sentences where both the two defined contrasts reached significance ($ps < .05$) were selected as the experimental materials. For all the selected sentences, the acceptability was significantly different between the plausible ($M = 4.32$, $SD = 1.17$) and less plausible conditions ($M = 3.14$, $SD = 1.42$; $p < .001$), and between the plausible and implausible conditions ($M = 1.53$, $SD = 1.06$; $p < .001$).

Methods

Participants

Forty-eight students from Beihang University were paid to participate in Experiment 1. Half of the participants participated in Experiment 1a (11 men, 13 women; mean age, 24.2 years [range, 21–28]) and the other half of the participants in Experiment 1b (10 men, 14 women; mean age, 23.2 years [range, 20–27]). Informed consent was obtained from all participants. All were native speakers of Mandarin Chinese with normal or correct-to-normal vision. None of the participants took part in the pretests.

Materials

Twenty-four sets of sentences were created as the experimental trials in Experiment 1a and Experiment 1b, respectively. Each experimental item was composed of three subclauses. For Experiment 1a the first two clauses form a concessive relation, led by *suiran* “although” in the first clause (C1) and *danshi* “but” in the second clause (C2). The third clause (C3) was a short commentary on C1 and C2. For Experiment 1b the connectives in C1 and C2 were changed into *yinwei* “because” and *suoyi* “so,” respectively. The total number of regions remained the same in both experiments. The adverbs preceding the VP in C2 were negative expressions in Experiment 1a and affirmative expressions in Experiment 1b. Example stimuli used in each experiment and the division of regions of each trial are shown in Table 1.

In each experiment the 24 sets of items, each containing three plausibility conditions, were divided into three lists in a Latin square design. Ninety-six fillers consisting of various syntactic structures were added. All together, 120 sets of sentences were presented to each subject in a pseudorandom order so that no two experimental trials appeared consecutively. Comprehension questions followed each trial to ensure that participants paid attention during the experiment. To

Table 1. Example Stimuli in Experiments 1a and 1b

Exp.	Region								
	1	2	3	4	5	6	7	8 (CR)	9 (CR+1)
1a	[Ahui Ahui	suiran although	yuyantianfu language talent	henqiang] _{C1} very good	danshi but	bu xihuan not like	xue learn	yingyu/raoshe/kaiche] _{C2} <u>English/hip-hop/driving</u>	[zhen qiguai] _{C3} very strange
	"Although Ahui has a talent for language, he doesn't like learning English/hip-hop/driving. It's very strange."								
1b	[Ahui Ahui	yinwei because	yuyantianfu language talent	henqiang] _{C1} very good	suoyi so	hen xihuan very like	xue learn	yingyu/raoshe/kaiche] _{C2} <u>English/hip-hop/driving</u>	[hen zhengchang] _{C3} very normal
	"Because Ahui has a talent for language, he likes learning English/hip-hop/driving very much. It's very normal."								

keep consistency across conditions, the comprehension questions were either about the first clause or involved an inference based on it. The number of yes or no and multiple-choice questions as well as the distribution of answers were counter-balanced.

Procedure

The experiments followed the standard moving-window self-paced reading design and were conducted using Douglas Rohde's Linger software version 2.94 (<http://tedlab.mit.edu/~dr/Linger/>). Each trial began with a sentence masked by dashes appearing on the screen and was presented region by region, as indicated in Table 1. In each trial participants pressed the SPACE key to proceed to the next sentence or region at their own pace. Test sentences were divided automatically by the software following a Latin square design and assigned to each participant pseudo-randomly. After the last word, participants were given a yes or no or multiple-choice comprehension question in each trial. Participants were instructed to read sentences at a natural pace to answer the comprehension questions correctly by pressing the button F or J on the keyboard. Feedback was given if the participant's response was incorrect. The reading time for each region, the time taken to answer the comprehension questions, and the responses to the comprehension questions were recorded. The whole experiment took an average of 25 minutes to complete.

Results

Linear mixed effects models with subject and item as random effects were fit to the comprehension accuracy data and the region-by-region reading time data using lme4 package version 1.1–21 (Bates, Mächler, Bolker, & Walker, 2015) in R version 3.5.3 (R Core Team, 2019). The reading times were log-transformed to stabilize variance and achieve approximately normal residuals (Box & Cox, 1964). Comprehension accuracy was analyzed as the binomial dependent variable using generalized linear mixed effects models. Random effects were removed when the model failed to converge.

In each experiment, two contrasts were defined comparing the plausible conditions with the less plausible conditions (plausible coded as +0.5, less plausible coded as -0.5) and comparing the plausible conditions with the implausible conditions (plausible coded as +0.5, implausible coded as -0.5). Residuals of linear mixed models were checked to ensure that there were no deviations from the normality assumption. The lmerTest package version 3.1–0 (Kuznetsova, Brockhoff, & Christensen, 2017) in R was used for the significance level.

Comprehension accuracy

The overall accuracy of the experimental items was 89.58% (SD = 0.32) in Experiment 1a and 96.35% (SD = 0.19) in Experiment 1b. Generalized mixed effect models showed that in Experiment 1a the plausible conditions (82.29%, SD = 0.38) were answered less accurately than both the less plausible conditions (90.63%, SD = 0.29; $\beta = -0.81$, $z = -2.45$, $p < .05$) and the implausible conditions (95.83%,

SD = 0.20; $\beta = -1.82$, $z = -4.08$, $p < .001$). In Experiment 1b the plausible conditions (98.96%, SD = 0.10) were answered more accurately than the implausible conditions (93.23%, SD = 0.25; $\beta = 2.17$, $z = 2.69$, $p < .01$) but showed no significant differences compared with the less plausible conditions (96.88%, SD = 0.17; $p > .10$). Given that the comprehension questions were about the information presented in C1 and not the logical relation between C1 and C2, the differences are not easy to interpret.

Reading times

The regions of interest were the object in C2 (Region CR), which is the critical region of our study, and the commentary clause in C3 (Region CR+1), which is the postcritical region. The reading times for the different regions across conditions are summarized in Figure 1, and the results of the statistical analysis are shown in Table 2.

For the contrast between plausible and less plausible conditions, no significant difference was found in either CR or CR+1 in both experiments. For the contrast between the plausible and implausible conditions, we found different results for concession (Experiment 1a) and causality (Experiment 1b). At the critical region (Region CR), we found a main effect of plausibility in causality (although it just reached the significance at .05) but not in concession, showing that participants spent longer time in causal-implausible sentences than causal-plausible conditions. At the postcritical region (Region CR+1), the effect of plausibility was significant in both causal and concessive relations, with implausible sentences taking longer to read than plausible ones.

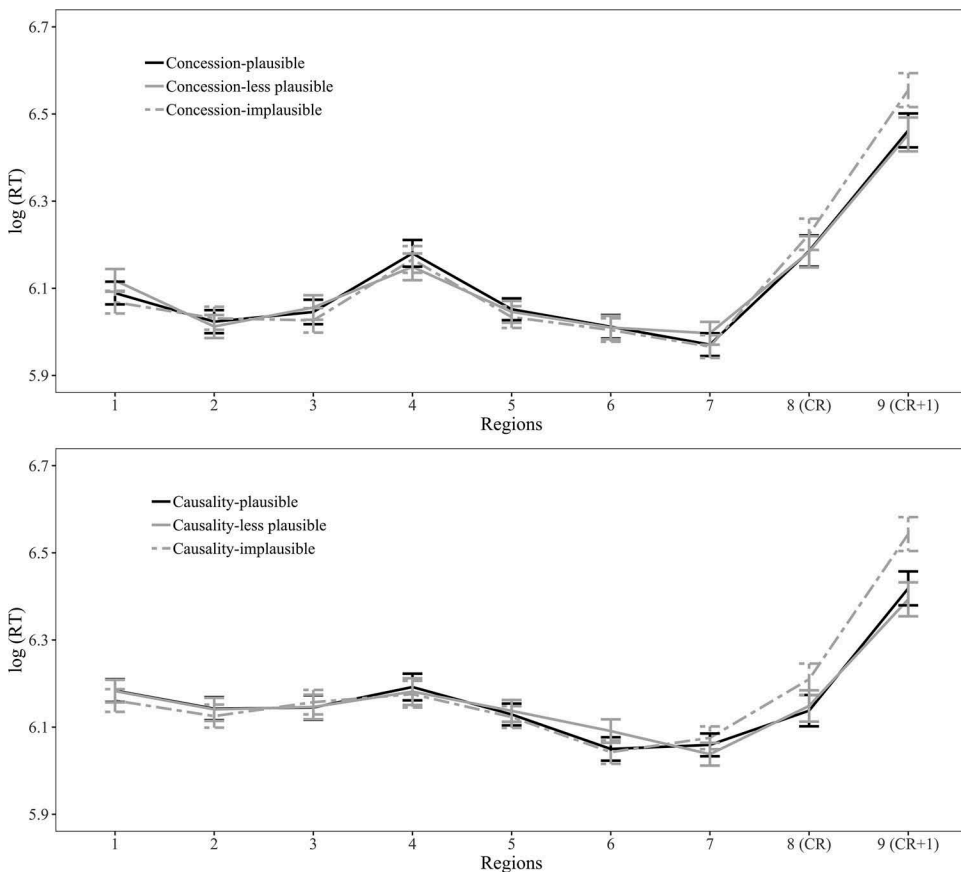


Figure 1. Reading time of each region in Experiments 1a (concession) and 1b (causality). Error bars represent one standard error.

Table 2. Summary of Linear Mixed Models Results in Each Region of Interest in Experiments 1a and 1b

Experiment	Contrast	CR			CR+1		
		Coef.	SE	<i>t</i>	Coef.	SE	<i>t</i>
1a. Concession	Plausible – less plausible	0.00	0.00	0.05	0.00	0.00	0.23
	Plausible – implausible	–0.04	0.04	–0.98			–0.09
0.04	–2.50*						
1b. Causality	Plausible – less plausible	–0.01	0.03	–0.33	0.03	0.04	0.65
	Plausible – implausible			–0.07	0.04		–1.97*
–0.12	0.04						–2.85*

The dependent variable is log-transformed reading time.

* $p \leq .05$

Discussion

In this experiment we found the plausibility effect at the critical and postcritical regions in causality but only at the postcritical regions in concession. The plausibility effect in the current study was found between plausible and implausible but not between conditions that differ in degree of plausibility (i.e., plausible vs. less plausible), revealing that only when it was clearly implausible would participants show sensitivity in reading time.

The plausibility effect observed in causal sentences replicated the findings of previous studies (Xu et al., 2018, 2015). However, compared with Xu et al. (2018), we provided novel evidence for the existence of the plausibility effect during the processing of concession by adding a postcritical region.

Although the results quite convincingly demonstrated the effect of plausibility on causal and concessive relations, the between-subjects design leaves open the possibility that the effect might be due to the different groups of participants. To examine whether the processing of the two relations was affected by the group difference, we conducted a self-paced reading experiment with the same materials but a within-subjects design in Experiment 2.

Experiment 2

Experiment 2 is a self-paced reading experiment in which plausibility is contrasted (i.e., plausible vs. implausible) in each type of discourse relation (i.e., concession vs. causality). Using a factorial design, all participants read both concessive and causal sentences. An additional modification of Experiment 2 is that we added a second postcritical region given that the plausibility effect was observed in the first postcritical region in both concession and causality in Experiment 1. This additional region allows us to observe how sustained the plausibility effect is once it emerges. In contrast to Experiment 1, the commentaries in these postcritical regions are neutral and identical across the four conditions.

Methods

Participants

Twenty-eight students (3 men, 25 women; mean age, 20.3 years [range, 19–24]) from North China University of Technology who did not participate in Experiment 1 or the pretests were paid to participate in Experiment 2. All participants were native speakers of Mandarin Chinese with normal or correct-to-normal vision and gave their informed consent.

Materials

The 24 sets of plausible and implausible sentences from Experiments 1a and 1b were included as the experimental trials. A minor change from Experiment 1 was the position of the connectives relative to the subject NP in C1. Based on the BCC corpus (Xun et al., 2016, retrieved on

10 January 2018), of all clauses that contain *yinwei*, the order of *NP + yinwei* has a frequency of 3.6% whereas *yinwei + NP* has a frequency of 15.7%. For concessive sentences, there was no significant difference between *NP + suiran* and *suiran + NP* structure, which accounted for 15.5% and 12.7% of all clauses that contain *suiran*, respectively. Therefore, Experiment 2 presents the connectives in their canonical position, namely at the clause-initial position for Mandarin. Another modification was that we used the same commentary C3 across all conditions, which was divided into two separate regions, resulting in two postcritical regions as shown in Table 3.

The 24 sets of items, each containing four conditions, were divided into four counter-balanced lists in a Latin square design. Seventy-two fillers used in Experiment 1 were also included. All together, 96 sentences were presented to each subject in a pseudorandom order. Each trial was followed by a yes or no comprehension question, which was targeted on either the first or the third clause or on the general content of the sentence.

We expect to find the effect of plausibility at the postcritical regions in both concession and causality. With an additional region, we expect to find indices (e.g., speeded reading) if participants do accept the speaker's point of view at a later stage. Because of comprehension questions targeting the content of the sentence but not the logical relation between clauses, we do not expect to observe differences in the comprehension accuracy. The comprehension latency, however, is expected to be longer in concession than causality as concession is expected to be harder to comprehend.

Procedure

Experiment 2 follows the same procedure as described for Experiment 1. The whole experiment took an average of 20 minutes to complete.

Results

Linear mixed models with connective type (concession coded as +0.5, causality coded as -0.5) and plausibility (plausible coded as +0.5, implausible coded as -0.5) as fixed effects and subjects and items as random effects were fit using lme4 package version 1.1-21 (Bates et al., 2015) in R version 3.5.3 (R Core Team, 2019). The dependent variables included the comprehension accuracy, comprehension latency, and the region-by-region reading time. Any significant interactions were followed by further tests on the effect of plausibility in concession and causality, respectively.

Similar to Experiment 1, the analysis was carried out on log-transformed values of the reading times, and residuals were checked to ensure that the normality requirement was met. Binomial dependent variables were analyzed using generalized linear mixed effects models with a binomial link function. The lmerTest package version 3.1-0 (Kuznetsova et al., 2017) in R was used for the significance levels.

Comprehension accuracy and latency

The overall accuracy for the experimental items was 93.90% (SD = 0.24). The comprehension accuracies (SD) of each condition were as follows: concession-plausible, 94.0% (0.24); concession-implausible, 94.0% (0.24); causality-plausible, 95.8% (0.20); and causality-implausible, 91.7% (0.28). Generalized mixed effects models showed no significant effect of connective type or plausibility or the interaction between them ($ps > .10$).

The comprehension latency based on all trials showed a significant main effect of connective type, with concessive sentences being answered significantly more slowly than causal ones ($\beta = -0.08$, $t = -2.13$, $p < .05$). Neither the effect of plausibility nor the interaction reached significance ($ps > .10$).

Reading times

The regions of interest were the object in C2 (Region CR), which is the critical region, and the two postcritical regions in the commentary C3 (Regions CR+1 and CR+2). The reading times of each region across conditions are shown in Figure 2, and the statistical results are presented in Table 4.



Table 3. Example Stimuli in Experiments 2 and 3

Condition	Region									
	1	2	3	4	5	6	7	8 (CR)	9 (CR+1)	10 (CR+2)
Concession-plausible	[suiran although	Ahui Ahui	yuyantianfu language talent "Although Ahui has a talent for language, he doesn't like learning English. Everybody knows it."	hengqiang] _{C1} very good	[danshi but	bu xihuan not like	xue learn	yingyu] _{C2} English	[dajia everybody	dou zhidaol] _{C3} all know
Concession-implausible	[suiran although	Ahui Ahui	yuyantianfu language talent "Although Ahui has a talent for language, he doesn't like learning driving. Everybody knows it."	hengqiang] _{C1} very good	[danshi but	bu xihuan not like	xue learn	kaiche] _{C2} driving	[dajia everybody	dou zhidaol] _{C3} all know
Causality-plausible	[suiran although	Ahui Ahui	yuyantianfu language talent "Although Ahui has a talent for language, he likes learning English very much. Everybody knows it."	hengqiang] _{C1} very good	[danshi but	hen xihuan very like	xue learn	yingyu] _{C2} English	[dajia everybody	dou zhidaol] _{C3} all know
Causality-implausible	[yinwei because	Ahui Ahui	yuyantianfu language talent "Because Ahui has a talent for language, he likes learning English very much. Everybody knows it."	hengqiang] _{C1} very good	[suoyi so	hen xihuan very like	xue learn	yingyu] _{C2} English	[dajia everybody	dou zhidaol] _{C3} all know
Causality-implausible	[yinwei because	Ahui Ahui	yuyantianfu language talent "Because Ahui has a talent for language, he likes learning driving very much. Everybody knows it."	hengqiang] _{C1} very good	[suoyi so	hen xihuan very like	xue learn	kaiche] _{C2} driving	[dajia everybody	dou zhidaol] _{C3} all know
Causality-implausible	[yinwei because	Ahui Ahui	yuyantianfu language talent "Because Ahui has a talent for language, he doesn't like learning English. Everybody knows it."	hengqiang] _{C1} very good	[suoyi so	bu xihuan not like	xue learn	yingyu] _{C2} English	[dajia everybody	dou zhidaol] _{C3} all know

Experiments 2 and 3 shared the plausible conditions. The implausible conditions in italics are the materials used in Experiment 3. The indication of regions is for the self-paced reading task in Experiment 2.

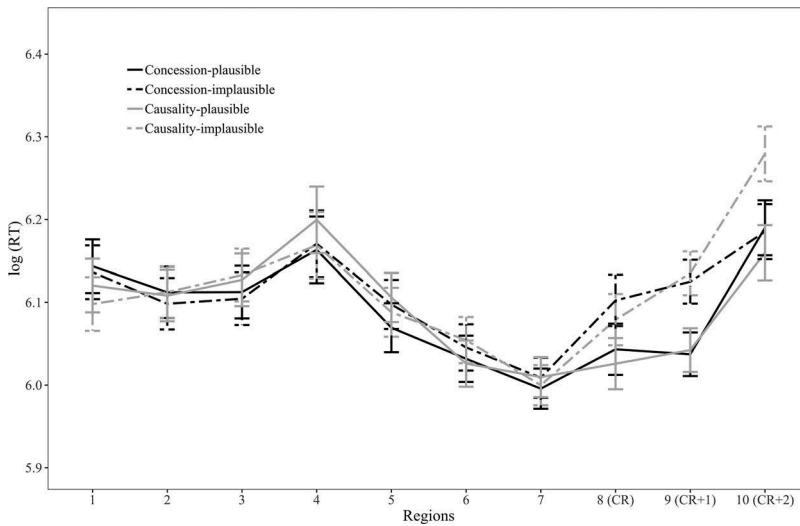


Figure 2. Reading time of each region in Experiment 2. Error bars represent one standard error.

Table 4. Main Effects of Connective Type (C) and Plausibility (P) and Their Interaction in Each Region of Interest in Experiment 2

	CR			CR+1			CR+2		
	Coef.	SE	<i>t</i>	Coef.	SE	<i>t</i>	Coef.	SE	<i>t</i>
C	-0.02	0.03	-0.71	0.01	0.03	0.35	0.09	0.04	2.58*
P	-0.06	0.03	-1.78	-0.09	0.03	-3.05**	0.01	0.04	0.19
C × P	0.01	0.05	0.11	0.00	0.04	-0.12			-0.12
									-2.44*

The dependent variable is log-transformed reading time.

* $p < .05$, ** $p < .01$

At CR, we only found a marginally significant effect of plausibility ($p < .10$), showing longer time spent on implausible sentences. At CR+1, we found a main effect of plausibility, with implausible sentences taking longer to read than plausible ones. The effect of connective type and the interaction did not reach significance.

At CR+2, we found a main effect of connective type, indicating longer reading time being spent in causal conditions. A significant interaction was observed. Further tests showed that the plausibility effect was only significant in causality ($\beta = -0.09$, $t = -2.56$, $p < .05$), with implausible sentences being read more slowly than plausible ones in causality but not in concession.

Discussion

In this experiment, we found a main effect of plausibility at CR+1 where an implausible item took a longer time to read than a plausible item. At CR+2, we found a main effect of connective type and a significant interaction, revealing that, whereas implausible sentences took significantly longer to read than plausible ones in causality, there is no difference in concession. The plausibility effect reached marginal significance at CR.

The results replicated the key findings in Experiment 1. At CR, the plausibility effect in causality reached significance ($p = .05$ in Experiment 1b, and in Experiment 2 it was marginally significant). The plausibility effect in concession was not significant in Experiment 1a but reached marginal significance in Experiment 2. At CR+1, we consistently found the plausibility effect in both concession and causality in the two experiments. At the additional postcritical region (CR+2), we found

distinct sustained effects in concession and causality; whereas implausible conditions took longer to read in causality, it became temporarily accepted in concession.

Readers in the moving-window task press the response key relatively rapidly until an opportune time to pause, usually at the end of a sentence (Danks, 1986). The comprehension process showing the plausibility effect in both concession and causality thus only reached marginal significance at the critical region (CR) and was delayed to the postcritical regions (CR+1 and CR+2).

The results at CR+1 in both concession and causality suggest that the implausibility in a reversed cause–effect relation (i.e., concession) was detected as fast as that in a direct cause–effect relation (i.e., causality), whereas the distinct effects at CR+2 suggest that different strategies were adopted in resolving the implausibility in concession and causality. We discuss this later in General discussion.

Although we consistently found the effect of plausibility in both concession and causality in Experiments 1 and 2, one possible factor that may lead to alternative explanations is that in both experiments, the critical words across conditions were different. Despite that we matched them in terms of the plausibility in the pretest, the different words may still lead to different reading times at this region. To examine the plausibility effect in both discourse relations more closely, we conducted an eye-tracking study in Experiment 3.

Experiment 3

Experiment 3 is an eye-tracking study on the reading differences between causal and concessive relations in discourse. Different from Experiments 1 and 2, in this experiment the critical regions and postcritical regions were kept identical across all conditions. Plausibility was therefore manipulated by negating the predicate portion of the consequence clause in concession and causality. We crossed negative and affirmative expressions in this experiment to observe the possible negation preference in concession. Using the eye-tracking method, we expect not only to observe the plausibility effect in concession and causality but also to find a larger effect in the precritical and critical regions of the former given that regressions are available.

Methods

Participants

Forty participants (11 men, 29 women; mean age, 26 years [range, 21–40]) from Shanghai Jiao Tong University who did not participate in the previous experiments or in the pretests were recruited for Experiment 3. All were native speakers of Mandarin Chinese with normal or correct-to-normal vision and were paid for their participation. Informed consent was obtained from all participants.

Materials

Twenty-four sets of sentences were included as the experimental trials. The materials had the same structure in Experiment 2, where C1 contained a statement about the conditional portion (i.e., the *p* of *if p then q*), C2 the consequence portion (i.e., the *q* of *if p then q*), followed by C3, which was a neutral commentary. Different from Experiments 1 and 2, the sentence plausibility was manipulated by modifying the adverb before VP in C2 (e.g., *hen xihuan* “likes very much” vs. *bu xihuan* “does not like”), whereas the critical region was kept identical across conditions (e.g., *xue yingyu* “learn English”). The example stimuli are shown in Table 3.

The 24 sets of experimental items, each containing four conditions, were divided into four lists in a Latin square design. Twenty-six filler items used in Experiment 1 were included, all together forming a list of 50 items for each participant. Items were presented pseudo-randomly, followed by a yes or no comprehension question on each trial. Similar to Experiment 1, the comprehension question was always targeted on the first clause or an inference from it.

We expect to observe an early effect (e.g., first-pass) at the adverb *bu/hen xihuan* “not/very like” if negation is indeed preferred in processing concession. In addition, we expect to find the effect of

plausibility in both concessive and causal relations, although a greater effect on more eye-movement measures is expected in concession than in causality. Specifically, we expect greater difficulty when processing the implausibility at the critical region of concession and thus predicted a higher regression-out rate from the critical region and longer rereading of the precritical region of concession.

Apparatus and procedure

Eye movements were recorded with an EyeLink 1000 Plus eye tracker (SE Research Ltd., Ottawa, Ontario, Canada) at a sampling rate of 1000 Hz. The eye-tracker recorded participants' gaze location and movement from the left eye, although viewing was binocular. Stimuli were presented on a 19-inch LCD monitor with a resolution of 1024 × 768 pixels; the stimuli were presented in Simplified Chinese characters (font type SimSun, font size 28) using black texts on a light gray background (RGB 211, 211, 211). The programming was performed using EyeLink Experiment Builder 2.1.140, and the eye-movement data were analyzed using EyeLink Data Viewer 3.1.97.

Participants sat 70 cm from the monitor with their head on a chin rest to reduce head movements. The task started with a 13-point calibration. Once this calibration check was completed accurately (<0.50 degrees of error), the experimenter advanced the screen to display two practice trials that were in the same format as the normal experimental item. Before each trial participants were instructed to fixate on a dot located at the position where the first character of the sentence would be subsequently displayed to enable drift correction. Participants were instructed to read at their normal rate. After reading each sentence, they pressed the SPACE key on the keyboard to begin the presentation of a yes/no comprehension question. True and false statements were equally distributed across conditions. Participants responded by pressing F (marked with a blue sticker) for true and J (marked with a red sticker) for false. Each testing sentence was followed by a yes/no comprehension question to ensure that the participants understood the sentences. The whole process took around 25 minutes.

Results

The data were analyzed following the same procedure in Experiment 2. The dependent variables were the comprehension accuracy (binomial) and a batch of selected eye-movement measures in each of our regions of interest.

Comprehension accuracy

The overall accuracy for the experimental items was 91.56% (SD = 0.28). Generalized mixed effects models showed significant main effects of connective type ($\beta = 1.32$, $z = 3.45$, $p < .001$) and plausibility ($\beta = 2.11$, $z = 0.48$, $p < .001$) as well as the interaction between them ($\beta = -3.06$, $z = -4.92$, $p < .001$). Further analysis revealed a significantly higher accuracy in causal-plausible conditions (97.08%, SD = 0.17) than causal-implausible ones (85.83%; SD = 0.35; $\beta = 2.04$, $z = 4.24$, $p < .001$), whereas a significantly lower accuracy in the concessive-plausible sentences (88.75%, SD = 0.32) than concessive-implausible ones (94.58%; SD = 0.23; $\beta = -1.03$, $z = -2.46$, $p < .05$), which replicated the results of Experiment 1. Again, due to the comprehension question targeting only C1 of the text, these comprehension accuracy results were difficult to interpret.

Eye-movement data

The regions of interest are shown in (12). The critical region was the verb phrase in C2 (Region 2), at which point the plausibility between events was established. Region 1 (precritical) was the adverb in C2 where the sentence plausibility was manipulated, and Region 3 (postcritical) was the commentary clause in C3.

- (12) [bu/hen xihuan]_{Region 1} [xue yingyu]_{Region 2} [dajia dou zhidao]_{Region 3}
 [not/very like]_{Region 1} [learn English]_{Region 2} [everybody all know]_{Region 3}

The eye-movement data used for analysis included the first-pass reading time (FP), second-pass reading time (SP), regression-out rate (RO), and total reading time (TR; Rayner, 1998). FP (also known as gaze duration) is defined as the sum of all fixations made from first entering a region of text until an eye-movement exits the region to either the left or right, reflecting early stages of processing such as lexical access and perceptual processing (Reichle, Rayner, & Pollatsek, 2003). SP (i.e., rereading; Rayner, 1998) defined as the sum of the second run of fixations within the current interest area. RO indicates the probability of regression(s) being made from the current interest area to earlier parts of the sentence, which reflects processing difficulty and the reprocessing of the sentence (Pickering & Frisson, 2001). TR is defined as the sum duration of all fixations made within a region and provides an indication of the overall amount of time spent processing text in that region (Reichle et al., 2003).

Fixations shorter than 80 ms or longer than 1200 ms were excluded from data analysis (Drieghe, Pollatsek, Staub, & Rayner, 2008; White, 2008). Trials in which there was track loss on the critical region and that were answered incorrectly were removed (in total 15.1% of the experimental trials were removed). All reading-time measures above or below three standard deviations from the mean were excluded, accounting for less than 6% of the total number of observations (FP, 2.1%; SP, 1.1%; TR, 2.1%). The mean value (with SDs) from different eye-movement measures are presented in Table 5, and the results of the statistical analysis are shown in Table 6.

Region 1 (Precritical). We found main effects of connective type and plausibility as well as significant interactions on FP and SP. Further tests revealed the plausibility effect only in concession (FP: $\beta = -0.09$, $t = -2.09$, $p < .05$; SP: $\beta = -0.17$, $t = -3.25$, $p < .01$), with implausible sentences taking longer to read, but not in causality ($ps > .30$). In addition, we found a main effect of plausibility on TR, indicating greater difficulty in processing implausible sentences. A significant interaction was found in TR. Further tests showed that while the effect of plausibility reached significance in both concession and causality, the effect in concession ($\beta = -0.38$, $t = -7.49$, $p < .001$) was larger than that in causality ($\beta = -0.23$, $t = -4.37$, $p < .001$).

Region 2 (Critical). We found main effects of connective type and plausibility on FP as well as their interaction. Further tests showed that implausible concession took the shortest time to read among all conditions ($ps < .10$). In addition, we found a main effect of plausibility on RO,

Table 5. Mean (SD) Values of Log-FP, Log-SP, RO, and Log-TR in Each Region of Interest in Experiment 3

	Region 1 (Precritical)	Region 2 (Critical)	Region 3 (Postcritical)
FP			
Concession-plausible	5.56 (0.44)	5.62 (0.47)	5.86 (0.51)
Concession-implausible	5.64 (0.50)	5.51 (0.51)	5.79 (0.52)
Causality-plausible	5.58 (0.45)	5.60 (0.53)	5.79 (0.51)
Causality-implausible	5.54 (0.43)	5.65 (0.51)	5.78 (0.46)
SP			
Concession-plausible	5.43 (0.44)	5.44 (0.49)	5.63 (0.58)
Concession-implausible	5.57 (0.51)	5.38 (0.50)	5.68 (0.51)
Causality-plausible	5.48 (0.49)	5.46 (0.49)	5.63 (0.52)
Causality-implausible	5.44 (0.52)	5.43 (0.47)	5.80 (0.57)
RO			
Concession-plausible	—	0.20 (0.40)	0.42 (0.49)
Concession-implausible	—	0.36 (0.48)	0.39 (0.49)
Causality-plausible	—	0.26 (0.44)	0.37 (0.48)
Causality-implausible	—	0.28 (0.45)	0.47 (0.50)
TR			
Concession-plausible	6.14 (0.64)	6.08 (0.62)	6.12 (0.61)
Concession-implausible	6.50 (0.64)	6.18 (0.65)	6.29 (0.65)
Causality-plausible	6.17 (0.64)	6.12 (0.63)	6.12 (0.62)
Causality-implausible	6.39 (0.61)	6.28 (0.66)	6.33 (0.62)

Table 6. Main Effects of Connective Type (C) and Plausibility (P) and Their Interaction in Each Region of Interest in Experiment 3 for the Dependent Measures Log- FP, Log- SP, RO, and Log-TR

	Region 1 (Precritical)			Region 2 (Critical)			Region 3 (Postcritical)		
	Coef.	SE	<i>t</i>	Coef.	SE	<i>t</i>	Coef.	SE	<i>t</i>
FP									
C	-0.09	0.04	-2.28*	0.13	0.05	2.85**	0.01	0.04	0.14
P			-0.08	0.04		-2.12*	0.10	0.04	2.29*
0.05	0.04		1.23						
C × P	0.12	0.06	2.12*	-0.14	0.06	-2.26*	-0.06	0.06	-1.01
SP									
C			-0.11	0.05		-2.14*	0.00	0.00	0.53
0.11	0.07		1.64						
P	-0.17	0.06	-3.08**	0.00	0.00	0.65	-0.04	0.08	-0.53
C × P	0.20	0.08	2.56*	0.00	0.00	0.01	-0.15	0.11	-1.42
RO									
C	—	—	—	-0.08	0.04	-1.72	0.08	0.05	1.58
P	—	—	—			-0.16	0.04		-3.64***
0.03	0.05		0.56						
C × P	—	—	—	0.14	0.06	2.19*	-0.13	0.07	-1.86
TR									
C	-0.10	0.05	-1.86	0.11	0.05	2.05*	0.05	0.05	0.92
P			-0.38	0.05		-7.44***	-0.11	0.05	-2.14*
-0.18	0.05								-3.66***
C × P	0.15	0.07	1.99*	-0.06	0.08	-0.74	-0.03	0.07	-0.49

* $p < .05$, ** $p < .01$, *** $p < .001$

showing a significantly higher RO in implausible sentences. A significant interaction was found in RO. Further tests revealed the effect of plausibility only in concession ($\beta = -0.15$, $t = -3.84$, $p < .001$), with a higher RO found in implausible conditions but not in causality ($p > .40$). Furthermore, we found main effects of connective type and plausibility on TR, showing longer total reading time spent in causal sentences and implausible conditions.

Region 3 (Postcritical). We only found a main effect of plausibility in TR, showing that the implausibility sentences took significantly longer to read than the plausible ones.

Discussion

The results of Experiment 3 confirmed the key findings of Experiments 1 and 2. We replicated the plausibility effect in concession and causality, as revealed by various measures in different regions.

As an early measure, FP showed main effects of connective type and plausibility as well as their interaction at Regions 1 and 2. We found that comprehenders read faster in plausible than implausible concession at Region 1 but spent less time in implausible than plausible concession at Region 2. The early measures like first-past reflect the local lexical integration (Rayner, 1998). The faster processing of implausible concession at Region 2 (i.e., the critical region) suggested that it is harder for the critical word *learn English* to be integrated to its negative antecedent *not like* (i.e., plausible condition) than to the positive antecedent *very like* (i.e., implausible condition), which corroborates with previous studies in which negation was found harder to process than its affirmative counterparts (Carpenter & Just, 1975; Just & Carpenter, 1971). The faster first-pass of plausible concession at Region 1 (i.e., the precritical adverb region) suggested that an overt negator *not* is expected in concession, as discussed later in General discussion.

We found significant interactions between connective type and plausibility in a few other regions, showing a larger plausibility effect in concession than in causality. At the critical region (Region 2), the plausibility effect was observed in RO only in concession but not in causality. Similarly, the plausibility effect was observed only in concession but not in causality in SP at

Region 1. Additionally, at Region 1, despite the plausibility effect being significant in TR in both concession and causality, the effect size was larger in the former.

These results revealed a widespread and stronger effect of plausibility in concession than causality. Consistent with Experiments 1 and 2, this experiment provided further evidence for the plausibility effect in concession.

General discussion

The current study sought to investigate the effect of plausibility on the processing of concessive and causal relations. In two self-paced reading experiments (Experiments 1 and 2), we consistently found the plausibility effect at the postcritical region (CR+1) in both concession and causality. When an additional postcritical region (CR+2) was added (Experiment 2), implausible sentences induced a sustained plausibility effect in causality but a speeded reading in concession. In Experiment 3, an eye-tracking study, we found significant interactions between connective type and plausibility at the precritical region in the early measures, which suggests a negation preference in concession, and significant interactions at the critical and precritical regions in a few late measures, which suggest a larger effect of plausibility and greater processing cost in concession than in causality. Taken together, the results corroborate a distinctive reading pattern and greater difficulty for processing concession.

Verifying sentence plausibility in concession and causality

In the current study we consistently found the plausibility effect in both concession and causality at the postcritical region (CR+1) in two self-paced reading experiments. Concession and causality are built on the same underlying knowledge *causal event* $p \rightarrow \textit{consequential event } q$, against which participants verify the incoming information in the discourse. In our materials, the consequential event was expressed in the positive form q for causality (e.g., *like learning English/driving*) and in an explicit negative form *not* q for concession (e.g., *not like learning English/driving*), each forming a plausible or implausible relation with the preceding causal event p . During online processing, participants verify the consequential event against their world knowledge $p \rightarrow q$. The observed effects at CR+1 in both concessive and causal relations suggest that the negated consequential event *not* q can be verified as fast as the positive event q against the common knowledge, with no extra step for the negator *not* to be integrated. Consistent with the incremental account (Nieuwland & Kuperberg, 2008), our results suggest that validating information in a reversed cause–effect relation $p \rightarrow \neg q$ (i.e., concession), as opposed to that in a direct cause–effect relation $p \rightarrow q$ (i.e., causality), did not require additional processing cost.

In fact, in the eye-tracking experiment where we contrasted the positive and negative forms in concession and causality, the overt negator was found to be a preferred form in concession. The FP showed that the negative adverbs (as in *bu xihuan* “does not like”) were read faster than their affirmative counterparts (as in *hen xihuan* “likes very much”). Since the critical region has not been reached and thus the plausibility contrast between the plausible and implausible conditions has not yet been established, the results suggest that this difference was due to a preference toward processing the negative form in concession. These results are in line with studies that report a facilitation of processing induced by overt negation (e.g., *not save*) relative to semantic antonyms (e.g., *delete*) in concession (Lyu, 2019). In Lyu (2019), the violated expectation in concessive clauses was expressed by a negated verb phrase, e.g., *mei baocun* “not save”, or a semantic antonym (e.g., *shanchu* “delete”), both describing the same concessive events. The conditions containing negation like *not save* were read as fast as the semantic antonyms on the verb and showed a marginal facilitation at the end of the sentence, suggesting that concessive sentences are easier to process when the negation in the main clause has been spelled out. In the current study, the early processing differences of *not like* and *like* in the concessive sentence *Although he has a talent for language, he doesn't like/likes ...*, where expressions with a negator *mei* “not”

or *bu* “not” are processed faster than their affirmative counterparts, suggest that a negator is expected in concession. The negated event *not q* in the consequential clause therefore was incrementally incorporated into previous discourse and rapidly verified against the world knowledge.

Late implausibility resolution and perspective shift in concession

We found distinct late plausibility effects in concession and causality. At the additional postcritical region (CR+2) in Experiment 2, whereas implausibility induced longer reading time in causality, it was quickly accepted in concession. The measures that reflect late processing in the eye-tracking study, in addition, revealed a larger effect of plausibility in a wider range of regions in concession than causality. We suggest that participants adopted different strategies in resolving the implausibility in concession and causality. Whereas implausibility in causality was taken as completely wrong, as evidenced by the sustained plausibility effect, that in concession can be resolved as participants *shift their perspective* to the speaker, which requires more cognitive effort.

From a cognitive perspective, concession is more complex than causality in that concessive connectives like *although* involve an additional mental representation where the conditional assumption is reversed (Verhagen, 2005). In a concessive construction *although p, not q*, while the speaker acknowledges the accepted knowledge $p \rightarrow q$, s/he nevertheless cancels it. Different from the causal relation in which a direct cause–effect relation between events is established, concession presents a challenge to a common assumption and involves greater personal engagement or subjectivity by the speaker.

The greater difficulty associated with concession corroborates with previous studies that suggest subjective relations are more costly to process than objective ones. Processing subjective relations involves a shift of perspective, that is, the interpretation of the sentence has to be related to the speaker’s personal point of view (Canestrelli, Mak, & Sanders, 2013; MacWhinney, 1977, 2005; Sanders, Sanders, & Sweetser, 2012). In Experiment 2, the implausible concession induced processing difficulty at CR+1 but quickly became acceptable later at CR+2. For instance, in the implausible concessive sentence *Although Ahui has a talent for language, (but) he doesn’t like learning driving ...*, participants slowed down immediately after reading the critical word *driving* (i.e., at CR+1); however, at the subsequent region (i.e., CR+2) the processing time of the implausible sentence showed no difference from the plausible condition, resulting in only a main effect of the connective type (with a causality disadvantage) at this region. We interpret the facilitation of concession at CR+2 as participants’ acceptance of the speaker’s point of view. It should be noted that the speeded reading does not mean it is easier to process concession than causality; rather, readers may have decided to temporarily tolerate the implausibility. The longer comprehension latency later reflected readers’ uncertainty and corroborated the overall greater difficulty in comprehending concession.

Additional evidence of the shifting of perspective came from Experiment 3 where concession showed a higher RO at the critical region, which reflects processing difficulty and reprocessing. When encountering implausibility at the critical region, comprehenders’ processing was interrupted to a greater extent in concession than causality. A larger effect of plausibility was found on the SP and TR in the precritical region of concession than causality. We suggest that the larger effect in concession was due to the extra cost of adopting the speaker’s point of view. In causality, while implausibility did have an effect on the reprocessing of the precritical region, it only came from checking the cross-event relation against *their own* world knowledge, which was less demanding.

Previous ERP studies found a late anterior negativity effect elicited by the implausibility in concession. Xiang and Kuperberg (2015) and Xu et al. (2015) attributed the late anterior negativity to the particular trials where participants strategically ignored the contradictory connective *even so* and interpreted clauses like *Elizabeth aced the exam. Even so, she celebrated widely* as forming a meaningful causal relation based on the world knowledge *ace the exam* \rightarrow *celebrate*. This explanation does not account for our findings where the implausible concession *Although he has*

a talent for language, (but) he doesn't like learning driving cannot be simply shifted to a plausible causal frame.

We therefore propose a perspective-shifting account for the implausibility resolution in concession. Previous research shows that a late anterior negativity effect reflects a shift-of-perspective to retain coherence in discourse (Coulson, 2000; Coulson & Kutas, 2001; Coulson & Williams, 2005). For instance, to understand a joke like *I let my accountant do my taxes because it saves time: last spring it saved me ten years*, readers begin by constructing a mental model in which a busy professional pays an accountant to do his taxes. However, at *years* they are forced to go back and reinterpret *time* as time in prison, evoking a new frame that induces a sense of humor. Similarly, when processing an implausible concessive relation, comprehenders shift to the speaker's perspective and interpret the claim within the new frame. In this account, when processing the implausible sentence *Elizabeth aced the exam. Even so, she celebrated widely*, participants had immediate difficulty after encountering the critical word *celebrated*, as reflected by the N400 effect, but they later shifted to the speaker's point of view and tolerated the unlikely (but still interpretable if the speaker's perspective is taken) case he claimed (i.e., *she still celebrated*), which elicited a late anterior negativity effect. Such a process differs from that in processing causality, during which participants hold a strong prediction toward the incoming information based on their own world knowledge and would consider it completely wrong when the critical word violates such a prediction, which instead results in a late positivity (i.e., P600) effect (Wlotko & Federmeier, 2012; Xiang & Kuperberg, 2015).

Forward and backward relations

One major difference between our study and Xu et al. (2018) is that the materials we used involved a concessive/causal clause preceding a consequence clause, which follows a logically iconic cause-effect order that facilitates processing (Noordman & de Blijzer, 2000; Noordman & Vonk, 1998). By contrast, in Xu et al. (2018) consequential events were positioned before the causes (e.g., *Grandma moved from A to B → although she liked the warm winter there*). In such an order the first clause is a claim made by the speaker, whereas the following concessive clause reads more like an afterthought that carries a pragmatic effect of weakening the original claim (Verhagen, 2005). The concessive clause is thus weakened and can be taken as supplementary, not necessarily forming a reversed cause-effect relation with the prior text.

While backward causality also expresses a more subjective relation than forward causality in both written and spoken Chinese discourse (Li, 2014; Song & Tao, 2008; Wei, 2018), directionality does not affect participants' processing of plausibility in causal sentences. Plausibility in causality was consistently observed in our study and in Xu et al. (2018). Regardless of position, *yinwei* in the two studies explicitly marks a causal relation between events and thus cues comprehenders to construct a direct cause-effect relation. Previous studies suggest there is only one type of mental operation triggered on encountering *A because B* (i.e., *B causes A*), if there are no explicit signals for *A* to be interpreted subjectively as a speaker's belief rather than an objective state of the world (Traxler, Sanford, Aked, & Moxey, 1997). The backward causality in Xu et al. (2018) does not accompany such cues as perspective markers (Li, 2014; Wei, 2018). Therefore, despite the relatively higher degree of subjectivity of backward causality, comprehenders show sensitivity when the discourse mismatches their knowledge. In a backward concessive relation, by contrast, the cause-effect relation is less explicit. The postposed concessive clause is rather a weakening of the earlier claim that is personal to the speaker (Lyu, 2014; Verhagen, 2005). When processing backward concession, participants interpret the sentence from the speaker's perspective, which leads to a higher tolerance of the sentence implausibility and thus a lack of plausibility effect.

Implications

The current study extends previous work on processing plausibility in concession and causality by proposing a novel perspective-shifting account for the late implausibility resolution in concession. The behavioral tasks adopted here allow us to track the time course of the construct of the cross-event relations and the resolution of the implausible case. The speeded reading at CR+2 in the self-paced reading experiment and the larger late effect at the precritical region in the eye-tracking study, for example, are not observable in ERP studies where the stimuli are usually presented word by word at fixed inter-stimuli intervals. The proposed account based on the behavioral tasks thus provides insights to the ERP results that are less clearly discussed in the literature. If this account is correct, then it would imply that a late anterior negativity effect is likely to be observed in all concessive trials, rather than only in some of the trials where participants select the real-world consistent causal event, as suggested by Xiang and Kuperberg (2015).

Moreover, future studies can be extended to other forms of reversed expectations in concession. In the current study, where we used a positive event *p* like *although/because he studied hard*, the overt negator *not* was preferred in event *q* in concession. The conflict between events can be expressed by alternative expressions, such as with an overt negator in event *p* like *although/because he did not study hard, he ... the exam*, or with an antonym in event *p* like *although/because he rarely studied, he ... the exam*. How the overt negation and antonym in event *p* affects the processing of the consequential events in concession and causality is worth exploring in future research.

Conclusion

In three experiments we showed that plausibility has an effect on both concessive and causal relations. Our results suggest that plausibility is validated similarly but resolved differently in concession and causality; while verifying the plausibility of a negated cause–effect relation (i.e., concession) is as fast as that of a direct cause–effect relation (i.e., causality), different strategies are adopted in resolving the implausibility of the relation. In a causal relation, comprehenders rely more on their own world knowledge and showed a sustained effect when their expectation was disconfirmed by the unfolding discourse. During the processing of concession, a shift of perspective is involved such that participants take into account the speaker’s point of view and tolerate the implausibility, which requires more cognitive effort. All together, our results corroborated the existence of the plausibility effect in Chinese concessives and suggested more cognitively demanding effort is required during the processing of concession.

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