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Implicit Causality And Consequentiality In Native And Non-Native Coreference Processing

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IMPLICIT CAUSALITY AND CONSEQUENTIALITY IN NATIVE AND NON-NATIVE
COREFERENCE PROCESSING

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Philosophy in

Linguistics

College of Arts and Sciences

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2016

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Acknowledgements

Finally, I made it to the finish line of the dissertation marathon! I have benefited from so many people in this long journey that words are not enough to express all my appreciation for their help.

First and foremost, I am greatly indebted to my advisor, Dr. Amit Almor, for his guidance, encouragement, assistance, and patience. He introduced me into the field of psycholinguistics and gave me tremendous help from the inception of the ideas to the completion of this dissertation. I am also thankful to my other committee members, Dr. Anne Bezuidenhout, Dr. Mila Tasseva-Kurktchieva, and Dr. Dirk den Ouden, for their insightful comments and encouraging words.

I would also like to thank my friends and colleagues for their assistance all the way long. Xiaojing Yang gave me an enormous help by recruiting participants in China and recording and coding data. Chaowang Ren and Zhe Qu helped me collect part of the norming data. Dr. Stanley Dubinsky, Dr. Anne Bezuidenhout, Xianmin Shen, Zhuo Feng, and Paul Coats were so kind to let me recruit participants from their classes. The undergraduate research assistants in the *a*Lab, Christina Keinath, Chris Mitropoulos, Victoria Vatansever, and Steffan Bassett, helped with data coding. Leo Gao, Kevin Lu, Jefferson Maia, Shinichi Shoji, and Ti Yan offered me a lot of encouragement and accompany. This dissertation would not have been possible without their help.

Last but not least, I thank my parents for their unfailing love and support. This dissertation is dedicated to them.

<center>Abstract</center>

This dissertation is composed of two studies that examined the role of implicit causality and consequentiality in coreference processing. Implicit causality (IC) refers to the phenomenon that certain interpersonal verbs bias the causation of the events described by the verbs towards either its subject (the first noun phrase NP1) or its object (the second noun phrase NP2). Implicit consequentiality (IR) refers to the phenomenon that certain verbs bias the consequence towards either NP1 or NP2. These IC and IR biases have been found to influence language comprehenders' establishment of coreference.

The first study examined whether intentionality of an event affects native English speakers' re-mention biases of IC and IR. In two sentence-completion experiments, the strength of event intentionality was manipulated via intentionality-strengthening adverbs such as *deliberately* and intentionality-weakening adverbs such as *accidentally*. Results show that reinforcing intentionality changed IC and IR biases with participants showing increased references to NP1 in the IC context and NP2 in the IR context. The present study thus adds to a growing body of literature showing that IC and IR re-mention biases are not just determined by verb semantics but rather reflect a discourse phenomenon resulting from comprehenders' causal inferences about the explanation for or the consequence of an event.

The second study investigated advanced Chinese-speaking English learners' use of IC and IR biases in establishing coreference. In two sentence-completion experiments

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that focused on IC and IR, respectively, participants wrote continuations to sentence fragments containing either NP1-biasing verbs or NP2-biasing verbs and ending with either a free prompt (e.g., *NP1 verb-ed NP2 because…*) or a pronoun prompt (e.g., *NP1 verb-ed NP2 because he…*). In both the IC and IR contexts, non-native speakers showed native-like re-mention biases in the free prompt condition. Moreover, like native speakers, non-native speakers produced more NP1 references in the pronoun prompt condition than in the free prompt condition. However, unlike native speakers, non-native speakers exhibited a "subject bias" in pronoun resolution by producing more NP1 references after NP2-biasing verbs. Overall, the study reveals that non-native speakers are able to generate predictions about the next-mentioned referent based on discourse-level information. The "subject bias" shown by non-native speakers in their resolution of pronouns indicates that when processing multiple sources of information, non-native speakers tend to resort to the cues that are easy to process, such as the subjecthood cue associated with the presence of pronouns.

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List of Abbreviations

ACTFL .... American Council on the Teaching of Foreign Languages

AE .... Agent-Evocator

AP .... Agent-Patient

CEFR .... Common European Framework of Reference for Languages

ES .... Experiencer-Stimulus

IC .... Implicit Causality

IR .... Implicit Consequentiality

L1 .... First Language

L2 .... Second Language

NP .... Noun Phrase

SE .... Stimulus-Experiencer

SLA .... Second Language Acquisition

TEM .... Test for English Majors

Introduction

This dissertation is composed of two independent studies, which investigated the role of implicit causality (IC) and implicit consequentiality (IR with R for result) in coreference processing from different perspectives. Focusing on the theoretical aspect of IC and IR, Study 1 examined how event intentionality affects native English speakers' re-mention biases induced by IC and IR. Study 2 extended the scope to non-native speakers and examined to what extent native and non-native English speakers differ in their use of the information of implicit causality and consequentiality in the establishment of coreference.

The dissertation is organized as follows. Since both studies are concerned with IC and IR, I first provide a detailed review of this phenomenon in Chapter One. I then report the two studies as stand-alone papers in Chapters 2 and 3, respectively.[1] I conclude the dissertation with a summary of the findings.

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[1] In order to keep the logic flow of each study clear, both chapters unavoidably have some contents overlapping with those of Chapter 1, particularly in the discussion of implicit causality and consequentiality.

Chapter 1

Implicit Causality and Consequentiality: A Review

This chapter reviews previous studies on IC and IR. I first give a brief

introduction about the phenomenon. I then introduce the verbs that are associated with IC

and IR. Next, I provide an overview of empirical evidence supporting IC and IR. Finally,

I present the major accounts of IC and IR.

The Phenomenon

The phenomenon of implicit causality (IC) was first reported by Garvey and

Caramazza (1974) who found that certain verbs show an implicit direction of causality

attributing the cause of the event[2] described by the verb to one of its arguments. For

example, when presented with a sentence fragment ending with an ambiguous pronoun

like (1.1), people usually continue the sentence with the pronoun referring to the first

noun phrase (NP1), i.e., the subject *Mary*. By contrast, when the verb is changed from

frighten to *fear* as in (1.2), people tend to refer the pronoun to the second noun phrase

(NP2), i.e., the object *Sara*.

(1.1) $Mary_i$ frightened Sara because she_i …

(1.2)   Mary feared $Sara_i$ because she_i …

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[2] In this dissertation I use the term *event* in a general way, including not only accomplishments and

achievements that are traditionally considered as events in theoretical linguistics but also states and

activities.

Garvey and Caramazza (1974) called these verbs implicit causality verbs. Specifically, *frighten*-like or NP1-biasing verbs attribute the cause to the subject, whereas *fear*-like or NP2-biasing verbs attribute the cause to the object. Accordingly, people tend to interpret the subject pronoun in the second clause as referring to NP1 when the main clause contains an NP1-biasing verb and NP2 when the main clause has an NP2-biasing verb.

IC biases are closely related to discourse coherence relations, in particular, the *Explanation* coherence relation (Kehler, Kertz, Rohde, & Elman, 2008), in which the second clause provides an explanation for the event described in the first clause. When the second clause is a consequence of the event, constituting a discourse coherence relation of *Result* (Kehler et al., 2008), the referential biases are reversed (Crinean & Garnham, 2006; Stevenson, Crawley, & Kleinman, 1994; Stewart, Pickering, & Sanford, 1998). For instance, when the connective in (1.1) and (1.2) is changed from *because* to *so* as in (1.3) and (1.4) below, the preferred referent of the pronoun becomes NP2 in (1.3) and NP1 in (1.4). This phenomenon is named as implicit consequentiality (Crinean & Garnham, 2006; Stewart et al., 1998), as it involves the entity that bears the consequence of the event described by the first clause.

(1.3) Mary frightened Sara$_i$ so she$_i$ …

(1.4) Mary$_i$ feared Sara so she$_i$ …

Verbs Associated with Implicit Causality and Consequentiality

IC and IR biases are associated with interpersonal verbs that describe the interaction between two human participants. While classified in different ways in

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different studies (Hartshorne & Snedeker, 2013; Malle, 2002; Rudolph & Försterling, 1997), these verbs can be roughly divided into psychological (psych) and action verbs.

Psych verbs describe human emotional states and usually take two arguments: the experiencer and the stimulus. Depending on the surface positions of these two arguments, psych verbs are further divided into experiencer-stimulus (ES) and stimulus-experiencer (SE) verbs. For ES verbs, such as *fear*, the experiencer is located in the subject position and the stimulus in the object position. For SE verbs, such as *frighten*, the argument positions are reversed, with the stimulus in the subject position and the experiencer in the object position.[3] The two types of psych verbs demonstrate a stable IC bias towards the stimulus, i.e., NP2 for ES verbs and NP1 for SE verbs (Au, 1986; Brown & Fish, 1983; Ferstl, Garnham, & Manouilidou, 2011; Hartshorne & Snedeker, 2013; Rudolph & Försterling, 1997).

Unlike psych verbs, action verbs or agent-patient (AP) verbs show a great deal of variance in IC biases. Some studies (Brown & Fish, 1983; Crinean & Garnham, 2006) proposed that action verbs have a causality bias towards NP1 (i.e., the agent). Although this is true for a number of action verbs, many do not exhibit such a bias (Au, 1986; Ferstl et al., 2011; Hartshorne & Snedeker, 2013). For example, among the 280 English action verbs reported in Hartshorne and Snedeker (2013), nearly 57% (my calculation)

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[3] In the literature of theoretical linguistics, the two types of psych verbs are labeled depending on the position of the Experiencer: EO(bject) verbs have the Experiencer in the object position, such as *frighten*, and ES(ubject) verbs have the Experiencer in the subject position, such as *fear*. In this dissertation, I follow the tradition in the psycholinguistics literature by calling the two types of psych verbs as ES and SE verbs.

show no bias towards either NP1 or NP2. Furthermore, some action verbs show a causality bias towards NP2. Au (1986) found that verbs of judging such as *criticize*, *praise*, *thank*, etc., are of this type. Take the verb *thank* for example. When presented with *John thanked Mary because,* Au's participants often continued the sentence with a reference to *Mary,* such as "*John thanked Mary because she has done him a favor*" (Au, 1986, p. 109). These NP2-biasing action verbs were named as agent-evocator (AE) verbs by Rudolph and Försterling (1997) in the sense that the participant in the object position evocates the actions described by these verbs. In the above example, John's act of thanking Mary was a response to Mary's earlier behavior of doing John a favor.

Compared to IC studies which examined a large number of interpersonal verbs (e.g., Ferstl et al., 2011; Hartshorne & Snedeker, 2013), studies on IR only investigated a small number of verbs. According to Crinean and Garnham (2006), IR biases of psych verbs are symmetrical to their IC biases: ES verbs have a consequentiality bias towards NP1 and SE verbs towards NP2. As for action verbs, they argued that both AP and AE verbs have an IR bias towards NP2. Although several studies (Au, 1986; Rigalleau, Guerry, & Granjon, 2014; Stevenson et al., 1994) confirmed these patterns among some verbs, Steward et al. (1998) and Commandeur (2010) found that not every action verb has an IR bias consistent with the above predictions. Thus, it is not completely clear whether IR biases are stable across different types of verbs, although it is possible that, as in the case of IC, psych verbs show stable IR biases while action verbs show some degree of variance.

Empirical Evidence for Implicit Causality and Consequentiality

IC has been studied extensively in the fields of social psychology and psycholinguistics. Using different methods, researchers from different academic backgrounds have confirmed the robustness of IC biases in certain interpersonal verbs as reviewed above.

Social psychologists found IC in causal attribution tasks that probe into people's causal reasoning (e.g., Brown & Fish, 1983; Rudolph & von Hecker, 2006). For example, in their seminal paper, Brown and Fish (1983; Study 1) used materials like (1.5) below and asked participants to give a likelihood rate on a Likert scale to the explanations for an interpersonal event such as *Ted likes Paul*. The first two explanations involved either human character in the event, and the comparative weight given to either choice reflected which character was more likely to cause the event.

(1.5)   Ted likes Paul.

How likely is it that this is because:

A. Ted is the kind of person that likes people.

B. Paul is the kind of person that people like.

C. Some other reason.

Not likely 1 2 3 4 5 6 7 8 9 Definitely likely

(Brown & Fish, 1983, p. 239)

Brown and Fish (1983) found that, when the event was expressed by an ES verb, participants assigned a higher rate to the explanation concerning the object than the explanation concerning the subject. Conversely, when the event was described by an SE or action verb, the rating on the subject explanation was higher than that on the object

explanation. Participants' explicit attribution judgments, therefore, reflected verbs' causality biases.

In addition to social psychology, IC has also been documented in psycholinguistic research, which found that IC has an effect on the establishment of coreference. As shown in examples (1.1) to (1.4) above, IC biases affect people's resolution of ambiguous pronouns. These studies (e.g., Garvey & Caramazza, 1974) used an offline sentence completion or story continuation method in which participants provided continuations to sentence fragments ending with an ambiguous pronoun. To complete the sentence, participants need to first figure out whether the pronoun referred to the subject or the object in the fragment clause. Their continuations therefore provide information about the verb's causality bias. In addition to the sentence completion method, some studies (e.g., Ehrlich, 1980; Hartshorne & Snedeker, 2013) also examined IC in explicit pronoun disambiguation tasks. For example, in a large scale IC study on 750 English verbs, Hartshorne and Snedeker (2013) asked participants to identify the antecedent of an ambiguous subject pronoun embedded in a complete sentence such as *Mary frightened Sara because she is a dax*, with the word *dax* being an invented word that referred to a property of a person. Whether the pronoun is resolved towards the subject or the object is affected by the direction of causality of the event described in the first clause. They found that while there was a stable object bias for ES verbs and a subject bias for SE verbs, there was a great deal of variance for action verbs.

Apart from pronoun interpretation, IC also exerts an influence on comprehenders' re-mention biases, that is, their prediction about which referent will be mentioned next. Some studies (e.g., Arnold, 2001; Au, 1986, Study 1; Kehler et al., 2008) used an open

completion method, in which participants were given a sentence of the form *NP1 verb NP2*, and were required to provide a natural continuation to the sentence. Some studies (e.g., Au, 1986, Study 2; Fukumura & van Gompel, 2010) also included a connective such as *because* to specify the discourse coherence relation as Explanation. Consistent with the findings on pronoun resolution, studies using this method found that ES verbs elicited a re-mention bias towards NP2 and SE verbs a re-mention bias towards NP1.

In addition to offline studies, the effect of IC on coreference has also been investigated in research using online methods. Studies adopting probe recognition tasks showed that participants were faster to recognize a probe consistent with a verb's IC bias (e.g., Garnham, Traxler, Oakhill, & Gernbacher, 1996; Greene & McKoon, 1995; Long & De Ley, 2000; McDonald & MacWhinney, 1995; McKoon, Greene, & Ratcliff, 1993). In online continuation experiments, Guerry, Gimenes, Caplan, and Rigalleau (2006) found that participants were slower to produce continuations when the anaphor in the fragment was incongruent with the IC bias. A similar congruency effect was observed in reading studies such that participants took less time to read sentences congruent with the IC bias than sentences incongruent with it (e.g., Caramazza, Grober, & Garvey, 1977; Caramazza & Gupta, 1979; Featherstone & Sturt, 2010; Garnham & Oakhill, 1985; Garnham, Oakhill, & Cruttenden, 1992; Koornneef & Van Berkum, 2006; Stewart, Pickering, & Sanford, 2000). In addition to reading studies, the role of IC in language comprehension was also investigated in spoken comprehension tasks. Using a visual world paradigm, eye tracking studies revealed that listeners rapidly focused their gazes on the referent consistent with IC biases, sometimes even before the pronoun is mentioned (Cozjin, Commandeur, Vonk, & Noordman, 2011; Pyykkönen & Jarvikivi,

2010). In addition to the above behavioral research, studies using neuroimaging method also confirmed the importance of IC in coreference as reflected in a P600 effect when the pronoun was incongruent with the verb's IC bias (Van Berkum, Koornneef, Otten, & Nieuwland, 2007).

Although the majority of evidence comes from English, IC has been found in other languages as well, suggesting it to be a universal phenomenon. For example, by looking at sentence-completion data from eight languages, Hartshorne, Sudo, and Uruwashi (2013) found a cross-linguistic consistency in IC bias, particularly with regard to ES and SE verbs. Similar findings were also reported in other studies focusing on languages such as Spanish (Goikoetxea, Pascual, & Acha, 2008), Chinese (Jiao & Zhang, 2005; Miao, 1996; Miao & Song, 1995; Sun, Shu, Zhou, & Zheng, 2001), Japanese (Ueno & Kehler, 2010), Korean (Lee & Lee, 2013), Dutch (Commandeur, 2010; Cozjin et al., 2011; Koornneef & Van Berkum, 2006), German and Norwegian (Bott & Solstad, 2014), and Finnish (Pyykkönen & Jarvikivi, 2010).

Compared to the abundant research on IC, only a few studies investigated IR (Au, 1986; Commandeur, 2010; Stevenson et al., 1994; Stewarts et al., 1998). For example, using the sentence-completion method with the fragment *NP1 verb NP2 so s/he*, Au (1986) found that many verbs in her study displayed either an NP1 or NP2 bias in a resultative context. In a self-paced reading study, Stewarts et al. (1998) observed a congruency effect as found in IC studies. That is, reading was slowed down when the pronoun was inconsistent with the verb's IR bias.

It needs to be emphasized that the connective plays a crucial role in determining IC and IR biases. As mentioned above, IC biases are usually observed when the second

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clause is an explanatory clause, as indicated by the connective *because*. By contrast, IR biases appear when the second clause is a resultative clause, as indicated by the connective *so*. These biases are attenuated or even disappear when a different connective or no connective is used (Ehrlich, 1980; Grober, Beardsley, & Caramazza, 1978; Kehler et al., 2008; Koornneef & Sanders, 2013; McKoon et al., 1993; Vonk, 1985). For instance, in an offline sentence completion and an online eye tracking study, Koornneef and Sanders (2013) investigated the effect of different connectives on IC biases. The offline results showed that strong IC biases were elicited only when the connective *because* was used: When the connective was *but* or *and*, IC biases disappeared; when no connective was used, there was still IC biases but much weaker than when the connective *because* was used. The online data corroborated the offline findings. When the connective was *because*, a congruency effect was observed such that participants experienced a reading delay when the subject pronoun in the second clause was inconsistent with the verb bias. However, when the connective is *but* or *and*, no such delay was found. Taken together, these findings demonstrate the importance of connectives, or arguably, discourse coherence relation, in determining referential preference. Different connectives signal different coherences relations, with *because* eliciting an Explanation coherence relation and *so* a Result coherence relation. Therefore, the fact that IC typically occurs with *because* and IR with *so* reveals that IC and IR biases appear in the Explanation and Result coherence relations, respectively. When the coherence relation is different, referential biases vary accordingly.

The Accounts of Implicit Causality and Consequentiality

Although previous studies have provided converging evidence for IC and IR biases of certain verbs, there is some controversy about how they are derived. Various studies have attempted to explain the mechanisms behind IC and IR from different perspectives. These accounts can be roughly classified into three categories: the social cognition approach as proposed in social psychology literature, the lexical and the discourse approaches as proposed in linguistics literature. Since the majority of the literature is about IC, I focus on the accounts of IC and discuss IR only when a particular account embodies it.

The Social Cognition Approach

The primary assumption of the social cognition approach is that IC is determined by human causal cognition – how people make causal inferences about a behavior. In the accounts following this approach, IC is explained by concepts and principles in social psychological theories of causal reasoning.

In their seminal paper, Brown and Fish (1983) proposed that IC is associated with two universal cognitive schemata that govern people's causal attribution: agent-patient schema and stimulus-experiencer schema. The two schemata are identified based on their assumption that there are two basic kinds of interpersonal interaction: actions and (emotional) states. The agent-patient schema applies to actions and determines that people attribute the cause of an interpersonal action to the agent, the individual performing the action. Therefore, action verbs have a causality bias towards NP1. The stimulus-experiencer schema applies to states and determines that people attribute the

cause to the stimulus, the entity that brings about the emotional state. Thus, SE verbs have an NP1 causality bias and ES verbs an NP2 causality bias.

Although the stimulus-experiencer schema is supported by empirical evidence showing that SE and ES verbs have a strong IC bias towards the stimulus, the action-patient schema is not. As mentioned above, verbs of judging, such as *praise*, *criticize*, etc., display a strong causality bias towards NP2 (i.e., the patient in Brown and Fish's terms) rather than NP1 (i.e., the agent). Based on this finding, Rudolph and Försterling (1997) proposed that the events described by these verbs are governed by the agent-evocator schema which determines that the cause is attributed to the evocator, the entity that evocates the action. However, as reviewed in the previous section, even excluding AE verbs, AP verbs still show a great deal of variance in IC bias (Hartshorne & Snedeker, 2013). Therefore, the action-patient schema only works for a small number of interpersonal interactions, making it not explanatorily powerful.

Brown and Fish (1983) argued that the causal schemata are associated with Kelley's (1967, 1973) covariation model, a model of attribution theory (Heider, 1958). According to this model, a behavior (action or state) is attributed to a cause with which it covaries over time. Causes are distinguished between internal causes that are attributed to the person, and external causes that are attributed to the stimulus.[4] For example, in *John admires Sara*, *John* is the person, the internal cause, and *Sara* is the stimulus, the external cause. Whether the cause is attributed to the person or the stimulus depends on the covariation variables of consensus and distinctiveness. Consensus refers to the

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[4] The stimulus as used in the attribution theory is different from the thematic role of stimulus as used in linguistics. Here, it simply refers to any external cause of the behavior.

covariation of behavior across different people. In the above example, if many people besides John admire Sara, the consensus of the behavior is high; if only John admires Sara, the consensus is low. Distinctiveness refers to the covariation of a person's behavior across situations. It is high when the person performs the behavior only in a particular situation, and low when the person is able to perform the behavior in many situations. For example, if John admires only Sara, the distinctiveness of the behavior is high; if John admires many people in addition to Sara, the distinctiveness is low. According to the covariation principle, the cause of a behavior is attributed to the person when its consensus or distinctiveness is low and the stimulus when its consensus or distinctiveness is high.

In accordance with the covariation model of attribution, IC is mediated by the consensus and distinctiveness of events described by interpersonal verbs. AP verbs have low consensus (i.e., few people may perform the action) and low distinctiveness (i.e., many people may be the patient of the action). Therefore, the cause is attributed to the person, i.e., the subject of the verb. AE verbs have high consensus (i.e., many people may perform the action) and high distinctiveness (i.e., few people may be the patient of the action). Thus, attribution is made to the stimulus, i.e., the object of the verb. For psych verbs, both SE and ES verbs have high consensus (i.e., many people may experience the psychological state) and high distinctiveness (i.e., few people may bring about the psychological experience). Thus, attribution is made to the stimulus, i.e., the subject of SE verbs and the object of ES verbs.

This covariation hypothesis, as labeled by Rudolph and Försterling (1997), is arguably supported by studies which examined people's perceptions of consensus and

distinctiveness of interpersonal verbs (e.g., Brown & Fish, 1983; Hoffman & Tchir, 1990; Rudolph, 1997, 2008). However, this line of research only showed that covariation patterns are correlational with IC biases, which does not necessarily mean that covariation patterns are the driving force for IC. Only a few studies (e.g., Rudolph, 1997; Van Kleeck, Hillger, & Brown, 1988) examined the latter issue, but no compelling evidence was obtained. Therefore, it is not conclusive to claim that covariation is the determining factor of IC.

Another potential problem with the covariation hypothesis lies in the covariation model itself. As pointed out by Malle (2004), the covariation model of attribution only assumes one type of explanation for behaviors (i.e., cause) and thus fails to capture the whole picture of causal attribution which embodies a distinction between reasons and causes for different behaviors.

Furthermore, Hartshorne (2014) found that the correlation between attribution judgments as found in social psychological studies and IC biases as found in linguistic continuation tasks is very weak. Therefore, he claimed that it is problematic to equate IC biases with social psychological attrition patterns.

The Lexical Approach

Different from the social cognition approach that views IC as a product of human causal cognition, the lexical approach contends that IC is a linguistic property of interpersonal verbs.

This view was first put forward by Garvey and Caramazza (1974), who argued that IC is a semantic property encoded in verb roots that computes the direction of cause towards one of the arguments of the verb. In other words, IC is an idiosyncratic part in a

verb's entry in the lexicon. This view, however, is not explanatorily adequate. There is no independent motivation that IC bias is part of verb roots. Therefore, it is an arbitrary and ad hoc claim that some verbs are semantically encoded with IC bias while some are not.

In later developments of the lexical approach, IC is not considered as part of the verb meaning *per se*, but rather is associated with other semantic properties of the verb, one of which is the verb's thematic structure (e.g., Arnold, 2001; Crinean and Garnham, 2006; McKoon et al., 1993; Stevenson et al., 1994). In an attempt to account for both IC and IR, Crinean and Garnham (2006) argued that whether an entity is associated with the cause or consequence of an event is determined by its thematic role. For state verbs (i.e., SE and ES verbs), since the stimulus is the entity that gives rise to the state and the experiencer is the entity that experiences the state, the stimulus is associated with the cause whereas the experiencer is associated with the consequence. Therefore, SE verbs have a causality bias towards NP1, and ES verbs have a causality bias towards NP2. By contrast, SE verbs have a consequentiality bias towards NP2, and ES verbs have a consequentiality bias towards NP1.

As for action verbs, Crinean and Garnham (2006) argued that the agent is associated with the cause and the patient the consequence. Therefore, AP verbs have an NP1 (agent) IC bias and an NP2 (patient) IR bias. For AE verbs, Crinean and Garnham (2006) hypothesized that these verbs have both an action and a state component. When the focus is on the cause of the event, the state component becomes prominent, making AE verbs behave like ES verbs. In this situation, the object functions as a stimulus and the subject as an experiencer, resulting in an NP2 IC bias. On the other hand, when the focus is on the consequence of the event, the action component becomes relevant. In this

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case, AE verbs behave like AP verbs, and hence, the IR bias is towards NP2. However, this analysis is completely ad hoc, as there is no independently motivated linguistic analysis that treats AE verbs as a combination of AP and ES verbs.

The big challenge with the thematic account is that it is not fully supported by empirical evidence. For example, it predicts that the agent is the IC biased entity for AP verbs. However, as reviewed in the previous sections, many AP verbs do not even show a clear bias. Hartshorne and Snedeker (2013) argued that this problem may be due to a coarse-grained classification of verbs on the basis of a limit set of thematic roles proposed in traditional semantics literature. It is likely that the division of interpersonal verbs into AP, AE, SE, and ES verbs is unable to capture the intricate differences among a large number of verbs.

To cope with this problem, Hartshorne and Snedeker (2013) adopted a finer-grained semantic analysis of verbs. They classified English verbs on the basis of VerbNet, a comprehensive verbal classification system (274 classes) developed from Levin (1993). In this system, verbs are grouped together mainly according to the type of arguments they take. In a large scale study, Hartshorne and Snedeker found that this VerbNet-based fine-grained classification made better predictions for verbs' IC biases than previous classifications.

Based on predicate decomposition theories, Hartshorne and Snedeker (2013) further proposed an independently motivated account for why certain VerbNet classes of verbs demonstrate consistent IC biases. According to predicate decomposition theories (e.g., Jackendoff, 1990), verb semantics is decomposed into several primitive predicates that determine the arguments' functions. To illustrate, consider the VerbNet class 31.1

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(roughly equivalent to SE verbs). By the decomposition analysis, the semantic structure of these verbs is "cause(NP1, E), emotional_state(result(E), emotion, NP2)" (Hartshorne & Snedeker, 2013, p. 21), which reads that NP1 causes an event E and that the emotional state as a result of the event is experienced by NP2. In this semantic structure, NP1 is specifically designated as the cause of the emotional state. Therefore, when asked to continue a sentence containing this kind of verbs and the connective *because*, such as *Mary frightened Sara because*, people would choose NP1 as the cause. Critically, verbs in the same class have the same semantic structure and thus consistent IC biases. Although this analysis applies well to psych verbs, it is not clear to what extent it can explain the IC bias of action verbs. For example, the verb *ask* has a 75% NP1 bias as found by Hartshorne and Snedeker, but its semantic structure does not seem to contain a primitive predicate of *cause*.

One common problem of both the thematic and the predicate decomposition accounts is that they confuse cause with reason (Pickering & Majid, 2007). The fact that some arguments are the causer does not necessarily mean that they are the *reason* for the event. For example, in *John killed Sara*, John is the causer of Sara's death according to the semantic structure of the verb *kill*, but the reason for John's action of killing may be attributed to either John or Sara. It could be that John killed Sara because John hated Sara or because Sara knew John's dirty secret. Therefore, the subject referent in the *because* clause may not necessarily be determined by the cause in the semantic sense.

Bott and Solstad (2014) approached IC from a different perspective than the above accounts. Working under the umbrella of the discourse representation theory, they argued that some verbs have IC biases because they have an empty slot that is

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underspecified with respect to some causal content. IC biases are manifested when people specify the missing contents of the slot in a *because*-clause.

Bott and Solstad (2014) proposed two underspecified verb semantic properties that determine IC biases. The first property is related to psych verbs. They argued that the stimulus argument in psych verbs is associated with an underspecified proposition which functions as a cause for the psychological experience. Consider the SE verb *disturb*. If John disturbed Mary, it should be John's certain property or action that caused the disturbance to Mary. Therefore, the stimulus argument is a placeholder for an underspecified proposition. Crucially, the underspecified proposition needs to be spelled out in the subsequent discourse as an explanation. Since the proposition is associated with the stimulus, the explanation shows a referential bias towards the stimulus, i.e., NP1 for SE verbs and NP2 for ES verbs.

The other underspecified semantic property concerns AE verbs. Bott and Solstad (2014) argued that these verbs carry a presupposition about the evocator. Consider the verb *punish*. *John punished Mary* presupposes that Mary must have done something punishable. Like the underspecified stimulus argument for psych verbs, the presupposition also needs to be specified in the *because* clause. Since the presupposition is associated with the evocator rather than the agent, the IC bias is linked to NP2.

This theory was tested in a German sentence-completion study by Solstad and Bott (2012). Participants provided continuations to sentences which expressed the underspecified contents of psych and AE verbs in adverbial modifiers, such as *Peter fascinated Linda by his travel descriptions* (SE verbs), and *Peter thanked Mary for the financial support* (AE verbs). The results showed that when the underspecified contents

were provided, IC biases disappeared with no clear preference for either argument. Solstad and Bott interpreted these findings as indicating that IC biases are contingent upon the underspecified causal contents within psych and AE verbs.

Although Bott and Solstad's (2014) theory provides a novel analysis of the IC biases of psych and AE verbs, they did not offer an account for the IC biases of AP verbs. Instead, they argued that AP verbs do not contain an underspecified spot and thus have no causality bias. This view, however, is not consistent with previous empirical findings that certain AP verbs do show a clear NP1 IC bias despite the variance for many other AP verbs (Ferstl et al., 2011; Hartshorne & Snedeker, 2013).

Another limitation with Bott and Solstad's (2014) theory, as well as other lexical accounts as reviewed above, is that they all suggest that IC biases are categorical. Since verbs in the same class have the same thematic roles and semantic structures, they are expected to have an absolute NP1 or NP2 causality attribution. However, as numerous studies (e.g., Garvey & Caramazza, 1974) have found, IC biases are continuous with different verbs showing different degrees of NP1 or NP2 bias. In response to this problem, Hartshorne and Snedeker (2013) argued that IC biases may be inherently categorical with the absolute bias modified by external factors. But, it is unclear what kind of external factors are at play, especially considering the fact that many studies kept all information other than the verb neutral.

The Discourse Approach

Different from the lexical approach that regards IC as a lexical issue, some researchers consider IC as a discourse phenomenon, which should be examined with reference to the discourse context beyond the verb itself.

Pickering and Majid (2007) proposed that IC bias is an abstraction over the possible explanation for an event and that IR bias is an abstraction over the possible consequence of an event. In this view, IC and IR biases are not a categorical part of verb semantics but rather result from comprehenders' inference about which entity is likely to be the focus of the explicit cause for the event (i.e., IC) or the explicit consequence of the event (i.e., IR). Importantly, such inference is probabilistic. For example, an 80% IC bias towards the subject means that there is an 80% chance that the subject of the verb will be interpreted as the focus of the explanation for the event. This view, therefore, is consistent with the fact that IC biases are continuous (e.g., Garvey & Caramazza, 1974).

Pickering and Majid (2007) further argued that the probabilistic causality or consequentiality inference is made on the basis of the representation of the event in comprehenders' mental model. Crucially, this representation is not only determined by verb semantics but also the local discourse context and world knowledge, such as whether the sentence is active or passive (e.g., Au, 1986; Caramazza, & Yates, 1976; Stevenson et al., 1994), the gender and social status of the entities (e.g., Corrigan, 1992; Garvey et al., 1976; Lafrance, Brownell, & Hahn, 1997), etc. To illustrate, consider the verb *praise*. As an AE verb, *praise* shows an NP2 IC bias in sentences such as *Mary praised Sara*. The same bias is observed when *Mary* and *Sara* are switched as in *Sara praised Mary*. However, when the NPs are *the father* and *the son*, the results are different, with *The father praised the son* showing a stronger NP2 IC bias than *The son praised the father* (Garvey et al., 1976). This shows that the bias of the verb *praise* is not only related to the meaning of the verb, but also the representation of the entire event. In this example, the event represented in the second sentence (i.e., *The son praised the*

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father) is less likely to happen, which may cause comprehenders to focus more on NP1 (i.e., the son) in the explanation for the event.

The probabilistic account of IC and IR biases as proposed in Pickering and Majid (2007) is consistent with a coherence-driven coreference model (Kehler et al., 2008; Kehler & Rohde, 2013). In an attempt to provide a unified theory of coreference processing, Kehler and colleagues argued that coreference is closely related to discourse coherence relations, with the former being a byproduct of the establishment of discourse coherence. According to this account, as the linguistic input unfolds, language comprehenders make probabilistic predictions about the discourse coherence relation between clauses or sentences, which further constrains the probability that a previously mentioned entity will be the referent in the following discourse. By this account, IC and IR biases are "simply microcosms of a more general system of coherence-driven biases" (Kehler et al., 2008, p. 37).

Based on Hobb (1979), Kehler (2002) proposed a typology of discourse coherence relations. With regard to IC and IR, the relevant coherence relations are *Explanation* and *Result* as defined in (1.6) below (S_1 and S_2 refer to the first and second sentence, respectively):

(1.6)   a. Explanation: Infer P from the assertion of S_1 and Q from the assertion of S_2, where normally Q $\rightarrow$ P.

b. Result: Infer P from the assertion of S_1 and Q from the assertion of S_2, where normally P $\rightarrow$ Q.

Both Explanation and Result coherence relations belong to the cause-effect category but differ in the order of cause and effect. In the case of *Explanation*, the first

utterance (S_1) is the effect and the second utterance (S_2) is the cause. In the case of

Result, the cause precedes the effect. To illustrate how the establishment of coherence

relation determines referential bias, consider the example *Mary amazed Sara because*.

The connective *because* signals the coherence relation as *Explanation*. To establish this

type of coherence, comprehenders need to figure out a continuation (S_2, Q) to S_1 so that if

Q, then P (S_1, *Mary amazed Sara*). For verbs like *amaze*, the inferring process usually

leads to the subject being selected as the first-mentioned entity in S_2, such as *because*

Mary played a trick. In other words, if it is true that Mary played the trick (Q), then it will

also be true that Mary amazed Sara (P) in accord with the definition of *Explanation*.

To sum up, the discourse approach as endorsed by Pickering and Majid (2007)

and Kehler et al. (2008) offers a unified account of IC and IR, contending that IC and IR

biases result from people's inference about the cause for and the consequence of an

event, respectively. Because the inference people make varies across events, it also

predicts that different verbs have different degrees of biases, which are consistent with

the fact that IC and IR biases are on a continuum.

Chapter 2

The Effect of Intentionality on Re-Mention Biases of Implicit Causality and Consequentiality[5, 6]

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[5] Cheng, W. and A. Almor. In preparation.

[6] Since this chapter is presented in a manuscript style, there is some overlap with Chapter 1 in the discussion of implicit causality and consequentiality.

Introduction

Discourse comprehension is not only based on decoding the linguistic elements of the text, but more importantly, involves the construction of a mental or situation model of the events described in the text, as well as relevant world knowledge activated during comprehension (Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998). Previous research has identified five important dimensions in a situation model: time, space, characters, causation, and intentionality (Chafe, 1979; Gernsbacher, 1990; Johnson-Laird, 1983; Zwaan, 1999; Zwaan, Langston, & Graesser, 1995). Numerous studies have shown that each of these dimensions plays an important role in discourse comprehension. However, the majority of these studies focused on readers' comprehension of global discourse or narrative. Few studies have looked at the role of these dimensions in readers' processing of local discourse, such as the establishment of coreference, in which two elements refer to the same individual. In this study, we focused on the interaction between causation and intentionality and investigated how these two important dimensions in a situation model affect re-mention biases in comprehenders' establishment of coreference, i.e., the likelihood that a referent will be mentioned again in subsequent discourse. In particular, we examined how an events' intentionality affects re-mention biases induced by implicit causality and consequentiality, which have been found to be closely associated with causal relations in discourse.

In the rest of the introduction, we first review previous studies on the role of intentionality in discourse comprehension and its relation with causation. We then give a brief overview on implicit causality and consequentiality, and the possible role intentionality may play in affecting IC and IR re-mention biases.

The Role of Intentionality in Discourse Comprehension

Intentionality, as one of the important dimensions of situation models (Zwaan & Radvansky, 1998), plays an important role in the comprehension of discourse. Readers are found to be actively keeping track of discourse characters' goals or intentions[7] that are explicitly stated in a narrative (e.g., *John wanted to have a vacation*) (Dopkins, Klin, & Myers, 1993; Lutz & Radvansky, 1997; Magliano & Radvansky, 2001; Trabasso & Suh, 1993; Suh & Trabasso, 1993). For example, in a series of experiments, Suh and Trabasso (1993) found that readers were faster to answer probe questions related to uncompleted intentions than completed intentions, indicating that uncompleted intentions are more accessible than completed ones in readers' mental model. Completed intentions, in turn, are more available than the information irrelevant to intentions (Lutz & Radvansky, 1997). In addition to the objective status of intentions (i.e., whether they are completed), readers are also sensitive to characters' subjective perception of intentions (Foy & Gerrig, 2014). Taken together, these results indicate that readers maintain characters' intentions active in situation models.

In addition to tracking intentions, readers are sensitive to the relation between characters' intentions and actions. If an action is not consistent with the intention, readers will be slower to understand the action (Egidi & Gerrig, 2006; Huitema, Dopkins, Klin, & Myers, 1993; Poynor & Morris, 2003). For example, Huitema et al. (1993) had their participants read a text that contained an explicitly stated intention of the character (e.g.,

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[7] Previous studies in discourse comprehension more frequently used the word *goal* to denote people's intentions. In this paper, we did not make a distinction between these two terms and used them interchangeably.

[Dick] wanted to go to a place where he could swim and sunbathe). At the end of the text, participants read a sentence describing an action either consistent with the intention (e.g., *[Dick] bought a ticket to Florida*) or inconsistent with it (e.g., *[Dick] bought a ticket to Alaska*). Results showed that it took participants more time to read the inconsistent sentence than the consistent one. In another study, Egidi and Gerrig (2006) further found that when the passage contained an urgent intention, participants were faster to read sentences that described an extreme action than a mild action. As a whole, these studies show that readers consider characters' intentions when understanding their actions.

Intentions are not always explicitly stated in the discourse. When this happens, there is evidence showing that readers spontaneously make inferences about characters' intentions of action (Graesser, Singer, & Trabasso, 1994; Haigh & Bonnefon, 2015; Hassin, Aarts, & Ferguson, 2005; Long & Golding, 1993; Poynor & Morris, 2003). For example, Poynor and Morris (2003) used materials similar to those of Huitema et al. (1993) but containing implicit intentions (e.g., *[Dick] had always been a real sun-worshipper*). Participants in their study spent longer time in reading sentences denoting implicit intentions than explicit ones, indicating that they were making inference about characters' intentions. More importantly, like explicitly stated intentions, inferred intentions are also actively available in readers' situation model. Poynor and Morris found that, when an action was inconsistent with the inferred intention, participants experienced more processing difficulty than when an action was consistent with the inferred intention.

Intentionality and Causal Inferences

Readers' tendency to track discourse characters' intentions as reviewed above is related to their impulse to establish causal relations between events in discourse. A great number of studies have found that whether the connectives that signal causation are present or not, readers constantly update their situation models by inferring the causal relation between events (e.g., Millis & Just, 1994; Singer, Halldorson, Lear, & Andrusiak, 1992; Traxler, Bybee, & Pickering, 1997). Moreover, discourses that contain causally related sentences are understood better than discourses whose contents are not causally connected (e.g., Duffy, Shinjo, & Myers, 1990; Keenan, Baillet, & Brown, 1984; Myers, Shinjo, & Duffy, 1987; Trabasso & van den Broek, 1985; Radvansky, Copeland, & Zwaan, 2005; Radvansky, Tamplin, Armendarez, & Thompson, 2014). As a whole, these studies indicate that causality is an important device that enables readers to construct a coherent representation of text and facilitates their comprehension.

Importantly, understanding discourse characters' intentions helps readers infer the causal relations between events because intentions are people's motivations for actions. To illustrate, consider the sequence of sentences: *John wanted to buy some food; he went to the grocery store*. As can be seen easily in this example, John's intention to buy some food is the reason for his subsequent action of visiting the grocery store where he can fulfill his goal. Thus, understanding characters' intentions helps readers connect a sequence of events in discourse into a coherent causal structure (Trabasso & Sperry, 1985; Trabasso & Van den Broek, 1985).

Although intentionality and causal inference are interconnected with each other, the exact nature of this relationship is not further explored in discourse comprehension

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research. Social psychologists have provided an answer. For example, working from the perspective of folk psychology, Malle (1999, 2004, 2011) proposed a folk theory of explanation that provides a systematic account for the relation between intentionality and causal inference. The core argument of this theory is that, depending on whether a behavior is intentional or not, people may infer different types of explanations: Intentional events are explained by reasons and unintentional events are explained by causes.

In the folk theory of explanation, intentional and unintentional behaviors are distinguished on the basis of the folk concept of intentionality (Malle & Knobe, 1997). A behavior will be considered intentional if "the agent had a *desire* for an outcome, a *belief* that the action would lead to that outcome, an *intention* to perform the action, the *skill* to perform the action, and *awareness* of fulfilling the intention while performing the action" (Malle, 2004, p.88). These five components are interrelated with each other and collectively determine an event's intentionality.

The folk concept of intentionality determines the way people explain intentional events (Malle, 1999). Among the five components of intentionality, awareness and intention do not have concrete causal content and hence do not appear in explanation. Skill specifies how the behavior is possible and is occasionally involved in explanation. Only desires and beliefs function as reasons and are the focus in people's explanations for intentional events. To illustrate, consider (2.1) and (2.2). Desire reasons such as (2.1) convey the desired outcome, or simply, the purpose of the action. Therefore, they are often indicative of the agent's subjectivity, and are linguistically marked by words such as *want*, etc. Belief reasons such as (2.2) demonstrate the agent's knowledge of the reality

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that may bring about the intention to act, and are usually marked by such words as *think*, *believe*, *feel*, etc.

>(2.1)   Desire reason: John called Mary because he wanted to tell her something.

>(2.2)   Belief reason: John called Mary because he thought that she knew the answer.

Different from intentional behaviors, unintentional behaviors are explained by causes, which refer to any factors that may bring about the behavior (Malle, 1999). The crucial difference between causes and reasons is that causes do not form an intention to act. For instance, in (2.3), the annoyance is an unintentional event, which was caused by Mary talking loudly. It is not a reason because it did not result in an intention in Mary's mind to annoy John.

>(2.3)   Mary annoyed John because she talked loudly. (Mary did not realize that John was annoyed.)

Due to the differences between reasons and causes as argued in the folk theory of explanation, the attribution patterns for intentional and unintentional events are also different. On the one hand, since reasons are primarily associated with the desire or belief of the agent, reason explanations are essentially internal to the agent. Therefore, intentional events are generally attributed to the agent. On the other hand, since causes refer to any factors than may bring out the unintentional behavior, they could be either internal or external to the agent. Unintentional behaviors, therefore, could be attributed to either the agent or other entities.

Implicit Causality and Consequentiality

Garvey and Caramazza (1974) found that some interpersonal verbs denote an implicit causal attribution towards one of its arguments. For example, when presented with a sentence fragment containing the verb *frighten* as in (2.4), people usually continue the sentence by re-mentioning the subject referent *John*, i.e., NP1 in the first clause. By contrast, when the verb is changed from *frighten* to *fear*, people tend to re-mention the object referent *Mary*, i.e., NP2 in the first clause. These verbs are known as implicit causality verbs.

(2.4)   John frightened/feared Mary because …

IC verbs are typically interpersonal verbs that involve the interaction between two human participants. While classified in different ways in different studies (for a detailed review, see Hartshorne & Snedeker, 2013, and Rudolph & Försterling, 1997), these verbs can be roughly divided into psych and action verbs.

Previous studies on IC have focused on two types of psych verbs: experiencer-stimulus (ES) and stimulus-experiencer (SE) verbs. ES and SE verbs have been found to be associated with different yet stable IC biases (e.g., Au, 1986; Brown & Fish, 1983; Ferstl et al., 2011; Hartshorne & Snedeker, 2013; Rudolph & Försterling, 1997). In particular, ES verbs such as *fear* show a causality bias towards NP2 and SE verbs such as *frighten* show a causality bias towards NP1.

Unlike psych verbs, action verbs or agent-patient (AP) verbs demonstrate a great deal of variance in IC biases. Some studies (e.g., Brown & Fish, 1983; Crinean & Garnham, 2006) proposed that AP verbs show a causality bias towards NP1 (i.e., the agent). Although this is true for a number of action verbs, many action verbs do not show an NP1 bias (Au, 1986; Ferstl et al., 2011; Hartshorne & Snedeker, 2013). For example,

among the 280 English action verbs reported in Hartshorne and Snedeker (2013), nearly 57% (our calculation) have no bias towards either NP1 or NP2. Furthermore, some action verbs, such as *criticize*, *praise*, *punish*, etc., show a causality bias towards NP2. These NP2-biasing action verbs were named as agent-evocator (AE) verbs by Rudolph and Försterling (1997) in the sense that the participant in the object position evocates the actions described by these verbs.[8]

IC biases are closely related to discourse coherence relations, in particular, the *Explanation* coherence relation (Kehler et al., 2008). When the discourse coherence relation is *Result* (Kehler et al., 2008), the referential biases are different. For example, when the connective in (2.4) is changed from *because* to *so* as in (2.5) below, the preferred referent to be re-mentioned becomes NP2 for the verb *frighten*, and NP1 for the verb *fear*. This phenomenon is named as implicit consequentiality (Crinean & Garnham, 2006; Stewart et al., 1998).

    (2.5)   Mary frightened/fear Sara so …

Crinean and Garnham (2006) argued that IR biases are largely symmetrical to IC biases: for psych verbs, ES verbs have a consequentiality bias towards NP1 and SE verbs towards NP2; for action verbs, both AP and AE verbs have a bias towards NP2. Although several studies (Au, 1986; Rigalleau et al., 2014; Stevenson et al., 1994) confirmed these patterns among some verbs, Commandeur (2010) and Steward et al. (1998) found that not every AP verb has a clear IR bias. However, unlike IC studies which examined a large

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[8] Note that the evocator is not a thematic role proposed in the linguistics literature. Indeed, as Hartshorne and Snedeker (2013) argued, AE verbs are based on a post-hoc classification. For convenience's sake, we still adopted this term in this paper, as the classification criteria are not of theoretical interest to the present study.

number of verbs (e.g., Ferstl et al., 2011; Hartshorne & Snedeker, 2013), studies on IR only investigated a small number of verbs. Thus, it is not completely clear whether IR biases are stable across different types of interpersonal verbs, although it is possible that, as in the case of IC, psych verbs have stable IR biases while action verbs have some degree of variance.

Many studies have attempted to explain IC and some have also offered an account for IR. One major view is that IC (and IR) biases are determined by the lexical-semantic properties of interpersonal verb, such as verb argument structure (e.g., Arnold, 2001; Crinean and Garnham, 2006; Hartshorne and Snedeker, 2013; McKoon et al., 1993; Stevenson et al., 1994). For example, Crinean and Garnham (2006) argued that IC and IR biases are determined by thematic roles. Specifically, IC is associated with the stimulus and the agent thematic roles, and IR is associated with the experiencer and the patient thematic role.

However, many studies also found that, in addition to verb semantics, IC biases are affected by other factors, such as the syntactic structure of the sentence (e.g., active vs. passive) (Au, 1986; Garvey et al., 1976; Stevenson et al., 1994), the gender and social status of the characters (e.g., Corrigan, 1992; Garvey et al., 1976; Lafrance et al., 1997), the properties of discourse such as its temporal structure (Dery & Bittner, 2015), etc. Therefore, it is likely that IC and IR biases are determined by multiple levels of factors, including verbs' lexical-semantic properties as well as discourse-level factors or even non-linguistic factors.

In recognition of the multidimensionality of this phenomenon, Pickering and Majid (2007) proposed that IC biases are an abstraction over the possible explanation for

an event and that IR bias is an abstraction over the possible consequence of an event. In this view, IC and IR biases are not categorical concepts dependent on verb semantics, but rather probabilistic biases resulting from comprehenders' inferences about which discourse character is likely to be the cause for the event (i.e., IC) or bear the consequence of the event (i.e., IR).

In a similar vein, Kehler et al. (2008) argued that IC and IR biases are a byproduct of comprehenders' attempt to establish coherent causal relations between utterances in discourse. Specifically, IC biases arise from the process in which readers construct an Explanation coherence relation, and IR biases result from readers' efforts to construct a Result coherence relation. To construct an Explanation coherence relation, comprehenders need to figure out what brings about the event (i.e., the explanation). To construct a Result relation, they need to figure out what the event brings about (i.e., the consequence).

The Present Study

Given the close relationship between intentionality and causation and the argument that IC and IR biases are related to causal inferences, it is reasonable to ask whether intentionality has an effect on IC and IR biases. As far as IC biases are concerned, since intentional events tend to be explained by reasons internal to the agent (Malle, 1999), the explanation for an intentional event is likely to begin with a reference to the agent, or NP1 if the agent appears in an active sentence. Since unintentional events tend to be explained by causes that are either internal or external to the agent, the explanation for an unintentional event may thus not show a referential bias towards the agent.

As for IR biases, the situation would be different. According to the folk concept of intentionality (Malle, 1999), an intentional behavior always involves an agent's desire for an outcome. In the case of interpersonal events with two participants (i.e., agent and patient), the outcome must have something to do with the patient; otherwise it would be meaningless to include the patient in the description. In other words, when an agent performs an action on the patient with some intention, he or she desires that the patient will be influenced by the action so that his or her desire for the action can be fulfilled. Once the action is successfully performed, the patient will be the entity that is directly influenced, thereby becoming the focus of the consequence. This logic is also consistent with previous argument that the patient is more readily associated with the consequence the agent (Stevenson et al., 1994). Following this logic, the consequence of an intentional event is likely to have a reference to the patient, or NP2 if the patient appears in an active sentence. For unintentional events, since the agent does not have a specific desire to perform the action on the patient, either the agent or the patient could be directly influenced by the action. Under these circumstances, the consequence of an unintentional event may be associated with either the agent or the patient and hence may not show a referential bias towards the patient.

In this paper, we tested these hypotheses in two sentence-completion experiments, one on IC (Experiment 2.1) and the other on IR (Experiment 2.2). In both experiments, participants were required to write up continuations to a sentence fragments that contained an interpersonal verb and two human characters, a method widely used in previous studies to probe participants' re-mention biases. In both experiments, we manipulated the strength of event intentionality via adverbs. Specifically, we contrasted

intentionality-strengthening adverbs, such as *deliberately*, and intentionality-weakening

adverbs, such as *accidentally*. We also included a control condition in which no adverb

was used. Moreover, considering that interpersonal verbs have a wide range of IC and IR

biases, we included different types of verbs (i.e., AP, AE, and SE verbs that could have

an action reading) in the design to investigate whether the effect of intentionality is

modulated by verb type. Below, we report the two experiments.

<div align="center">**Experiment 2.1**</div>

Introduction

Experiment 2.1 investigated the effect of intentionality on IC biases. As

mentioned above, we manipulated different levels of intentionality by using adverbs such

as *deliberately* vs. *accidentally*. When verbs are modified by adverbs that serve the

function of reinforcing intentionality, the actions represented by the verbs now denote a

high level of intentionality in the sense that readers would infer easily that the agent

performs the action with a strong intention. As argued above, the explanations for

intentional events generally have a referential bias towards the agent. Therefore, it is

predicted that prompts with intentionality-strengthening adverbs would elicit more

references to the agent (i.e., NP1 because the agent in active sentences are also the first-

mentioned entity) than when no adverbs are used.

By contrast, when verbs are modified by adverbs denoting weak intentionality,

the actions would be more likely to be interpreted as unintentional. Since there is no

evidence showing that the explanations for unintentional events have a bias towards the

agent, we predict that prompts with such adverbs would not lead to more NP1 references

than prompts with intentionality-strengthening adverbs.

<div align="center">35</div>

Moreover, previous studies found that interpersonal verbs show a wide range of IC biases: SE and some AP verbs have an NP1 bias, AE verbs have an NP2 bias, and some AP verbs have a neutral bias (Ferstl et al., 2011). Considering such baseline differences, the effect of intentionality on these verbs' IC biases may vary such that, compared to verbs with a higher NP1 bias, verbs with a lower NP1 bias would elicit more NP1 references when modified by intentionality-strengthening adverbs. Therefore, if intentionality affects IC biases in the way described above, we expect to see an interaction between verb and adverb such that, in conditions with intentionality-strengthening adverbs, there would be more increases in NP1 reference following verbs with a low NP1 bias than verbs with a high NP1 bias.

Method

Participants. One hundred native English speakers were recruited from the participant pool of the Department of Psychology at the University of South Carolina. Participants were undergraduate students taking psychology classes and received extra credit for their participation. In the end, 79 participants finished the experiment (55 women, 24 men, M_{age} = 20.4 years, age range: 18-37 years). Although the majority of them knew one or two other languages than English, none of them were native speakers of other languages, and all reported that English was their major language of use in their daily life.

Materials and design. Four types of verbs were selected from the Ferstl et al. (2011) study, a large norming study on the IC bias of English verbs. They were AP verbs with an NP1 bias (>70% NP1 references), AP verbs with a neutral bias (40% ~ 60% NP1

references), AE verbs (<30% NP1 references), and SE verbs with an action reading (>70% NP1 references).[9] Seventy-two verbs were chosen, with 18 in each type.

The selected verbs were embedded in sentence fragments alternating between three conditions: no adverb, intentionality, and unintentionality. In the no-adverb condition, the sentence fragments were composed of a simple sentence of the form *NP1 verb-ed NP2* followed by a connective *because* signaling the Explanation coherence relation. A free prompt (i.e., nothing after *because*) was used to elicit participants' continuations. The two NPs were common English names of different genders. We did not use names of the same gender because if participants chose to use a pronoun to begin the continuation, the reference of the pronoun would usually be ambiguous, making it difficult to identify their intended referent. Using names of different genders could avoid this problem and increase coding accuracy. Half items had a female name in the subject position and a male name in the object position, and the other half had the genders in the opposite order. The sentence fragments in the other two conditions had similar structures except that verbs in the context sentence were modified either by adverbs strengthening intentionality or weakening intentionality. The adverbs used in the intentionality condition were *deliberately*, *purposely*, *intentionally*, *willfully*, and *consciously*, and the adverbs adopted in the unintentionality condition were *accidentally*, *incidentally*, *unintentionally*, *inadvertently*, *unconsciously*, and *unwittingly*. Table 2.1 (at the end of this Chapter) displays sample items.

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[9] The percentages of NP1 references were our calculation based on Ferstl et al.'s (2011) data. They reported verbs' IC bias as the difference between the numbers of NP1 and NP2 references. Whether a verb was an AP, AE, or SE verb was also based on their classifications.

The experiment had a 4×3 design with independent variables of verb (AP verbs with an NP1 bias, AP verbs with a neutral bias, AE verbs, and SE verbs) and adverb (NoAdverb, Intentionality, and Unintentionality). The variable of verb was manipulated within participants and between items, and the variable of adverb was manipulated within both participants and items. The dependent variable was the re-mention reference to either NP1 or NP2 in the first clause. The design was counterbalanced: Every participant saw all the items distributed evenly across the three conditions of Adverb, but never saw one item in more than one condition. In the end, three lists were prepared. Each list contained 72 experimental stimuli and the same number of fillers that had the same structure as the experimental stimuli but contained other types of connectives (e.g., *and*, *but*, *so*, etc.). Two-thirds of the fillers also contained other types of adverbs, such as adverbs of degree, frequency, manner, etc. To counterbalance the effect of gender of the names in the context sentence, three more lists were constructed, in which the two names in each experimental item were presented in a reverse order from the original three lists.

Procedure. The experiment was administered on a survey website (www.qualtrics.com). Participants took the survey on their own computer. Many studies have shown that web-based surveys yield similar results to studies conducted in a laboratory setting (e.g., Buhrmester, Kwang, & Gosling, 2011; Gosling, Vazire, Srivastava, & John, 2004; Sprouse, 2011). Specifically, web-based methods were used in several previous studies of IC, which have yielded results largely consistent with those from studies using traditional paper-and-pencil methods (e.g., Cheng & Almor, 2016; Ferstl et al, 2011; Hartshorne & Snedeker, 2013). Based on this previous research, we

chose to employ a web-based method as this allowed us to conveniently collect data without sacrificing data quality.

Participants were asked to type a natural continuation to the sentence fragment and were told to give their most intuitive responses. Before starting the experiment, they filled in a language background questionnaire and then completed a practice block of five filler items (different from the fillers in the experiment) to be familiarized with the task. The task was not timed, but participants were instructed to finish the survey at a normal speed and complete it in one session. Participants were randomly assigned to one of the six lists, and all items in each list were automatically randomized for each participant.

Coding. The data were coded by the first author and a trained native English speaker naive to the purpose of the study. The coding agreement rate was 98%. The coding agreement rate was high because the different genders of names helped coders identify the referent. All disagreements were resolved through discussion. Those disagreements that could not be resolved were coded as "unclear."

The data were coded in the following ways. The subject NP in participants' continuations was coded as referring to either the subject ("NP1") or the object ("NP2") in the first clause. Since the referring form was not specified, participants could refer to the antecedent by using either a reduced form such as a pronoun or a fuller form such as a name. If a pronoun was used, the referent was identified on the basis of the gender information encoded by the pronoun. There were also cases where the continuation began with a plural reference or a reference to other entity ($n = 318$), the connective *because* was interpreted as part of *because of* ($n = 213$), and no continuation was given ($n = 50$).

For convenience's sake, these cases were classified as "unclear" as well. Overall, there were 10% unclear responses. Table 2.2 illustrates different types of coded continuations.

Results

All data coded as "unclear" were excluded from analysis, affecting 10% of the data set. Since the design contained two types of AP verbs which differed in the strength of IC bias (i.e., NP1 vs. neutral), we first calculated the percentage of NP1 references for each AP verb in order to verify their referential biases. Four AP verbs that were initially classified as having an NP1 bias showed a neutral bias in our data, and two AP verbs that were initially classified as having a neutral bias showed an NP1 bias. These six verbs were then reclassified such that the first four verbs were classified as AP verbs with a neutral bias, and the last two verbs were classified as AP verbs with an NP1 bias. Table 2.3 presents the mean proportions of NP1 references out of all NP1 and NP2 references for the four types of verbs in different adverb conditions.

We used logit mixed-effects regressions to model the binary choice between NP1 and NP2 of the subject reference in participants' continuations. According to Jaeger (2008), logit mixed-effects models are more suitable for analyzing categorical data than ANOVA. Model comparison was used to estimate the significance of each term, starting with a maximal model containing all individual factors and their interactions. The interaction term was first eliminated. If the elimination did not lead to a significant loss of model fit, each of the individual factors was then removed (Baayen, 2008). Following Barr, Levy, Scheepers, and Tily (2013), all the models contained the random effects of participants and items as well as maximal slopes when appropriate and allowed by the data. The analysis was conducted with the lme4 package (Bates, Maechler, Bolker, &

Walker, 2014) in R (R core team, 2014), and an alpha level of .05 was used for all statistical tests.

We first estimated a maximal model with verb type, adverb type, antecedent gender, and their interactions as the fixed effects. All categorical factors were sum-coded to obtain main effects and interactions (Barr, 2013). Model comparisons indicated that antecedent gender and its interactions with other terms did not contribute significantly to model fit and were thus removed from modelling. Removing the two-way interaction between verb and adverb resulted in a significant loss of model fit, $\chi^2(6) = 54.91$, $p < .001$, indicating that the interaction between verb and adverb was a significant term. Figure 2.1 (at the end of this chapter) shows the interaction.

In order to better understand the effect of adverb on different types of verb, we ran logistic models on each type of verb separately to obtain the simple effects of adverb. The results are summarized in Table 2.4. As can be seen in Table 2.4, when the verbs were AP verbs with a neutral bias or AE verbs, there were significantly more NP1 references in the unintentionality condition than in the intentionality conditions, which in turn had significantly more NP1 reference than the NoAdverb condition. For AP verbs with an NP1 bias, despite a similar trend of difference among the three adverb conditions, such differences did not reach significance. SE verbs showed a different pattern with the intentionality condition having fewer NP1 references than both the NoAdverb and the unintentionality conditions.

Discussion

In this study, we investigated whether event intentionality affects IC biases by manipulating adverbs denoting different degree of intentionality. We found an interaction

between verb and adverb: the effect of adverb on IC biases was modulated by verb type. Specifically, for AE verbs and AP verbs with a neutral bias, more NP1 references were elicited when intentionality-strengthening adverbs were used than when no adverbs were present. This finding confirms the hypothesis that reinforcing event intentionality leads to more NP1 re-mentions. However, for AP verbs with an NP1 bias, although there was a trend of increase among the three conditions, it did not reach significance. Since all three types of verbs are action verbs with the agent role in the same position, this contrast between AP verbs with an NP1 bias and the other two types of action verbs suggests that the effect of intentionality on IC biases depends on verbs' original NP1 bias. If a verb already has a strong NP1 bias, strengthening the intentionality of the event described by the verb will not lead to more NP1 re-mentions. This may be due to the fact that these verbs have different baseline IC biases. For AP verbs with an NP1 bias, since there is already a strong bias for NP1 as shown in the baseline condition, the effect of intentionality may be difficulty to be observed in this type of task. By contrast, since AP verbs with a neutral bias as well as AE verbs do not have an NP1 bias, their IC biases are more likely to be influenced by strengthened intentionality.

In addition to adverbs denoting strong intentionality, we also used adverbs such as *accidentally*, which denote weak intentionality. The results showed that, for AE verbs and AP verbs with a neutral bias, the inclusion of these adverbs led to more NP1 re-mentions than the use of adverbs of intentionality or no adverbs. Again, for AP verbs with an NP1 bias, no significant difference was observed. These results are different from our prediction. According to Malle's folk theory of explanation (1999), unintentional events are explained by causes, which could be associated with factors either internal or

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external to the agent. By contrast, intentional events are primarily explained by reasons which mainly involve the agent. Thus, probabilistically, when adverbs like *accidentally* were used, there should have been less NP1 references than when adverbs like *deliberately* were used. This unexpected finding will be further discussed in the General Discussion.

The results of SE verbs are different from those of AP and AE verbs. Compared to when no adverbs were used, there were significantly less NP1 re-mentions when adverbs like *deliberately* were used, but no significant differences when adverbs like *accidentally* were used. The discrepancy between SE and AP/AE verbs could be due to the fact that many SE verbs have both agentive and non-agentive readings (Arad, 1998). When modified by adverbs signaling no intention or when no adverbs are used, SE verbs usually have a non-agentive reading. By contrast, since adverbs like *deliberately* signal volition on the part of the subject, SE verbs carry on an agentive reading when modified by these adverbs (Arad, 1998). In the latter condition, SE verbs may behave like action verbs rather than psych verbs. Previous studies have found that SE verbs generally show stronger NP1 biases than AP verbs (Bott & Solstad, 2014; Hartshorne & Snedeker, 2013). This may explain why SE verbs in the intentionality condition elicited fewer NP1 references than the other conditions.

Experiment 2.2

Introduction

Following the same design as in Experiment 2.1, we examined in Experiment 2.2 whether event intentionality has a similar effect on IR biases. In the IR context, the discourse coherence relation is Result, and thus the causal inference readers make is forward inference (van den Broek, 1990). That is, comprehenders need to infer the

possible consequence that results from the event described in the first clause. Previous studies suggest that when making causal inference in the forward direction, comprehenders tend to resolve the subsequent reference to NP2 after action verbs (both AE and AP verbs) as well as SE verbs (Crinean & Garnham, 2006; Stevenson et al., 1994). Thus, this experiment examined whether intentionality has an effect on this NP2 IR bias.

As described in the introduction of this paper, the consequence of an intentional event tends to be associated with the patient, while the consequence of an unintentional event may not show a referential bias towards the patient. Therefore, it is expected that, when verbs are modified by intentionality-strengthening adverbs, there are more subsequent references to the patient (i.e., NP2 because the sentences are in the active voice) than when intentionality-weakening adverbs or no adverbs are used.

Moreover, like in Experiment 2.1, the effect of intentionality on IR biases may also be modulated by verb type such that, compared to verbs with a higher NP2 bias, verbs with a lower NP2 bias may elicit more NP2 references when modified by intentionality-strengthening adverbs. In other words, an interaction between verb and adverb is also expected in this experiment.

Method

Participants. Seventy-five native English speakers were recruited from the same population as in Experiment 2.1. Sixty of them finished the experiment (50 women, 10 men, $M_{age} = 20.23$ years, age range: 18-35 years). None of them were native speakers of other languages than English, and all reported that English was their major language of use in their daily life.

Materials and design. Since previous studies on IR only examined a small number of verbs, a norming study was first carried out on the 300 verbs tested in Ferstl et al. (2011) to determine the IR biases of these verbs. The verbs were embedded in sentence fragments of the form *NP1 verb-ed NP2 and as a result,* eliciting a Result coherence relation. The two NPs were English names of difference genders. Half of the items had a male-female order and the other half had a female-male order. The 300 items were randomly divided into three lists, each consisting of 100 items. To counterbalance the effect of gender, three more lists were prepared by reversing the order of the two names. Another group of native English speakers recruited from the same population (*N* = 115) took part in the norming study on the survey website Qualtrics. They were randomly assigned to each of the six lists and typed continuations to the sentence fragments. Following the same procedure as in Experiments 2.1, participants' continuations were coded as referring to either NP1 or NP2 by the first author and another trained native English speaker. Since IR biases were largely associated with NP2 (Crinean & Garnham, 2006), each verb's IR bias was determined by calculating the percentage of NP2 references out of all NP1 and NP2 references.

Seventy-two verbs were selected: 36 AP verbs, 18 AE verbs, and 18 SE verbs. All AE and SE verbs had a strong IR bias towards NP2 (>90% NP2 references). Different from Experiment 2.1, in this experiment we did not make a further distinction between AP verbs. This is due to the finding of the norming study that AP verbs have an overall IR bias towards NP2 (*M* = 85%, *SD* = 16%). Therefore, we treated AP verbs as a single level in this experiment. However, given that there is still a big variance of IR bias for AP

verbs ($SD = 16\%$), the 36 AP verbs used in the experiment also represented such a variance ($M = 81\%$, $SD = 20\%$).

The stimuli were prepared in the same way as in Experiment 2.1. The only difference was that the connective was changed to *and as a result*. The connective *so* as used in previous studies was not adopted here because it may denote other meanings than consequence (Stevenson et al., 1994). The phrase *as a result*, by contrast, specifically indicates that the coherence relation is Result.

The design of Experiment 2.2 was the same as Experiment 2.1 except that there were three levels for the independent variable of verb (AP, SE and SE).

Procedure. The experiment was conducted in the way as Experiment 2.1.

Coding. The data were coded in the same way as in Experiment 2.1. Overall, there were 11% unclear responses: plural references or references to other entity ($n = 446$), and no response ($n = 47$).

Results

All data coded as "unclear" were excluded from analysis, affecting 11% of the data set. Since IR biases are primarily associated with NP2, the dependable variable of this experiment is NP2 reference in the continuations. Table 2.5 presents the mean proportions of NP2 references out of all NP1 and NP2 references across different verb and adverb conditions.

The data were analyzed in the same way as in Experiment 2.1. We first estimated a maximal model with verb, adverb, antecedent gender, and their interactions as the fixed effects. Model comparisons indicated that antecedent gender and its interactions with other terms did not contribute significantly to model fit and were thus removed from

modelling. However, removing the two-way interaction between verb and adverb resulted in a significant loss of model fit, $\chi^2(4) = 13.32$, $p = .01$, indicating that the interaction between verb and adverb was a significant term. The interaction is illustrated in Figure 2.2.

In order to better understand the interaction, we ran the same simple-effects analyses as in Experiment 2.1. The statistical results are summarized in Table 2.6. As can be seen in the table, the factor of adverb did not have a significant effect on either AP or AE verbs. As for SE verbs, the unintentionality condition elicited significantly less NP2 references than either the NoAdverb or the intentionality condition.

Although AP verbs showed an overall NP2 bias ($M_{\text{proportion}} = 0.76$), there was a big variance in the proportion of NP2 references (range: 0.13 to 1.00, $SD = 0.24$), which might confound the data. To address this issue, we performed a separate analysis on AP verbs by including AP verbs' NP2 bias (centered) as a covariate. Model comparison showed a significant interaction between adverb and AP verbs' NP2 bias, $\chi^2(2) = 8.06$, $p = .02$. The parameter estimates of the best-fitted model are presented in Table 2.7, and the two-way interaction is visually represented in Figure 2.3. As can be seen in the table, when centered at the mean, AP verbs' NP2 bias had no effect on adverb. However, the interaction coefficients indicate that, overall, AP verbs' NP2 bias did have a modulating effect on the factor of adverb such that the lower a verb's NP2 bias, the more NP2 re-mentions in the intentionality/unintentionality conditions than in the NoAdverb condition.

To better understand the interaction, following Preacher, Curran, and Bauer (2006), we calculated the range of AP verbs' NP2 bias within which the differences between the NoAdverb conditions and the other two conditions were significant. Results

showed that there was a significant difference between the NoAdverb and the intentionality conditions or between the NoAdverb and the unintentionality conditions when AP verbs' NP2 bias was below 61% or 55%, respectively. There were no significant differences when the NP2 bias was above these two critical values.

Discussion

In this experiment, we investigated whether intentionality affects IR biases. Like in Experiment 2.1, there was an interaction between adverb and verb, indicating that the effect of intentionality was modulated by verb type. For AP verbs, the effect was further modulated by the verb's original IR bias. Specifically, for AP verbs without an NP2 bias (< 61% NP2 references), there were more NP2 re-mentions when intentionality-strengthening adverbs were used than when no adverbs were used. However, no significant difference was found for AP verbs with an NP2 bias. Moreover, adverb had no effect on AE verbs either. Given that AE verbs also have a strong NP2 bias, the patterns of these results are consistent with our prediction. That is, the effect of intentionality depends on verbs' original IR bias: If a verb has no NP2 IR bias, reinforcing intentionality will lead to more NP2 re-mentions. However, different from our prediction, these patterns were also found for adverbs weakening intentionality. This will be further discussed in the General Discussion.

<div align="center">

General Discussion

</div>

In this study, we investigated whether event intentionality affects IC and IR re-mention biases in two sentence-completion experiments. We manipulated the strength of event intentionality by using intentionality-strengthening adverbs such as *deliberately* and intentionality-weakening adverbs such as *accidentally*. In the first experiment on IC,

we found that intentionality-strengthening adverbs had an effect on participants'

subsequent reference, but this effect was modulated by verbs' original IC biases.

Specifically, for action verbs with an NP1 IC bias, intentionality does not have an effect.

However, for action verbs that do not have an NP1 IC bias, intentionality significantly

increased NP1 references. Similar patterns were found in the experiment on IR:

intentionality increases NP2 references only for actions verbs with no NP2 bias.

The finding that reinforcing the intentionality of an event increases the IC or IR

re-mention biases towards one of its participants shows the role of intentionality in

inferring the cause and consequence of an event. In the context of IC, comprehenders

need to make backward inferences about the explanation for the event described in the

preceding context. When adverbs reinforcing intentionality are used, the event would

convey a high level of intentionality, that is, the agent has a strong intention for the event

to occur. According to Malle's (1999) folk theory of explanation, an event's

intentionality determines how people explain this event, with intentional events usually

being explained by reasons internal to the agent. Thus, when explaining the event,

comprehenders tend to attribute it to the agent. Since the agent is also NP1 in an active

sentence, intentionality thus leads to more NP1 references in the IC context.

In the case of IR, comprehenders need to make forward inferences about the

consequence of an event. According to Malle (1999), an intentional behavior involves an

agent's desire for a consequence. Therefore, when an event's intentionality is reinforced

by adverbs like *deliberately*, it indicates that the agent has a stronger desire for a

consequence to happen. Since the consequence of an event is usually associated with the

patient (Stevenson et al., 1994), an event with reinforced intentionality would bias

comprehenders to refer more to the patient when inferring the consequence. As the patient is NP2 in an active sentence, there are more NP2 references in the IR context.

In addition, we also found that intentionality-weakening adverbs like *accidentally* have an influence on IC and IR biases in a way similar to intentionality-strengthening adverbs. That is, compared to when no adverbs are used, there were more NP1 re-mentions in the case of IC and more NP2 re-mentions in the case of IR. Unlike intentional events, unintentional events are explained by causes either internal or external to the agent (Malle, 1999). Furthermore, the agent of an unintentional event does not have a desire for a consequence. Therefore, there is no priori reason to assume that weakening an event's intentionality would elicit re-mention biases similar to reinforcing an event's intentionality. This unexpected result might be related to the adverbs used in the experiments. We used adverb such as *accidentally*, *unintentionally* to denote unintentionality. Although sentences with these adverbs do have a literal meaning of doing something without an intention, by specifying the unintentional aspect these adverbs may be creating an inference that intentionality was expected, especially considering that unintentional actions generally do not occur frequently in people's daily life. To control this, future studies could use adverbs that are unrelated to intentionality, or use verbs that normally denote unintentional actions. Alternatively, we may not use an adverb at all but precede the sentence with a context (e.g., as part of a story) that implicitly conveys intentionality or unintentionality.

Overall, the current findings add to the literature in discourse processing by showing the importance of intentionality in discourse comprehension. Previous studies have shown that intentionality plays an important role in readers' construction of a

causally coherent situation model (Trabasso & Sperry, 1985; Trabasso & Van den Broek, 1985). Since coreference is also an important feature of a coherent discourse (Halliday & Hassan, 1976), the present study extends this line of research by showing that readers are sensitive to an event's intentionality when inferring which referent will be mentioned next.

Last, the present study also contributes to the understanding of IC and IR biases. In the psycholinguistic literature, there is a debate about whether IC and IR biases derive from the lexical-semantic properties of verbs (e.g., Crinean & Garnham, 2006; Hartshorne & Snedeker, 2013; Hartshorne, 2014) or the more general discourse information (e.g., Kehler et al., 2008; Pickering & Majid, 2006). Since intentionality is a dimension in the mental model of discourse, the current findings are consistent with recent studies showing that various discourse factors influence IC and IR biases. For example, Dery and Bittner (2015) found that the temporal structure of discourse, such as whether events are temporally proximal or distal, affects or oven overrides IC biases. As both time and intentionality are important indexes in the construction of situation models (Zwaan & Radvansky, 1998), the present study, therefore, provides converging evidence that IC and IR biases are a discourse phenomenon resulting from comprehenders' causal inferences about the explanation for or the consequence of an event on the basis of its representation in the situation model.

Table 2.1

Sample Items in Experiment 2.1

Adverb	AP (NP1 bias)	AP (neutral bias)	AE	SE
NoAdverb	Anna called Jack because…	Megan grabbed Edward because…	Teresa praised Brent because…	Kathy frightened Chris because…
Intentionality	Anna deliberately called Jack because…	Megan deliberately grabbed Edward because…	Teresa deliberately praised Brent because…	Kathy deliberately frightened Chris because…
Unintentionality	Anna accidentally called Jack because…	Megan accidentally grabbed Edward because…	Teresa accidentally praised Brent because…	Kathy accidentally frightened Chris because…

Table 2.2

Sample Coded Continuations in Experiment 2.1

Codes	Sample continuations
NP1	Megan deliberately grabbed Edward because *she wanted to get his attention.*
NP2	Megan deliberately grabbed Edward because *he was about to get hit by a car.*
Other/plural entity	Angela distracted Dawson because *they had a surprise for him.*
Because of	Angela distracted Dawson because *of how beautiful she was.*

Note. Participants' continuations were in italics.

Table 2.3

Means Proportions and Standard Deviations of NP1 References by Verb and Adverb in Experiment 2.1

Adverb	AP (NP1 bias)	AP (neutral bias)	AE	SE
NoAdverb	0.78 (0.22)	0.45 (0.25)	0.12 (0.14)	0.85 (0.19)
Intentionality	0.78 (0.23)	0.55 (0.26)	0.29 (0.27)	0.75 (0.22)
Unintentionality	0.81 (0.20)	0.69 (0.19)	0.52 (0.27)	0.83 (0.18)

Note. Standard deviations are in parentheses.

Table 2.4

Summary of Simple Effects of Adverb on Different Types of Verbs in Experiment 2.1

Contrasts	*B*	*SE B*	*z*	*p*
AP verbs with NP1 bias				
NoAdverb vs. Intentionality	0.15	0.18	0.80	1.00
NoAdverb vs. Unintentionality	0.18	0.19	0.94	1.00
Intentionality vs. Unintentionality	0.03	0.19	0.17	1.00
AP verbs with neutral bias				
NoAdverb vs. Intentionality	0.37	0.14	2.67	.02 *
NoAdverb vs. Unintentionality	1.11	0.14	7.80	< .001 *
Intentionality vs. Unintentionality	0.74	0.14	5.23	< .001 *
AE verbs				
NoAdverb vs. Intentionality	1.17	0.19	6.10	< .001 *
NoAdverb vs. Unintentionality	2.32	0.19	12.40	< .001 *
Intentionality vs. Unintentionality	1.16	0.15	7.63	< .001 *
SE verbs				
NoAdverb vs. Intentionality	-0.68	0.18	-3.76	< .001 *
NoAdverb vs. Unintentionality	-0.12	0.19	-0.60	1.00
Intentionality vs. Unintentionality	0.57	0.18	3.21	.001 *

Note. The *p* value is adjusted by Bonferroni adjustment. Significant effects at a $p \leq .05$ level are marked with a *.

Table 2.5

Means Proportions and Standard Deviations of NP2 References by Verb and Adverb in Experiment 2.2

Adverb	AP	AE	SE
NoAdverb	0.76 (0.26)	0.97 (0.07)	0.96 (0.10)
Intentionality	0.79 (0.22)	0.95 (0.11)	0.98 (0.07)
Unintentionality	0.76 (0.24)	0.95 (0.10)	0.90 (0.14)

Note. Standard deviations are in parentheses.

Table 2.6

Summary of Simple Effects of Adverb on Different Types of Verbs in Experiment 2.2

Contrasts	*B*	*SE B*	*z*	*p*
AP verbs				
NoAdverb vs. Intentionality	0.27	0.16	1.72	0.26
NoAdverb vs. Unintentionality	0.04	0.15	0.27	1.00
Intentionality vs. Unintentionality	-0.22	0.16	-1.46	0.42
AE verbs				
NoAdverb vs. Intentionality	-0.71	0.42	-1.70	.09
NoAdverb vs. Unintentionality	-0.68	0.43	-1.60	0.33
Intentionality vs. Unintentionality	0.03	0.35	0.08	1.00
SE verbs				
NoAdverb vs. Intentionality	0.53	0.52	1.03	1.00
NoAdverb vs. Unintentionality	-0.90	0.42	-2.16	.09
Intentionality vs. Unintentionality	-1.43	0.44	-3.22	.003 *

Note. The *p* value is adjusted by Bonferroni adjustment. Significant effects at a $p \leq .05$ level are marked with a *.

Table 2.7

Summary of the Logistic Regression Analysis for AP verbs including AP verbs' NP2 bias as a covariate in Experiment 2.2

Predictors	*B*	*SE B*	*z*	*p*
(Intercept)	1.69	0.17	10.14	< .001 *
Adverb (Intentionality)	0.008	0.23	0.04	0.97
Adverb (Unintentionality)	-0.11	0.23	-0.47	0.64
NP2 bias	7.11	0.76	9.34	< .001 *
Adverb (Intentionality) × NP2 bias	-2.66	0.93	-2.86	.004 *
Adverb (Unintentionality) × NP2 bias	-2.66	0.95	-2.81	.005 *

Note. The factor of condition was coded using R's dummy coding with NoAdverb being the reference level (value = 0). The continuous factor of NP2 bias was centered at the mean (value = 0.76). Significant effects at a $p \leq .05$ level are marked with a *.
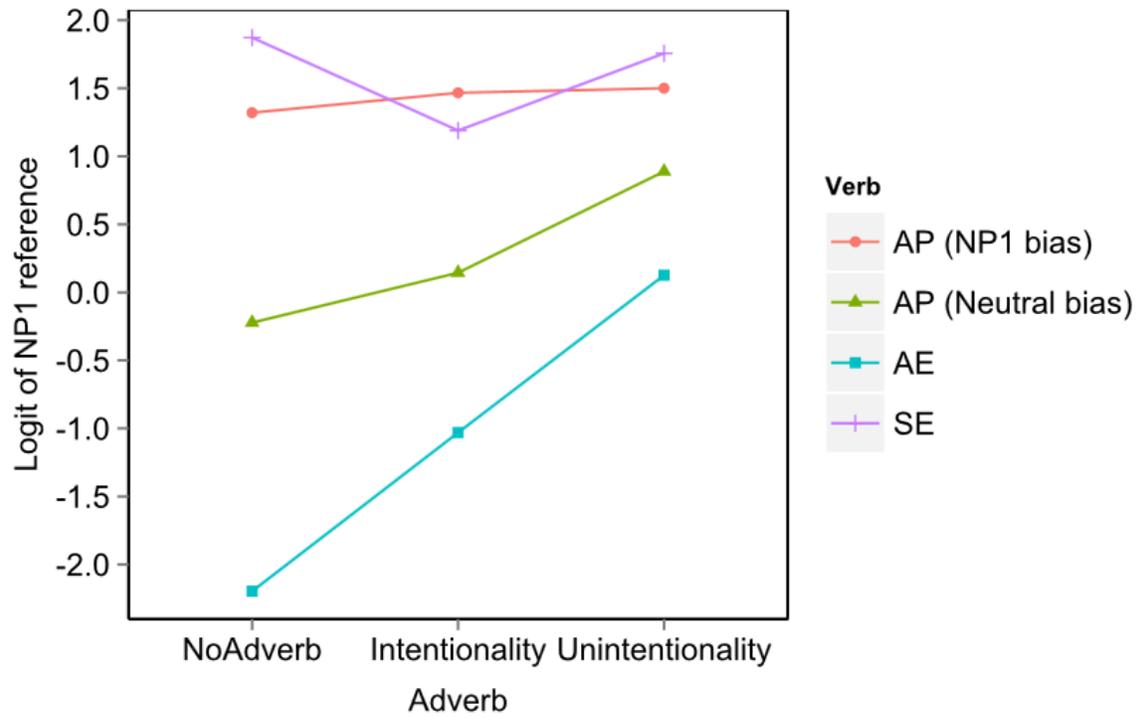
Figure 2.1. Graph showing a two-way interaction between adverb and verb in Experiment 2.1.
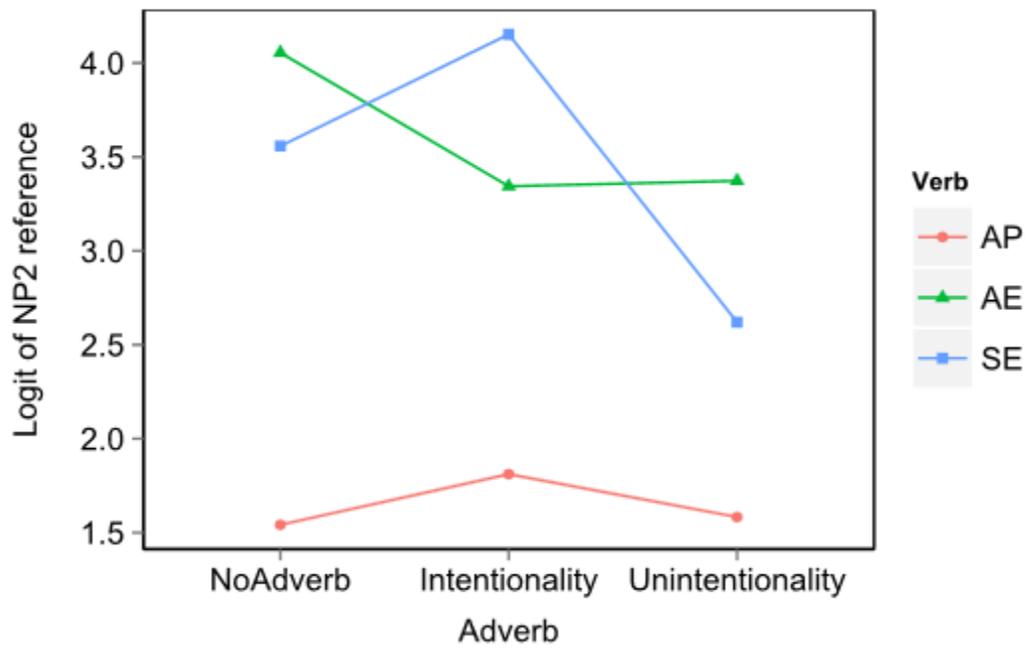
Figure 2.2. Graph showing a two-way interaction between adverb and verb in Experiment 2.2.
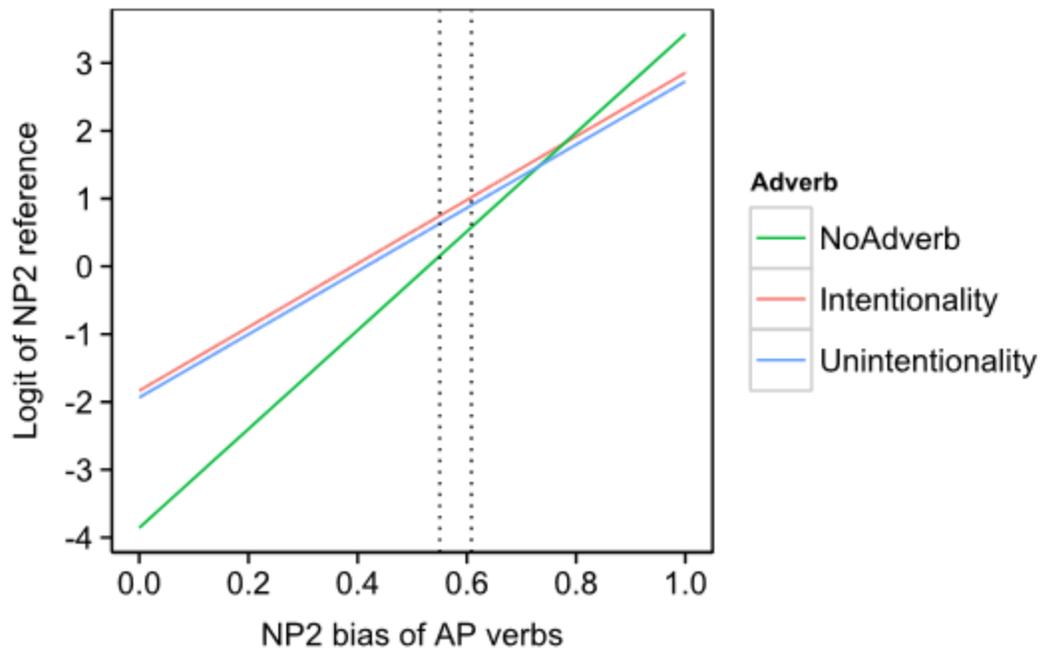
Figure 2.3. Graph showing a two-way interaction between adverb and AP verbs' NP2 bias in Experiment 2.2. *Note.* The vertical lines represent the critical values of NP2 bias, below which there was a significant difference in NP2 references between the conditions of NoAdverb and intentionality (right line)/unintentionality (left line).

Chapter 3

Establishing Coreference in Second Language Discourse: Evidence from

Implicit Causality and Consequentiality Verbs[10, 11]

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[10] Cheng, W. and A. Almor. In preparation.

[11] Since this chapter is presented in a manuscript style, there is some overlap with Chapters 1 and 2 in the discussion of implicit causality and consequentiality.

Introduction

Discourse is composed of coherently organized elements. One important way to achieve coherence is coreference, where a referring expression (e.g., a pronoun) and a previously mentioned entity (i.e., the antecedent) refer to the same individual (Halliday & Hassan, 1976). The establishment of coreference is influenced by the semantic content of the local discourse. For example, when presented with a sentence fragment ending with an ambiguous pronoun like (3.1), comprehenders usually continue the sentence with the pronoun referring to the subject *Mary*. By contrast, when the verb is changed from *frighten* to *fear* as in (3.2), they tend to resolve the pronoun as referring to the object *Sara*.

(3.1) $Mary_i$ frightened Sara because she_i …

(3.2)   Mary feared $Sara_i$ because she_i …

This contrast results from the different semantic biases of the verbs, which are known as implicit causality biases (Brown & Fish, 1983; Crinean & Garnham, 2006; Garvey & Caramazza, 1974). Specifically, *frighten*-like or NP1-biasing verbs have a causality bias towards the subject, whereas *fear*-like or NP2-biasing verbs have a causality bias towards the object. IC biases can be altered when the connective in the examples above is changed from *because* to *so*. In this situation, the preferred referent of the pronoun becomes the object of the verb *frighten* and the subject of the verb *fear*. The latter phenomenon is known as *implicit consequentiality* (IR) (Crinean & Garnham, 2006; Stewart et al., 1998). Although coreference such as the examples above has been studied extensively among mono-linguistic speakers, few studies have been conducted on second language (L2) speakers. To further our understanding of L2 coreference, we report in this

paper two experiments that investigated advanced Chinese-speaking English learners'
coreference resolution in the contexts of IC and IR. In the rest of the introduction, we first
lay out the background of our study by reviewing previous research on the establishment
of coreference by non-native speakers in their L2. We then introduce the general
mechanism underlying coreference resolution. Last, we present the research questions
and hypotheses of the current study.

Establishing Coreference in the L2

Compared to the large body of research on how native (L1) speakers establish
coreference in discourse, only a few studies have addressed this issue among L2 learners.
In the literature of second language acquisition (SLA), despite a handful of studies
examining L2 speakers' acquisition of the Binding Principles that govern anaphora (e.g.,
Felser, Sato, & Bertenshaw, 2009; Hirakawa, 1990; Kim, Montrul, & Yoon, 2015; Lee &
Schachter, 1997; Patterson, Trompelt, & Felser, 2014; Thomas, 1991; White, 1998), little
is known about how L2 speakers resolve pronouns in discourse.

Roberts, Gullberg, and Indefrey (2008) examined German and Turkish-speaking
L2 Dutch learners' offline and online interpretation of pronouns. Both Dutch and German
do not allow null subjects, with the overt pronoun usually referring to the most salient
entity in discourse. Turkish, on the other hand, allows null subjects, and overt pronouns
in the subject position normally signify a topic shift. Using materials like those in (3.3)
and (3.4), Roberts et al. found an L1 effect in learners' offline pronoun interpretation:
While German-speaking learners patterned with native Dutch speakers in preferring the
discourse-biased local antecedent *Peter* as in (3.4), Turkish-speaking learners showed no
preference for either antecedent.

(3.3) The workers are in the office. While Peter is working, he is eating a

sandwich.

(3.4) Peter and Hans are in the office. While Peter is working, he is eating a

sandwich.

(Roberts et al., 2008, p. 341)

In the online eye-tracking task, however, both Turkish and German speakers displayed a

processing disadvantage with longer reading times of (3.4) than (3.3). Since there were

two possible referents for the pronoun in (3.4) and only one referent in (3.3), L2 learners'

processing disadvantage with the former demonstrates their difficulty in resolving

pronominal ambiguity in discourse. One limitation with this study, however, is that since

the materials contrasted ambiguous and unambiguous pronouns, the results only revealed

that ambiguous pronouns are more difficult for L2 speakers to resolve than unambiguous

pronouns. It is still unclear what specific discourse factors could contribute to this

difficulty.

Grüter, Rohde, and Schafer (2014, 2016) addressed this issue in an offline

sentence-completion study that investigated L2 learners' sensitivity to discourse-driven

biases in resolving ambiguous reference. Studies on native English speakers found that

aspect marked on source-goal verbs (e.g., *hand*) can change sentence event structures,

which in turn affects coreference (Rohde, Kehler, & Elman, 2006). Specifically,

perfective events such as the example in (3.5) elicit a referential bias towards the goal

referent (i.e., *Bob*), whereas imperfective events such as the example in (3.6) would

increase references to the source referent (i.e., *John*). Grüter et al. found that while native

English speakers continued the sentences with more references to the source referent in

(3.6) than in (3.5), Japanese and Korean-speaking learners of English showed a referential bias towards the goal referent following both structures.

(3.5) John handed a book to Bob.

(3.6) John was handing a book to Bob.

When presented with items with a pronoun prompt such as *John handed/was handing a book to Bob. He …*, L2 speakers still could not distinguish the referential differences elicited by the aspect manipulation but patterned with native speakers with more references to the subject referent than when no pronoun was present in the prompt. Since pronouns are the preferred referring form for the subject referent (Almor & Nair, 2007; Ariel, 1990; Garrod & Sanford, 1982; Givón, 1987; Gordon et al., 1993; Gundel, Hedberg, & Zacharski, 1993), their results showed that while L2 speakers are not sensitive to the aspect information in the establishment of coreference, they are as sensitive to the subjecthood cue as native speakers.

Different from Grüter et al. (2014, 2016), other studies found that L2 speakers are sensitive to contextual information in coreference resolution. In a self-paced reading experiment, Liu and Nicol (2010) examined L1-Chinese L2-English learners' sensitivity to IC biases in online pronoun resolution. They manipulated IC biases by using either NP1-biasing verbs (see [3.7]) or NP2-biasing verbs (see [3.8]) in the context sentence. The two antecedents were of different genders so that the alternation between *he* and *she* in the second clause created either a consistency or a conflict with the verb's IC bias. The results showed that both L1 and L2 speakers' reading was slowed down when the gender of the pronoun was different from the gender of the IC-biased referent. Liu and Nicol interpreted the results as indicating that L2 speakers were sensitive to verbs' IC biases.

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However, since they used mixed genders in their design, their results mainly reflected that L2 learners are sensitive to gender cues in online processing. It is still not clear how learners resolve pronouns in the context of IC when there are ambiguous referents that have the same gender as the pronoun.

(3.7)   The mother amused the father because she/he told funny jokes at dinner.

(3.8)   The boy admired the girl because she/he was so intelligent.

(Liu & Nicol, 2010, p. 154)

Our study (Cheng & Almor, 2016) is a recent attempt to examine the effect of both IC and IR biases on L2 speakers' resolution of ambiguous pronouns. Using Experiencer-Stimulus (ES) verbs such as *fear* and Stimulus-Experiencer (SE) verbs such as *frighten* in two sentence-completion experiments, we examined advanced Chinese-speaking L2 English learners' interpretation of ambiguous pronouns in the contexts of IC and IR. As introduced at the beginning of the paper, the two types of verbs have different IC or IR biases. We had participants write continuations to sentence fragments ending with a pronoun prompt such as *Mary frightened/feared Sara because/so she*, and found that although L2 participants resolved the pronoun in accordance with different IC and IR biases between ES and SE verbs, they could not apply this type of information as robustly as native speakers. Specifically, when the discourse-biased referent was NP2, L2 participants produced significantly more references to NP1 than native speakers. The difference between L1 and L2 speakers could be due to L2 speakers' reduced ability to understand IC and IR biases. That is, whether there is a pronoun or not, they have problems figuring out native-like IC and IR biases from the context. Alternatively, they may have no difficulty understanding IC or IR biases, but have problems applying these

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biases to the resolution of ambiguous pronouns. As will be discussed in detail later, in addition to IC and IR biases, pronoun resolution is also influenced by other factors such as subjecthood of the antecedent. Therefore, the weaker IC or IR bias and stronger NP1 bias shown in the L2 data may be due to L2 speakers' difficulty in integrating multiple sources of information. However, since we used materials that all contained pronouns in the prompt, we could not tease apart the two possibilities. Another possible reason may lie in the verbs we used. Compared with English with a large number of SE verbs, Chinese has a limited set of SE verbs (Zhang, 2003), and English SE verbs are generally difficult for Chinese L2 speakers to acquire (Juffs, 1996; Zhang, 2003). Thus, it may be that the L1-L2 difference resulted from L2 speakers' difficulty in understanding SE verbs, especially those without counterparts in their native language, rather than their ability to use IC or IR biases.

To sum up, despite the importance of coreference in discourse processing, not much is known about how L2 speakers establish coreference in discourse. The present study furthers our understanding of this issue by investigating advanced L1-Chinese L2-English speakers' use of IC and IR biases in coreference resolution in two sentence-completion experiments. It extends our previous study (Cheng & Almor, 2016) in two important ways. First, we used materials that contained both pronoun prompts and free prompts. In the free prompt condition such as *Mary frightened Sara because*, the sentence fragment ends with no pronoun. This method allowed us to find out whether L2 speakers have a general difficulty in understanding IC and IR biases. By doing so, we were able to determine whether L2 speakers' different patterns of pronouns resolution as found in our earlier study (Cheng & Almor, 2016) is due to their general reduced ability

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to understand IC and IR biases, or their difficulty in integrating these biases with other factors in the course of pronoun resolution. Furthermore, as will be explained later, when no pronoun is used, comprehenders need to use the information from the context to generate predictions about which referent will be re-mentioned. Thus, the free prompt condition employed in the present study also probed L2 speakers' ability to apply IC and IR biases to the formation of re-mention predictions. The second difference between the present study and Cheng and Almor (2016) is that, instead of using exclusively ES and SE verbs, we included in this study a wide variety of verbs that have equivalents and exhibit similar IC or IR biases in both Chinese and English. By using this set of verbs, we were able to exclude the possible cross-linguistic influence from learners' native language that results from lexical items.

The Mechanism of Coreference Resolution

As mentioned at the beginning of this paper, the resolution of pronouns is influenced by IC and IR biases, which are associated with interpersonal verbs that involve the interaction between two human participants. These biases are not random but rather appear under certain discourse coherence relations. Coherence relations are the means that hold between discourse segments so that the discourse is understood as a coherent piece (Hobbs 1990; Kehler, 2002; Sanders, Spooren & Noordman, 1992). In particular, IC biases are closely related to the *Explanation* coherence relation (Kehler et al., 2008), in which the second clause provides an explanation for the event described in the first clause. IR biases arise in the *Result* coherence relation (Kehler et al., 2008), in which the second clause is a consequence of the event described in the first clause.

In addition to discourse coherence relations, IC and IR biases are also based on other factors such as verb argument structure (e.g., Brown & Fish, 1983; Crinean & Garnham, 2006; Hartshorne & Snedeker, 2013), the gender and social status of participants (e.g., Corrigan, 1992; Garvey et al., 1976; Lafrance et al., 1997), the temporal and intentional properties of discourse (Dery & Bittner, 2015; Chapter 2 of this dissertation), etc. Thus, IC and IR biases are due to multiple factors at both the lexical-semantic and discourse levels (Dery & Bittner, 2015; Pickering & Majid, 2007).

IC and IR biases are not only found in English but also in other languages. For example, by looking at sentence-completion data from eight languages, Hartshorne et al. (2013) found a cross-linguistic consistency in IC bias. In particular, studies on Chinese confirmed that IC biases are robust among many Chinese verbs (e.g., Cheng & Almor, 2015; Jiao & Zhang, 2005; Miao, 1996; Miao & Song, 1995; Sun et al., 2001). Our earlier study (Cheng & Almor, 2015) also found consistent IR biases in Chinese. Thus, IC and IR biases are arguably universal biases.

In addition to semantic and discourse factors such as IC and IR biases, pronoun resolution is also affected by syntactic factors, one of which is the antecedent's grammatical role. Numerous studies have shown that the entity in the subject position is the preferred referent of a pronoun (e.g., Ariel, 1990; Arnold, 1998; Crawley, Stevenson, & Kleinman, 1990; Frederiksen, 1981; Givón, 1992, 1995; Groz, Joshi, & Weinstein, 1995). This is because there is an inverse relation between a referent's salience and its referring form: The salient entity tends to be referred to by a reduced expression such as a pronoun (e.g., Almor & Nair, 2007; Ariel, 1990; Garrod & Sanford, 1982; Givón, 1987; Gordon et al., 1993; Gundel, Hedberg, & Zacharski, 1993). The referent in the subject

position is usually a salient entity in language users' mental model, and hence is more likely to be referred to by a pronoun than fuller expressions such as a repeated name.

Kehler and colleagues (Kehler et al., 2008; Kehler & Rohde, 2013) integrated the above-mentioned factors that influence pronoun resolution in a Bayesian model as shown in (3.9).

(3.9) $p(referent \mid pronoun) = p(referent) \times p(pronoun \mid referent) / p(pronoun)$

In this formula, $p(referent \mid pronoun)$ represents the probability that a pronoun is coreferential with an antecedent. It is determined by two factors. The first is $p(referent)$, the probability that a referent will be re-mentioned in subsequent discourse. This represents a top-down predictive process, in which language comprehenders use contextual cues to generate a prediction about the next-mentioned referent before encountering the pronoun. Importantly, the likelihood of re-mention is dependent upon discourse coherence relations. As the input unfolds, listeners or readers make a probabilistic evaluation of the coherence relation between clauses or sentences, and then form a prediction about the next-mentioned referent consistent with the coherence relation. Since IC and IR biases are associated with the Explanation and Result coherence relations, respectively, it is in this process that IC and IR biases come into play in affecting subsequent reference. Thus, comprehenders will make reference to an IC or IR bias-consistent antecedent in this stage.

In the Bayesian model, another factor that affects pronoun resolution is $p(pronoun \mid referent)$, the probability that a particular referent is referred to by a pronoun as opposed to other forms of reference. This is a bottom-up integrative process. When comprehenders encounter the pronoun, their interpretation of the pronoun will be

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modulated by how likely the entity they have made reference to in the predictive process could be referred to by a pronoun. In other words, the pronoun itself provides additional information concerning the assignment of referent. Given that the referent in the subject position is usually referred to by a pronoun instead of other referring expressions, this process is where the subjecthood cue is involved.

To sum up, according to the Bayesian model, to successfully resolve a pronoun requires two things. First, comprehenders need to be able to use contextual information such as IC and IR biases to predict which referent will be re-mentioned. Second, they need to integrate the re-mention biases with the subjecthood cue associated with the referential form of pronouns. Thus, pronoun resolution is a process that involves comprehenders' prediction of referent, as well as integration of multiple sources of information.

The Present Study

In this study we aim to unravel the similarities and differences in the establishment of coreference between native and non-native speakers by investigating L1-Chinese L2-English speakers' pronoun resolution in the contexts of IC and IR. Specifically, we addressed the following research questions:

1. To what extent do advanced Chinese-speaking learners of L2 English use IC and IR biases to predict which referent will be re-mentioned?

This question corresponds to the *p*(*referent*) in the Bayesian model of pronoun resolution (Kehler et al., 2008; Kehler & Rohde, 2013) and therefore, is associated with the issue of prediction. Although recent research on monolinguals has established that L1 processing is characterized by prediction (Kamide, 2008; Kuperberg & Jaeger, 2015),

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there is still some controversy about whether L2 speakers are able to generate predictions. As reviewed above, Grüter et al. (2014, 2016) found that, unlike L1 speakers, L2 speakers are not able to use the information of event structure to predict which referent will be re-mentioned. On the basis of this finding, they proposed the RAGE hypothesis (Reduced Ability to Generated Expectations), arguing that L2 speakers are not able to engage in native-like prediction. Grüter et al. did not specify what the essence of "reduced" is, or how broadly their hypothesis can apply. However, since this hypothesis was proposed based on their study situated in the Bayesian model of coreference resolution as reviewed above (Kehler et al., 2008; Kehler & Rohde, 2013), following their logic and findings, we would expect that L2 speakers do not use IC and IR biases to predict the next-mentioned referent to the same extent as L1 speakers.

By contrast, Kaan (2014) argued that there is no qualitative difference between L1 and L2 speakers in terms of prediction and that the differences, if there are any, may result from external factors that influence predictive processing in general. She proposed four such factors: frequency information, competing information, the accuracy and consistency of lexical information, and tasked-related strategies. Frequency information refers to the likelihood that a linguistic element occurs in a particular context. L2 speakers' different linguistic experiences may lead to different frequency biases in their interlanguage, which in turns affect their prediction. The second factor, competing information, refers to the interference from the linguistic information activated in L2 speakers' native language. When competing words or structures from their native languages are activated, L2 speakers may not be able to make effective predictions. The third factor is the quality of lexical representation. If L2 speakers do not have stable and

accurate representations of relevant words in the target language, they cannot effectively

retrieve these words to make predictions. The last factor is task-related strategies. Due to

different linguistic experiences and proficiency levels, L2 speakers may have different

degrees of sensitivity to experimental manipulation from native speakers, which may

influence whether they make predictions while performing the task. It can be seen that all

the four factors are related to L2 speakers' native language influence and their

proficiency in the target language. If L2 speakers experience minimal negative influence

from their L1 and have a high level of L2 proficiency, the influence of the four factors on

prediction in the L2 would be weakened so that L2 speakers may exhibit native-like

performance in prediction. Since IC and IR biases are universal (i.e., similar biases

between English and Chinese) and involve simple interpersonal verbs (i.e., high lexical

quality for advanced L2 English learners), Kaan's (2014) view on L2 prediction would

suggest that advanced Chinese-speaking learners of English are able to use IC and IR

biases to make predictions about the next-mentioned referent.

2. To what extent do advanced Chinese-speaking learners of L2 English rely on

   IC and IR biases to resolve a pronoun? To what extent does the presence of a

   pronoun influence their resolution?

This pair of questions are associated with *p*(*referent│pronoun*) in the Bayesian

model (Kehler et al., 2008; Kehler & Rohde, 2013) and thus deal with the mechanism of

L2 pronoun resolution. They are also relevant to the first research question. On the one

hand, if L2 speakers cannot efficiently predict the next-mentioned referent, they will rely

more on the cue provided by the pronoun (i.e., the subjecthood cue) for resolution. On the

other hand, if they can efficiently predict the referent, there are two possibilities. In the

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first case, they will consider both IC/IR biases and the subjecthood cue in the same way as native speakers. Alternatively, they will put more weight on one of the two sources of information than L1 speakers.

To answer these questions, we conducted two sentence-completion experiments, one on IC (Experiment 3.1) and the other on IR (Experiment 3.2). In both experiments, participants were required to write up a natural continuation to a sentence fragment which contained two ambiguous names and either an NP1-biasing or NP2-biasing verb. The fragment ended with either a free prompt or a pronoun prompt. Materials with free prompts were used in previous studies to probe comprehenders' predictions of the next-mentioned referent (e.g., Kehler et al., 2008; Grüter et al., 2014, 2016) and thus tested if L2 speakers are able to effectively use IC and IR biases to generate expectations. Comparing free prompt and pronoun prompt conditions enabled us find out whether L2 speakers' coreference is influenced by the presence or absence of a pronoun.

Both experiments measured participants' binary choice between the two possible referents. Given our previous finding that there is an L1-L2 difference in pronoun resolution (Cheng & Almor, 2016), we would expect a three-way interaction between group, verb type and prompt type. Specifically, when the pronoun is present, we expect a two-way interaction between group and verb type such that, compared to L1 speakers, L2 participants produced more NP1 references following NP2-biasing verbs. When the pronoun is not present (i.e., free prompt), there are two possibilities. If L2 speakers have no difficulty with referent prediction, there will be no two-way interaction between group and verb type. However, if they do have difficulty with prediction, there will be a two-

interaction between group and verb type such that L2 participants are not as sensitive to the differences in re-mention bias induced by the two types of verbs as L1 participants.

Experiment 3.1

Method

  Participants. Forty-three native English speakers (L1 group) were recruited from the participant pool of the Department of Psychology and the linguistics classes at the University of South Carolina. Participants were undergraduate students taking psychology or linguistics classes and received extra credit for their participation. To the best of my knowledge, the linguistic phenomena addressed in this study were not covered in their classes. Debriefing after the experiment confirmed that they were not aware of the purpose of the experiment. One participant was eliminated from analysis because she reported to have been raised up in a bilingual family. In the end, the data from 42 native English participants (31 women, 11 men, M_{age} = 19.6 years, age range: 18-39 years) were analyzed. Although the majority of them also knew one or two other languages than English, none of them were native speakers of other languages, and all reported that English was their major language of use in their daily life.

  Forty-four Chinese-speaking English learners (L2 group) were recruited from the Guangdong University of Technology in China and received extra credit for participation. All of them were undergraduate students majoring in English in their sixth semester. This is the same population from which L2 participants in our earlier study (Cheng & Almor, 2016) were recruited. L2 participants were required to finish two tasks: a sentence-completion task and a translation task (see details in Procedure). Only the data of those who finished both were included in the analysis. In the end, 36 participants finished both

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tasks (28 women, 8 men, $M_{age} = 21.5$ years, age range: 21-23 years). They started

learning English as a foreign language in a school setting at an average age of 9.5 years

(age range: 7-14 years) and had learnt English for an average of 12 years (range: 9-15

years). At the time of testing, two of them had visited English-speaking countries for a

brief period of time (10 days and 2 months, respectively), and the others had never been

to English-speaking countries.

The English proficiency of L2 participants were determined by their Test for

English Majors (TEM) Band 4 scores. The TEM-Band 4 is a standardized proficiency test

for English majors in Chinese universities that is administered in the fourth semester by

the National Advisory Committee for Foreign Language Teaching in China (Jin & Fan,

2011). The TEM-Band 4 is equivalent to the level between B1 and B2 of the Common

European Framework of Reference for Languages (CEFR) (Liu, 2012; Tang, Pritchard, &

Shi, 2012). Although there is no well-established criterion of the correspondence between

the proficiency scales of CEFR and American Council on the Teaching of Foreign

Languages (ACTFL), B1 and B2 of CEFR are roughly equivalent to the levels of

intermediate high and advanced low of ACTFL, respectively (Martínez Baztán, 2008).

Participants took the TEM-Band 4 one year before the present study. Given that they

were English majors and the majority of their classes were taught in English, it is

reasonable to assume that L2 participants in this study were advanced learners of

English.[12]

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[12] Three out of the 36 participants included in the analysis did not pass the TEM-Band 4. However,
given that they took the TEM-Band 4 one year before the study, their current English proficiency should be
higher than that indicated by their TEM-Band 4 score. Indeed, the Z-scores of their C-test scores had an

In order to better understand the individual differences in their English proficiency, a C-test was administered to L2 participants. The C-test, adopted from Schulz (2006), was composed of three short passages with 60 blanks in total. The first half of each missing word was provided, and participants were required to complete the word (see Appendix C for the C-test). Following Schulz, spelling mistakes were not counted, and each correct completion was worth one point, making a total of 60 points. The average C-test score was 35.05 ($SD = 6.46$, range: 12-44). The C-test score was used as a covariate in the analysis.

Materials and design. The experiment contained two types of verbs: 16 NP1-biasing IC verbs and 16 NP2-biasing IC verbs. In order to eliminate any potential influence from learners' native language that results from lexical differences, the verbs were selected from Ferstl et al. (2011), a norming study on English verbs' IC biases, on the basis of the following criteria. First, the English verbs must have lexical counterparts in Chinese. This is important because, according to Kaan (2014), if L2 speakers do not have a stable and consistent representation of lexical items, or their native language has competing information, they may not be able to make predictions effectively. Therefore, selecting verbs that are shared in both English and Chinese lexicons guaranteed that the verbs could have a high lexical quality in L2 participants' mental representation and hence could be easy to be retrieved. Following this criterion, some SE verbs, though frequently used in IC studies, were not selected because Chinese has a limited set of SE verbs (Zhang, 2003).

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absolute value of ≤1, indicating that, at the time of this study, their English proficiency was not different from that of other participants.

Second, each verb must have a strong IC bias in the same referential direction in both English and Chinese. If a verb has a much weaker IC bias in Chinese than in English, L2 participants may be influenced by this cross-linguistic difference so that they do not show as strong an IC bias as native speakers in the establishment of coreference. To control this, a norming study comparative to Ferstl et al. (2011) was conducted on a large number of Chinese verbs in the following ways.

We first translated the 300 verbs in the study of Ferstl et al. (2011) into Chinese with reference to the Oxford Advanced Learner's English-Chinese Dictionary. These verbs were then embedded in sentence fragments of the form *NP1 verb NP2 yinwei* 'because,' with the two NPs being common Chinese names of difference genders. Half of the items had a male-female order and the other half had a female-male order. The 300 items were randomly divided into five lists, each consisting of 60 verbs. To counterbalance the effect of gender, five more lists were prepared by reversing the order of the two names.

The norming study was conducted via paper-and-pencil surveys. The ten lists of items were presented in ten booklets. Undergraduate students from the Guangdong University of Technology in China (N = 174) took part in the surveys in classes and received extra credit for their participation. They were evenly divided into ten groups, each of which was assigned one of the ten surveys. Participants' continuations were coded as referring to either NP1 or NP2 by the first author and another trained native Chinese speaker. Each verb's IC bias was determined by the percentage of NP1 references out of all NP1 and NP2 references.

We compared all Chinese verbs' IC biases to those of their counterparts in English (Ferstl et al., 2011) and selected 16 NP1-biasing and 16 NP2-biasing verbs satisfying the following criteria. First, NP1-biasing verbs have a high percentage of NP1 reference ($\geq$ 65%) and NP2-biasing verbs have a low percentage of NP1 reference ($\leq$ 35%). Second, all verbs had the same direction of reference and similar bias strength in both English and Chinese with the bias difference smaller than 15%. Third, the verbs were familiar to L2 participants as verified by their English instructor.

The selected verbs were embedded in sentence fragments of the type *NP1 verb-ed NP2 because*. The two NPs were common English names of the same gender. If the characters were of different genders, we would not be able to know whether coreference was guided by IC biases, or simply by the gender information encoded in pronouns. To counterbalance the effect of gender, half items had female names and the other half had male names.

Every item alternated between a pronoun prompt and a free prompt condition. In the pronoun prompt condition, a pronoun of the same gender as the human names in the first clause was placed after the connective *because*. In the free prompt condition, no pronoun was used. Sample items are given in Table 3.1 (at the end of this chapter).

The experiment had a 2×2 design with the independent variables being verb type (NP1-biasing vs. NP2-biasing verbs) and prompt type (pronoun vs. free). The variable of verb type was manipulated within participants and between items, and the variable of prompt type was manipulated within both participants and items. The dependent variable was the continuation reference to either NP1 or NP2 in the first clause. The design was counterbalanced. Every participant saw half of the items in the prompt condition and the

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other half in the pronoun condition. Every item was presented in the pronoun prompt condition to half of the participants and in the free prompt condition to the other half. In the end, two lists were prepared. Each list contained 32 experimental stimuli as well as 48 fillers that had the same structure as the experimental stimuli but contained non-IC verbs and other types of connectives (e.g., *and*, *but*, etc.). All the stimuli within a list were pseudo-randomized with at least one filler between experimental stimuli.

In addition to the sentence-completion task, L2 participants were also required to finish a translation task as a measurement of their semantic knowledge of the items used in the experiment. This was a necessary step because their responses would not have made sense if they didn't know what the verb meant. The translation task was composed of the same 32 items constructed for the sentence-completion experiment except that participants were only presented with the first clause of the items as an independent sentence (e.g., *Mary called Sara.*).

Procedure. The study was conducted via an offline paper-and-pencil survey. L1 participants took the survey in small groups of 3-7 people in a quiet classroom on the campus of the University of South Carolina. L2 participants took the survey in a class at the Guangdong University of Technology. Participants were randomly and evenly assigned to one of the two lists, which were printed on a booklet. On the first page of the booklet was a passage of instructions of the experiment and a language background questionnaire. Before the experiment started, participants were given verbal instructions on how to do the survey. Specifically, they were required to write down natural continuations to the sentence fragments in an intuitive way. They were also instructed to finish the sentences in the prescribed order. Following Goikoetxea et al. (2008),

participants were required to go over all the stimuli from the beginning to the end after finishing the survey. If there was a subject pronoun in the second clause, regardless of whether it was part of the stimuli (i.e., in the pronoun prompt condition) or supplied by participants themselves (i.e., in the free prompt condition), they needed to circle the character that they intended the pronoun to refer to. Examples were given to participants to demonstrate how to do this. This step was taken to improve coding accuracy because the two referents in each sentence were of the same gender and referential ambiguity would arise when a pronoun was used. Participants were not constrained in time to finish the survey, but the majority of them completed it around 40-50 minutes.

Additionally, L2 participants were required to finish a translation task and an English proficiency C-test. In the translation task, they needed to write down the Chinese translations of the experimental stimuli in the sentence-completion experiment (excluding fillers). In the C-test, they were required to fill in the blanks in three short passages. The sentences for translation and the C-test were printed on two sides of a sheet, which was distributed to L2 participants after they completed the sentence-completion task. The translation task was administered after the sentence-completion experiment because the former might put L2 participants in a bilingual mode, and if administered beforehand, would influence their performance on the sentence-completion experiment, as found by Kim and Grüter (2016) in a similar offline study on L2 reference resolution. Participants were instructed to finish the two additional tasks in their spare time and turn in the sheet one week later. Specifically, they were alerted that they were not allowed to use dictionaries if they encountered unfamiliar words.

Coding. The data in the sentence-completion experiment were coded in the following ways. Based on participants' sentence continuations, the subject NP in the second clause was coded as referring to either the first antecedent ("NP1") or the second antecedent ("NP2") in the first clause. The reference was easy to identify when the continuations in the free prompt condition began with a repeated name referring to either NP1 or NP2. For continuations in the pronoun prompt condition or those in the free prompt condition but beginning with a subject pronoun, the pronominal reference was determined on the basis of participants' own choices.

There were cases where it was difficult to determine what the reference was. For example, probably due to carelessness during the second pass, some of the participants' choices of the referent of the pronoun did not appear to make sense. When this happened, the reference was determined by the coders' judgment. Similarly, in cases where participants forgot to circle the referent of the pronoun, coders also decided independently whether the reference was ambiguous or not. In the above two situations, coders were instructed to be conservative so that as long as there was a possibility of ambiguity, the reference was coded as ambiguous (L1, $n = 9$; L2, $n = 20$). There were also cases where the continuation was nonsense (L1, $n = 10$; L2, $n = 13$) or began with a plural reference or a reference to other entity (L1, $n = 21$; L2, $n = 20$), the gender of the names was misunderstood (L1, $n = 2$; L2, $n = 39$), the connective *because* was interpreted as part of *because of* (L1, $n = 11$; L2, $n = 6$), and no continuation was given (L1, $n = 0$; L2, $n = 5$). For convenience's sake, these cases were classified as "unclear." Table 3.2 illustrates different types of coded continuations.

The data were coded by the first author and another trained native English speaker naive to the purpose of the study. The coding agreement rate was 93.2%. All disagreements were resolved through discussion between the first author and a third coder. Those disagreements which could not be resolved were coded as "unclear." Overall, there were 3.9% unclear responses in the L1 group and 8.9% unclear responses in the L2 group.

Furthermore, the first author who is a Chinese-English bilingual coded L2 participants' translation data as either "correct" or "not correct." Missing translations were counted as "incorrect" as well. Overall, there were 6.4% incorrect translations ($n = 74$, $M = 2$, $SD = 1.61$, range: 0-6).

Results

All data coded as "unclear" were excluded from analysis. For the L2 group, the data whose counterparts in the translation task were coded as "incorrect" were also excluded from analysis.[13] Data trimming affected 4% of the dataset in the L1 group and 15% in the L2 group. Table 3.3 presents the mean proportions of NP1 references out of all NP1 and NP2 references.

We used logit mixed-effects regressions to model the binary choice between NP1 and NP2 for the subject reference in participants' continuations. Logit mixed-effects models are more suitable for analyzing categorical and unbalanced data than ANOVA (Jaeger, 2008). All categorical factors were initially sum-coded to obtain main effects and interactions (Barr, 2013). Model comparison was used to estimate the significance of

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[13] Note that the counterparts of some wrongly-translated sentences were coded as "unclear" in the main experiment.

each term, starting with a maximal model containing all individual factors and their interactions. The interaction term was first eliminated. If the elimination did not lead to a significant loss of model fit, each of the individual factors was then removed (Baayen, 2008). Following Barr et al. (2013), all the models contained the random effects of participants and items as well as maximal slopes when appropriate and allowed by the data. The analysis was implemented in R (R core team, 2014) using the lme4 package (Bates et al., 2014), and an alpha level of .05 was used for all statistical tests.

We performed an analysis on both the L1 and L2 data. A maximal model was fitted with group (L1 vs. L2), verb type (NP1 vs. NP2-biasing verbs), and prompt type (free vs. pronoun), and all interactions between the three factors as the fixed effects. Removing the three-way interaction resulted in a significant loss of model fit, $\chi^2(1) =$ 8.28, $p = .004$. The parameter estimates of the full model are reported in Table 3.4. The model shows three important things. First, there was no two-way interaction between group and prompt type, but a main effect of prompt type with more NP1 references following the pronoun prompt than the free prompt, suggesting that L1 and L2 participants showed similar patterns of coreference in response to different types of prompts. Second, although there was a main effect of verb with more NP1 references following NP1-biasing verbs than NP2-biasing verbs, there was a two-way interaction between group and verb type, demonstrating that L1 and L2 participants resolved references differently in continuations following NP1 and NP2-biasing verbs. Third, there was a three-way interaction between group, verb type and prompt type, indicating that the effect of group on NP1 reference were modulated by the factors of verb type and prompt type. Figure 3.1 (at the end of this chapter) shows the three-way interaction.

A simple slope analysis was conducted to better understand the three-way interaction. To find out the differences among the simple slopes, we fitted two full models, using dummy coding for the factors and a Bonferroni p value adjustment. The reference levels for the factors of verb type and prompt type were different between the two models, and the differences among slopes were tested as two-way interaction terms included in these models. The results showed that, in the free prompt condition, there was no two-way interaction between group and verb type or an effect of group, demonstrating that L1 and L2 participants produced similar re-mention biases in continuations following free prompts, that is, NP1 after NP1-biasing verbs and NP2 after NP2-biasing verbs. However, when the prompt was a pronoun, there was a two-way interaction between group and verb type, $B = -1.85$, $SE\ B = 0.56$, $z = -3.31$, $p = .002$. Specifically, although L2 participants were able to distinguish the causality biases of the two types of verbs, they showed less NP1 references than L1 participants in continuations following NP1 verbs, $B = -0.94$, $SE\ B = 0.35$, $z = -2.70$, $p = .01$, but more NP1 references than L1 speakers in continuations following NP2 verbs, $B = 0.91$, $SE\ B = 0.42$, $z = 2.16$, $p = .06$. The latter difference also led to a two-way interaction between group and prompt type when the verbs were NP2-biasing verbs, $B = -1.18$, $SE\ B = 0.53$, $z = -2.25$, $p = .05$.

In order to determine whether the variance in L2 participants' English proficiency had an effect on the results, we included their C-test scores (centered) in a maximal model regressed to the L2 data only. Model comparisons showed that the C-test score did not contribute significantly to model fit, indicating that L2 participants' English proficiency did not influence their referential choice.

In addition to the reference bias, we also looked at participants' choice of referring expressions in the free prompt condition, in which they were free to choose any form (e.g., pronoun, repeated name) to refer to a referent. We coded their binary choice between pronouns and names for the subject of the second clause referring to either NP1 or NP2. As can be seen in Table 3.5, regardless of verb bias, both L1 and L2 participants pronominalized the NP1 referent at a higher rate than the NP2 referent. Moreover, L2 participants did not seem to pronominalize referents more often than L1 participants. (Statistical analysis was not performed because of the extremely unbalanced cell sizes.) These preliminary findings are consistent with previous studies showing that, in reference production, pronouns are the preferred referential form for antecedents in the subject position (e.g., Arnold, 2001; Fukumura & van Gompel, 2010).

Discussion

This experiment investigated how L1 and L2 speakers establish coreference by using the IC information from the context. Results showed that L1 participants made references following IC biases: NP1 after NP-biasing verbs and NP2 after NP2-biasing verbs, indicating that L1 speakers' coreference processing is guided by their calculation of the causal relation in discourse, that is, who is the causer of the event. This calculation, however, is affected by whether the pronoun is present or not. When they saw a pronoun prompt in the sentence fragment, they continued the sentence with significantly more references to NP1 than when they saw a free prompt. Moreover, when they were free to choose a referring expression, they were more likely to use pronouns than names to refer to the NP1 referent. The findings are thus consistent with those of Rohde and Kehler (2014) on the effect of IC bias on native pronoun resolution, and lend further support to

the view that there is a strong co-referential relationship between a pronoun and the subject.

Like L1 speakers, L2 participants showed similar coreference patterns. They were able to distinguish the different causality biases of the two types of verbs and apply the differences to the establishment of subsequent coreference. The prompt also influenced their referential choices with more NP1 references following the pronoun prompt than the free prompt, indicating that L2 participants were aware of the special relationship between pronouns and subject antecedents.

In this experiment, we also observed a three-way interaction among group, verb type, and prompt type, indicating that whether L2 participants' performance was nativelike depends on the types of verb and prompt. When there was a free prompt, L2 participants showed the same extent of re-mention biases as L1 participants, demonstrating that L2 participants had no problems using the IC information to predict the next-mentioned referent. However, when the prompt was a pronoun, L2 participants produced more NP1 references in continuations after NP2-biasing verbs than L1 participants. The discrepancy between the free and pronoun prompt conditions indicates that L2 participants resolved pronouns in different ways from L1 speakers. That is, when the context had an NP2 IC bias, they were more likely to interpret the pronoun as referring to NP1 than L1 speakers. Since NP1 is also the subject of the sentence, we call this a "subject bias" for conveniences' sake.[14] This "subject bias" shown in the L2 data

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[14] Note that the "subject bias" as used here and after refers to the finding that, compared to L1 speakers, L2 speakers continued the sentence with more NP1 references. It does not mean that there is an overall referential bias (>50%) towards the subject.

was also found in our earlier study (Cheng & Almor, 2016), which only included pronoun prompt and found more NP1 references after NP2-biasing psych verbs by L2 speakers than L1 speakers.

Experiment 3.2

In Experiment 3.1, we used the connective *because* and found that L2 speakers were able to use IC information in a native-like way to establish coreference following a free prompt but not a pronoun prompt. In this experiment, we used *and as a result* to elicit the Result coherence relation and investigated to what extent L2 speakers use the information of IR in the establishment of coreference.

Method

Participants. New L1 and L2 participants were recruited from the same populations as in Experiment 3.1. Forty-nine native English speakers participated in the experiment for extra credit. Three participants were eliminated from analysis because one was an early bilingual, one was at an old age (78 years), and the other one's responses were not relevant to the task. In the end, the data from 46 native English participants (38 women, 8 men, $M_{age} = 20.30$ years, age range: 18-48 years) were analyzed. None of them were native speakers of other languages, and all reported that English was their major language of use in their daily life.

Forty-seven Chinese-speaking English learners took part in this experiment for extra credit. Only the data of those who finished both sentence-completion and translation tasks were included in the analysis. In the end, 35 participants finished both tasks (34 women, 1 man, $M_{age} = 21.51$ years, age range: 20-23 years). They started learning English as a foreign language in a school setting at an average age of 9.80 years

(age range: 7-14 years) and had learnt English for an average of 11.68 years (range: 8-14 years). At the time of testing, none of them had visited English-speaking countries. All of them took the same C-test as in Experiment 3.1 with an average score of 33.74 (SD = 8.17, range: 14-51). Although seven of them did not pass the TEM-Band 4, the Z-scores of their C-test scores all had an absolute value of ≤ 2, indicating that, at the time of this study, their English proficiency was not different from that of other participants. Independent samples t Test showed that there was no significant difference in participants' C-test scores between Experiments 3.1 and 3.2, suggesting that L2 participants in the two experiments were at comparable English proficiency levels.

Materials and design. The verbs used in this experiment were IR verbs selected from a norming experiment on English IR verbs (see Chapter 2 of this dissertation). In order to ensure that the verbs in the current experiment had similar IR biases in learners' native language, a norming study on Chinese verbs, similar to the one conducted in Experiment 3.1, was administered to 180 native Chines speakers. In this study, verbs were embedded in sentence fragments of the form *NP1 verb NP2 yinci* 'because of that,' eliciting a Result coherence relation. A set of IR verbs (16 NP1-biasing and 16 NP2-biasing verbs) were selected following the same procedure and criteria as outlined in Experiment 3.1. Note that because not every verb has both strong IC and IR biases, some of the verbs used in this experiment were different from those in Experiment 3.1.

The stimuli were prepared in the same way as in Experiment 3.1 except that the verbs were embedded in sentence fragments of the type *NP1 verb-ed NP2 and as a result*. We did not use the connective *so* as in our earlier study (Cheng & Almor, 2016) because the connective *so* may denote other meanings than result (Stevenson et al., 1994). The

phrase *as a result*, by contrast, specifically indicates that the coherence relation is Result. The materials for the translation task were also prepared in the same way following Experiment 3.1.

The design was the same as that of Experiment 3.1.

Procedure. The experiment was conducted in the way as in Experiment 3.1.

Coding. The data were coded following the same procedure of Experiment 3.1. Overall, there were 10% unclear responses in the L1 group and 17% unclear responses in the L2 group, including cases of ambiguous references (L1, $n = 8$; L2, $n = 39$), nonsense continuations (L1, $n = 3$; L2, $n = 6$), references to other entity or plural references (L1, $n = 132$; L2, $n = 100$), misunderstood gender (L1, $n = 0$; L2, $n = 23$), and no response (L1, $n = 0$; L2, $n = 19$). Furthermore, there were 6% incorrect translations for the L2 group ($n = 58$, $M = 1.66$, $SD = 1.55$, range: 0-6).

Results

The responses coded as "unclear" were excluded from analysis. For the L2 group, the data whose counterparts in the translation task were coded as "incorrect" were also excluded. Data trimming affected 10% of the dataset in the L1 group and 20% in the L2 group. Table 3.6 presents the mean proportions and standard deviations of NP1 references out of all NP1 and NP2 references.

The data were analyzed in the same manner as in Experiment 3.1. A maximal model was fitted with group, verb type, and prompt type, and all interactions between the three factors as the fixed effects. Removing the three-way interaction resulted in a significant loss of model fit, $\chi^2(1) = 6.13$, $p = .01$. The parameter estimates of the full model are reported in Table 3.7. In addition to the three-way interaction, the model also

shows a two-way interaction between group and prompt type. To better understand this two-way interaction, we did pairwise comparisons, using a Bonferroni p-value adjustment. For both L1 and L2 groups, there were significantly more NP1 references following the pronoun prompt than the free prompt, p's < .001. However, while there was no difference between the two groups in the free prompt condition, L2 participants produced more NP1 references than L1 participants in the pronoun prompt condition, $B = 1.47$, $SE B = 0.41$, $z = 3.57$, $p = .002$.

To understand the three-way interaction as graphed in Figure 3.2, a simple slope analysis was conducted in the same way as in Experiment 3.1. As in Experiment 3.1, in the free prompt condition, there was no two-way interaction between group and verb type, or an effect of group, demonstrating that L1 and L2 participants had similar re-mention biases in continuations following free prompts, that is, NP1 after NP1-biasing verbs and NP2 after NP2-biasing verbs. When the prompt was a pronoun, there was no two-way interaction between group and verb type. However, there was a two-way interaction between group and prompt type when the verbs were NP2-biasing verbs, $B = -2.44$, $SE B = 0.48$, $z = -5.10$, $p < .001$. This interaction occurred because when verbs had an NP2 bias, L2 participants produced significantly more NP1 references than L1 participants in continuations following a pronoun prompt, $B = 2.09$, $SE B = 0.44$, $z = 4.77$, $p < .001$. In this situation, while there was an *NP2* bias in the L1 group (NP1 percentage = 34%), there was an *NP1* bias in the L2 group (NP1 percentage = 68%).

Finally, we included L2 participants' C-test scores (centered) in a maximal model regressed to the L2 data. Model comparisons showed that the C-test score did not

contribute significantly to model fit, indicating that L2 participants' English proficiency did not influence their coreference resolution in this experiment.

As was done in Experiment 3.1, we also analyzed participants' choice of referring expressions (pronouns vs. names) in the free prompt condition. Table 3.8 reports the proportion and frequency of pronouns. (Statistical analysis was not performed because of the extremely unbalanced cell sizes.) The general patterns were similar to those in Experiment 3.1: Both L1 and L2 participants pronominalized the NP1 referent at a higher rate than the NP2 referent regardless of verb type.[15]

Discussion

Experiment 3.2 investigated the extent to which L2 speakers use the information of IR in coreference resolution. Specifically, we used the phrase *and as a result* to elicit a Result coherence relation, which, together with the verbs, produced an IR referential bias.

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[15] Because a coordinated structure was used in this experiment (i.e., *and as a result*), participants could continue the sentence with an elided subject in addiction to pronouns or names. For example, to continue the fragment "*Frank missed Simon, and as a result,*" one could write *called him* with the subject being omitted. (Note that the ellipsis could be possible only when the subject reference in the second clause was towards NP1.) This additional possibility of continuing sentences with elided subjects could confound the results, as it was not clear whether the elided subject was a pronoun or a name. In the L1 group, 41% of continuations fell into this type, which prevents us from drawing a definite conclusion about to what extent L1 participants pronominalized NP1 vs. NP2 referents. However, given the well-established coreferential relationship between pronouns and subjects in studies on monolingual speakers (e.g., Arnold, 2001; Fukumura & van Gompel, 2010; Gordon et al., 1993; Rohde & Kehler, 2014), it is likely that if the subjects were not elided, most of them would still be realized as pronouns rather than names. In the L2 group there was only one continuation with elided subject. Therefore, the L2 results were unlikely to be confounded by this problem.

Consistent with previous IR studies (e.g., Au, 1987; Stevenson et al., 1994; Stewarts et al., 1998), the results showed that L1 speakers followed IR biases to establish coreference: NP1 reference after NP1-biasing verbs and NP2 reference after NP2-biasing verbs. Like what was found in Experiment 3.1, the strength of bias was affected by the referring form with significantly more NP1 references in continuations following a pronoun prompt than a free prompt. The consistent findings between the two experiments indicate that the effect of pronoun on coreference is an independent effect regardless of contextual biases.

As far as L2 speakers are concerned, the results showed that L2 participants also produced more continuations with NP1 references following a pronoun prompt than a free prompt. The findings are similar to those in Experiment 3.1, indicating that, in both the IC and IR contexts, the referring form affected L2 speakers' establishment of coreference such that the presence of a pronoun increased the likelihood of NP1 reference.

As expected, we once again observed a three-way interaction between group, verb type, and prompt type in this experiment. In the free prompt condition, L2 participants behaved in the same way as L1 participants by showing an NP1 re-mention bias following NP1-biasing verbs and an NP2 re-mention bias following NP2-biasing verbs. Their native-like performance in the free prompt condition indicates that L2 participants were able to derive IR biases from the context and use them to determine which referent would be re-mentioned in the following discourse.

However, when the pronoun was present, L2 participants were more likely than L1 participants to resolve the pronoun towards NP1, even though the context had an NP2

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bias. Thus, as found in Experiment 3.1, L2 participants demonstrated a "subject bias" for pronoun interpretation. The "subject bias" in this experiment was even stronger in that when the context contained NP2-biasing verbs, there was an NP1 bias in the L2 group. This finding is different from that of Experiment 3.1, in which, despite eliciting more NP1 references than in the L1 group, the pronoun prompt following NP2-biasing verbs still led to an NP2 bias in the L2 group. Nonetheless, it is consistent with our earlier study (Cheng & Almor, 2016), in which L2 participants also showed an NP1 bias in pronoun resolution although the context had an NP2 IR bias. Therefore, this experiment provides converging evidence showing that, in the IR context, L2 speakers' pronoun interpretation tends to violate the contextual NP2 bias. We discuss this finding in greater detail in the General Discussion.

General Discussion

This study investigated to what extent L2 speakers use the information of IC and IR in the establishment of coreference. By examining advanced Chinese-speaking L2 English learners, we addressed this question in two sentence-completion experiments that focused on IC and IR, respectively. In both experiments, we manipulated verb type (NP1-biasing vs. NP2-biasing verbs) and prompt type (free prompt vs. pronoun prompt), and found the following results:

1. In the free prompt condition, L2 participants showed the same extent of re-mention biases as L1 participants: NP1 following NP1-biasing verbs and NP2 following NP2-biasing verbs. This indicates that advanced L2 speakers are able to use IC or IR biases derived from the context to generate native-like predictions about the referent to be re-mentioned.

2. Like L1 participants, L2 participants in both experiments produced more NP1 references in the pronoun prompt condition than in the free prompt condition. In the latter condition, they were also more likely to use pronouns than names to refer to NP1. Taken together, these results indicate that L2 coreference processing is affected by the form of reference. Specifically, L2 speakers are sensitive to the subjecthood cue which biases the pronominal reference towards the antecedent in the subject position. However, compared to L1 participants, L2 participants exhibited a "subject bias" by producing more NP1 references for the pronouns after NP2-biasing verbs, suggesting that L2 speakers rely on the subjecthood cue to a greater extent than L1 speakers.

In the rest of this section, we discuss the findings as situated within current theories of coreference processing, as well as the implications for general L2 processing theories and the limitations of the present study.

L1 and L2 Coreference Resolution

The findings of L1 speakers are consistent with the Bayesian model of pronoun resolution (Kehler et al., 2008; Kehler & Rohde, 2013). According to this model, as the input unfolds, comprehenders update their mental models and adjust the probabilistic predictions about discourse coherence relations which determine their final coreference resolution. Specifically, before the pronoun is encountered, comprehenders use semantic and discourse information to generate predictions about which referent is going to be re-mentioned. When the pronoun is encountered, the pronoun itself provides an additional cue. Since the pronoun is the preferred referential form adopted by speakers to refer to

the subject (Almor & Nair, 2007; Ariel, 1990; Garrod & Sanford, 1982; Givón, 1987; Gundel et al., 1993), it signals to comprehenders a particular subjecthood cue that the referent is the subject. Therefore, pronoun interpretation involves the integration of the top-down expectations about the next-mentioned referent and the bottom-up information provided by the pronoun. The results of the L1 group are compatible with the predictions of the Bayesian model. In the free prompt condition, L1 participants' re-mention biases were consistent with the verbs' IC or IR biases, indicating that their prediction about the referent was guided by discourse coherence relations. When the pronoun was present in the prompt, L1 participants still showed referential biases consistent with IC and IR biases, but more importantly, they also produced more NP1 references than in the free prompt condition. This difference reveals that L1 speakers were aware of the subjecthood cue provided by the pronoun.

If L1 coreference processing is consistent with the Bayesian model, then to what extent does L2 coreference processing share the same mechanism? We discuss this issue by looking at the free prompt and the pronoun prompt conditions separately. In the free prompt condition, there was no significant difference between the L1 and L2 groups. Like L1 participants, in both the IC and IR contexts, L2 participants produced more NP1 re-mentions following NP1-biasing verbs and more NP2 re-mentions following NP2-biasing verbs. The results, therefore, indicate that L2 speakers are able to derive IC and IR biases from the context and use them in a native-like way to generate top-down predictions about the referent to be re-mentioned.

These results contradict those of Grüter et al. (2014, 2016) who found that advanced L1-Japanese and L1-Korean L2 English learners were not able to use discourse

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information to generate native-like re-mention biases. One possible reason for the difference between the present study and theirs is related to the different linguistic phenomena. To create distinct kinds of discourse contexts, Grüter et al. manipulated verb aspect whereas we manipulated verb meaning. Aspect is a well-known difficult area for L2 learners (Bardovi-Harlig, 2000). It is also linguistically encoded in different ways between participants' native languages (Korean and Japanese) and the target language of English (Shirai, 1998). Yet, word meaning is comparatively easier to master, especially when learners' L1 and L2 have equivalent lexical items, as controlled in our study. Therefore, it may be easier for L2 learners to use the information of verb meaning than aspect when establishing coreference in discourse. Another possible reason lies in the bias strength associated with aspect versus IC/IR. In their study, even in the L1 group, both the perfective and imperfective aspect led to a re-mention bias towards NP2 (i.e., the goal referent as named in their study) despite a difference in the percentage of NP1 references. In our study, however, NP1-biasing and NP2-biasing verbs had referential biases in different directions. Thus, it may be easier for L2 speakers to perceive the difference in re-mention biases between NP1 and NP2-biasing IC/IR verbs than between the perfective and imperfective aspect. Overall, the discrepancy between the two studies indicates that it may not be sufficient to simply claim that L2 speakers can or cannot predict which referent will be mentioned next. Rather, we need to consider the linguistic information involved. While aspect may be difficult for L2 speakers, the information of IC and IR is not. Of course, other factors could also lead to the different findings, such as participants' L2 proficiency and L1 backgrounds. Future studies can control these factors

to investigate whether indeed L2 speakers' ability to produce native-like re-mention biases are dependent upon linguistic phenomena.

In the pronoun prompt condition, L2 participants patterned with L1 participants by producing more continuations with NP1 references than in the free prompt condition. This finding is consistent with Grüter et al.'s (2014, 2016) study, which also found that the presence of a pronoun increased L2 speakers' references to NP1 despite their difficulty in using the information of aspect to establish coreference. Therefore, the two studies provide converging evidence that L2 speakers are sensitive to the subjecthood cue activated by the pronoun.

However, our study also found that L2 speakers show a "subject bias" of pronominal reference compared to L1 speakers. When the context had an NP2 bias, L2 participants were more likely to interpret the pronoun as referring to NP1 than L1 participants. In particular, in the IR context, L2 participants even showed an NP1 bias when resolving pronouns after NP2-biasing verbs. This finding thus replicates our earlier study (Cheng & Almor, 2016) which found a similar "subject bias" in L2 speakers' pronoun interpretation in the IC and IR contexts. In that study, we used SE verbs, which might prevent L2 speakers from understanding IC or IR biases, because SE verbs are rare in Chinese and difficult to acquire for Chinese-speaking English learners (Juffs, 2006; Zhang, 2003). In this study, we used a different set of verbs which are shared in both Chinese and English. The fact that we still observed the "subject bias" in this study indicates that this L1-L2 difference is not likely to be due to the verbs *per se*, but rather reflects a general tendency to resolve the pronoun to the subject by L2 speakers.

Then the question remains why there is a "subject bias" in L2 speakers' pronoun interpretation. One possible reason is the cross-linguistic influence from learners' native language, namely, Chinese in our case. However, this is not likely given the findings that, in both the contexts of IC and IR, native Chinese speakers interpret pronouns in accordance with the discourse bias: NP1 following NP1-biasing verbs and NP2 following NP2-biasing verbs (Cheng & Almor, 2015). Another possible cross-linguistic influence is that Chinese has both null and overt pronouns. However, this cannot fully explain the data either, because both corpus and experimental evidence shows that Chinese null pronouns are more likely than overt pronouns to refer to the subject in the preceding clause (Hu, 2008; Xu, 2004; Zhao, Cheng, & Almor, 2016). If there were any influence from learners' inventory of referring expressions, we would not expect to see any "subject bias" in their pronoun interpretation. Therefore, it is not likely that L2 participants' native language led to the "subject bias" observed in our data.

In Cheng and Almor (2016), we argued that L2 speakers' "subject bias" in pronoun interpretation may be due to their reduced ability to use the information of IC and IR to generate discourse-level expectations. To compensate this reduced ability, they may rely more on the subjecthood cue, resulting in more NP1 references than L1 speakers. However, as the results in the free prompt condition showed, L2 participant did generate native-like predictions about the referent to be re-mentioned. Thus, it is not likely that the "subject bias" in their pronoun interpretation is due to their problems making predictions about the referent to be re-mentioned.

If predicting the referent is not a problem for L2 speakers, then in accordance with the Bayesian model of pronoun interpretation (Kehler et al., 2008; Kehler & Rohde,

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2013), the only source of their "subject bias" would come from the integration stage, in which comprehenders need to integrate the top-down predictions about the next-mentioned referent with the bottom-up information from the pronoun indicating a preference for the subject (i.e., the subjecthood cue). Therefore, the "subject bias" shown by in the L2 data indicates that L2 speakers are more likely to be influenced by the subjecthood cue than L1 speakers in the integration stage. There are two possible explanations for how this happens, which are discussed below.

The first account assumes that both L1 and L2 speakers process discourse information rapidly such that they incrementally and predictively build up a mental representation of the local discourse. For example, by the time they read *Mary feared Sara because*, they have already built up a mental representation of the discourse which generates probabilistic predictions about the referent to be re-mentioned in the following clause. In this example, they would make more references to NP2 *Sara* than NP1 *Mary* on the basis of the verb's IC bias. This explains why there was no difference between L1 and L2 speakers in the free prompt condition.

Next, when they see the pronoun, both L1 and L2 speakers will update their mental model by incorporating the subjecthood cue provided by the pronoun. In the example above, their initial reference to NP2 *Sara* would be weakened such that there would be more references to NP1 *Mary*. This explains why there were more NP1 references in the pronoun prompt condition than the free prompt condition. L2 speakers produce more references to NP1 than L1 speakers in this stage because their processing system may have a stronger subjecthood cue, or a higher $p(pronoun \mid SubjectReferent)$, to put in the Bayesian term. That is, there is a higher probability for L2 speakers to use

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pronouns as opposed to other referential forms to refer to subjects than L1 speakers. In this situation, when they see the pronoun, they would have a greater tendency to associate it with the subject. Although this is a possible explanation for L2 speakers' "subject bias" in pronoun interpretation, there is not enough evidence suggesting that L2 speakers' processing system indeed has a higher $p(pronoun \mid SubjectReferent)$ than L1 speakers. In the Results section of both experiments, we report participants' choice of referential forms (pronouns vs. names) in the free prompt condition. Despite being preliminary, the results showed that L2 participants did not pronominalize the subject referent more often than L1 participants. Future studies are needed to investigate L2 speakers' choice of referential forms to see whether they indeed have a stronger likelihood of using pronouns to refer to subjects than L1 speakers.

Alternatively, as argued by Grüter et al. (2016), while L1 speakers process discourse information rapidly as input unfolds, L2 speakers may delay processing until they have to make a resolution. In the free prompt condition, this is not a problem because the input only provides one source of re-mention bias (i.e., the IC and IR biases) no matter when they start processing. Thus, L1 and L2 speakers do not differ in their final prediction about the next-mentioned referent. By contrast, in the pronoun prompt condition, the situation is different because the pronoun itself provides an additional bias towards the subject. In this case, whether comprehenders start processing the IC and IR information early becomes crucial in their final interpretation of the pronoun.

Let's consider L1 speakers first. Previous studies showed that L1 speakers are able to process causal information rapidly (e.g., Cozjin et al., 2011; Koornneef & Van Berkum, 2006; Pyykkönen & Järvikivi, 2010; Traxler et al., 1997; Van Berkum et al.,

2007). Therefore, by the time they encounter the pronoun, they have already made reference to an antecedent on the basis of IC and IR biases. By considering the additional subjecthood cue from the pronoun, they would slightly adjust their initial expectation by producing more continuations with NP1 references. Yet, their overall referential patterns are still based on their initial choices that are consistent with IC or IR biases.

L2 speakers, as argued by Grüter et al. (2016), may not start processing until they encounter the pronoun. At this moment, they need to consider two sources of information: IC or IR biases derived from the preceding context, and the subjecthood cue from the pronoun. There are two possible reasons why L2 speakers are more likely to be influenced by the subjecthood cue than the IC or IR biases. First, the pronoun is the most recently encountered linguistic element and thus more salient in their mental model than the content in the first clause. Second, in terms of processing cost, the subjecthood cue may incur fewer burdens than the information of IC and IR. To understand IC and IR biases requires the integration of multiple sources of information including verb meaning and discourse coherence relations, which is argued to be difficult for L2 speakers (Hopp, 2010; Roberts et al., 2008; Sorace & Filiaci, 2006). By contrast, establishing a coreferential relation between the pronoun and the subject may be easier, as it does not require complex computation to figure out a referent's grammatical role or surface position. Thus, after encountering the pronoun, L2 speaker may first resort more to the easier-to-process subjecthood cue and thus resolve their initial reference to NP1. After that, they will consider the content of the first clause to write a continuation that makes a coherent discourse. It is at this later stage that the information of IC and IR comes into play, which may modify their final interpretation. When IC or IR biases are also towards

NP1, it is easy for participants to keep their initial choice by writing a continuation with a reference to NP1. When IC or IR biases are towards NP2, they may either stick to their initial choice of NP1, or switch the reference to NP2 if they find it difficult to come up with a continuation that begins with a reference to NP1. Despite this modification, since their initial reference is resolved towards NP1, they still show a higher likelihood of resolving the pronoun to refer to the subject than L1 speakers.

The above account may also help explain why L2 speakers' "subject bias" in pronoun interpretation is stronger in the IR context than in the IC context. In this study, we found that, when the context had an NP2 bias, despite producing more NP1 references than L1 participants, L2 participants still showed an NP2 bias in the IC context but an NP1 bias in the IR context. The same result was found in our earlier study (Cheng & Almor, 2016). The results in that study, however, could be due to the fact that the connective we used to elicit the Result coherence relation (i.e., the word *so*) may express other meanings than consequence (Stevenson et al., 1994). In this study, we controlled this factor by using the phrase *as a result*, which only has one interpretation, but still observed a discrepancy between the IC and the IR contexts. Although the contrast could be due to a between-subjects design, it may also be related to the processing differences between the two coherence relations. Some studies on causal processing argue that inferring the consequence of an event is more difficult than inferring its cause (e.g., van den Broek, 1990; Zwaan & Radvansky, 1998). In a visual world eye tracking study, Commandeur (2010) investigated the effect of IC and IR biases on coreference processing in Dutch and found that while participants used the IC information to identify the referent, they did not use the IR information. He argued that this may be because

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people find it easier to process sentences in a consequence-cause order than in a cause-consequence order. If L2 speakers also find the IR information more difficult to process than the IC information, they would be more likely to postpone processing the IR information than the IC information. As argued above, processing delay would cause L2 participants to rely more on the subjecthood cue activated by the presence of a pronoun. As a result, they would produce more continuations with NP1 references in the IR context than in the IC context.

Implications for L2 Processing Theories

The findings of the present study provide some insights into L2 processing theories in general. First, they further our understanding about L2 discourse processing. In this study, we employed two types of causal coherence relations, that is, Explanation and Result, which were signaled by an explicit connective (i.e., *because*) or signaling phrase (i.e., *as a result*). In both experiments, L2 speakers produced continuations that made up a coherent discourse, indicating that they were able to understand causal coherence relations between clauses and construct coherent representations of the local discourse. Moreover, their understanding of the coherence relations helped them establish coreference, as reflected in their ability to differentiate between NP1 and NP2-biasing IC or IR verbs in the free prompt condition. Their native-like behavior could result from the positive transfer from their native language, as IC and IR biases are argued to be universal discourse biases (Hartshorne et al., 2013). Future studies may examine situations where learners' native languages process discourse coherence relations differently from the target language to see whether cross-linguistic differences influence discourse processing. Furthermore, as argued above, although the results indicate that L2

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speakers are able to understand both IC and IR biases, it appears that the former are easier to process than the latter. Yet, in this study we did not manipulate the discourse coherence relations of Explanation and Result within one experiment. Future studies can use a within-subjects design to clarify whether L2 speakers indeed find the Explanation coherence relation easier to process than the Result coherence relation.

Second, the present study contributes to our understanding about L2 predictive processing. In the free prompt condition, we found that L2 participants used IC or IR biases decoded from the context to make native-like predictions about the referent to be mentioned next. According to the Bayesian model of coreference resolution (Kehler et al., 2008; Kehler & Rohde, 2013), the anticipation of a referent is based on the higher-level calculation about discourse coherence relations. Thus, L2 speakers' native-like performance in the free prompt condition indicates that they are able to use higher-level information to predict lower-level information, an important feature of L1 prediction (Kuperberg & Jaeger, 2015). However, our results are different from those of Grüter et al. (2014, 2016), whose L2 participants were not able to use higher-level event structures to predict the next-mentioned referent. As argued above, this could be due to the different linguistic phenomena we investigated: aspect in their study and IC/IR biases in our study. It is likely that L2 speakers may find it difficult to use aspect to construct native-like discourse representations because aspect is linguistically encoded in different ways between learners' native languages (i.e., Korean and Japanese) and the target language of English (Shirai, 1998). By contrast, IC and IR biases are argued to be universal biases involving simple interpersonal verbs (Hartshorne et al., 2013). The different findings

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between our study and Grüter et al. (2014, 2016) highlight the possibility that learners' native language may influence their ability to make predictions (Kaan, 2014).

In addition, L2 participants' performance in the pronoun prompt condition indicates that the timing of prediction may also be important. As argued above, L2 speakers have a "subject bias" in pronoun interpretation because they may delay making predictions about the referent (Grüter et al.'s, 2016) and consequently be more likely to be influenced by the subjecthood cue activated by the pronoun than L1 speakers. Nonetheless, it is important to emphasize that both Grüter et al.'s (2014, 2016) and our study used offline methods. Although L2 speakers' "subject bias" in pronoun interpretation could be due to the timing problem of prediction, more time-sensitive online methods are needed to test this possibility.

Furthermore, the "subject bias" shown by L2 speakers in their resolution of pronouns indicates that L2 speakers have difficulty in processing multiple levels of information. In our case, to resolve a pronoun, comprehenders need to integrate the IC/IR biases generated from the context with the subjecthood cue activated by the pronoun. The finding that L2 participants showed a "subject bias" demonstrates that they put more weigh on the subjecthood cue than L1 speakers. As argued above, this could be due to the different processing costs associated with the two types of information. IC and IR biases are based on multiple factors at lexical-semantic and discourse levels. By contrast, the subjecthood bias signaled by the presence of a pronoun only requires comprehenders to determine reference based on grammatical roles. Thus, processing the information of IC and IR may pose greater challenges than processing the subjecthood cue. Yet, it should be noted that, strategically, resolving the pronoun to the subject is not necessarily

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beneficial to the processing system. For example, when the IC or IR bias is towards NP2, it may be more difficult to come up with a continuation with a reference to NP1 than NP2. In this case, resolving the pronoun to the subject may actually lead to more processing burdens. However, despite this potential processing disadvantage, L2 speakers still show a preference for the subjecthood cue. This demonstrates that when facing the need to integrate various levels of information, the L2 processing system tends to resort to the seemingly "easy" information. The finding, therefore, lends further support to the argument that L2 speakers have difficulty in integrating multiple sources of information (Hopp, 2010; Roberts et al., 2008; Sorace & Filiaci, 2006).

Limitations

There are some questions unanswered in this study. First, we only focused on English learners at the advanced level. It is possible that L2 speakers at higher proficiency levels, such as near-native speakers, may be less likely to show the "subject bias" in their pronoun resolution. Moreover, although L2 participants in this study showed native-like sensitivity to IC and IR biases in the free prompt condition, learners at lower proficiency levels may not do so. Thus, future studies can investigate the role of proficiency in L2 speakers' establishment of coreference.

Second, we only used the offline method in our experiments. Although this method satisfied the aim of this study and was also widely used in previous studies to investigate coreference, it has some drawbacks. Participants taking offline tasks may rely more on their explicit rather than implicit knowledge. Moreover, participants may take particular strategies in offline tasks. For instance, it is possible that L2 participant in this study might delay processing the information of IC and IR because there was no

cognitive pressure to process the input incrementally and predictively. After all, they could read the stimuli multiple times to think of a possible continuation. By contrast, they may not delay processing in online tasks because doing so would hinder their final comprehension. Thus, future studies can use time-sensitive online methods to better understand the mechanism and time course of L2 coreference processing.

Another direction for future study is to examine L2 speakers' reference production. The present study presented some preliminary data on L2 speakers' choice of referring expressions (pronouns vs. names) in the free prompt condition. However, due to the low number of observations in some cells, no statistical analysis was conducted. Given the close relationship between pronoun production and comprehension (Arnold, 2001; Kehler & Rohde, 2013), future studies can investigate whether L2 speakers pronominalize referents in the same ways as native speakers, and whether their pronoun comprehension biases are related to their production biases.

Table 3.1

Sample Items in Experiment 3.1

	Verb Type	
Prompt Type	NP1-biasing verbs	NP2-biasing verbs
Pronoun	Mary called Sara because she …	Jake trusted Adam because he …
Free	Mary called Sara because …	Jake trusted Adam because …

Table 3.2

Sample Coded Continuations in Experiment 3.1

Codes	Sample continuations
NP1	Joe frightened Luke because *Joe liked to frighten people.*
	Joe frightened Luke because he *was really muscular.*
NP2	Joe frightened Luke because *Luke thought Joe would rat him out.*
	Joe frightened Luke because *he wasn't expecting to see him around the corner*.
Ambiguous	Joe frightened Luke because he *was not paying attention*.
Nonsense	Diana respected Rebecca because she *never know*.
Other/plural entity	Ben telephoned James because *there was a family emergency*.
Gender misunderstanding	Charles cheated George because *George cheated her first*.
Because of	Barbara harmed Tiffany because *of carelessness*.

Note. Participants' continuations were in italics.

Table 3.3

Mean Proportions and Standard Deviations of NP1 References by Verb Type and Prompt Type in L1 and L2 Groups in Experiment 3.1

| | L1 | | L2 | |
| | Verb type | | Verb type | |
Prompt type	NP1 verb	NP2 verb	NP1 verb	NP2 verb
Free	0.78 (0.17)	0.05 (0.08)	0.73 (0.19)	0.04 (0.08)
Pronoun	0.86 (0.17)	0.08 (0.14)	0.70 (0.20)	0.15 (0.20)

Note. Standard deviations are presented in parentheses.

Table 3.4

Summary of the Logistic Regression Analysis for Variables Predicting NP1 Reference in L1 and L2 Participants' Continuations in Experiment 3.1

Predictors	B	SE B	z	p
(Intercept)	-0.78	0.17	-4.54	< .001 *
Group (L2)	-0.08	0.12	-0.63	0.53
Very type (NP2)	-2.31	0.18	-13.07	< .001 *
Prompt type (pronoun)	0.29	0.10	2.94	.003 *
Group × Verb type	0.26	0.13	2.04	.04 *
Group × Prompt type	0.06	0.09	0.68	0.50
Verb type × Prompt type	0.08	0.09	0.86	0.39
Group × Verb type × Prompt type	0.23	0.08	2.84	.004 *

Note. All factors were sum-coded. The L1 group, NP1 verb, and free prompt were used as the reference levels (value = -1) for the factors of group, verb type, and prompt type, respectively. Significant effects at a $p \leq .05$ level are marked with a *.

Table 3.5

Proportion of Subject Pronouns in the Free Prompt Condition in Experiment 3.1

| | L1 | | L2 | |
| | Verb type | | Verb type | |
Referent	NP1 verb	NP2 verb	NP1 verb	NP2 verb
NP1	0.89 (216/242)	0.80 (12/15)	0.61 (99/161)	0.80 (8/10)
NP2	0.39 (26/67)	0.57 (173/300)	0.30 (18/60)	0.26 (66/251)

Note. The formula within parentheses represent the frequency of pronouns divided by the

frequency of pronouns and names.

Table 3.6

Means Proportions and Standard Deviations of NP1 References by Verb Type and Prompt Type in L1 and L2 Groups in Experiment 3.2

| | L1 | | L2 | |
| | Verb type | | Verb type | |
Prompt type	NP1 verb	NP2 verb	NP1 verb	NP2 verb
Free	0.83 (0.19)	0.14 (0.16)	0.85 (0.18)	0.10 (0.13)
Pronoun	0.94 (0.09)	0.34 (0.28)	0.97 (0.07)	0.68 (0.29)

Note. Standard deviations are presented in parentheses.

Table 3.7

Summary of the Logistic Regression Analysis for Variables Predicting NP1 Reference in L1 and L2 Participants' Continuations in Experiment 3.2

Predictors	*B*	*SE B*	*z*	*p*
(Intercept)	0.92	0.17	5.54	< .001 *
Group (L2)	0.35	0.14	2.50	.01 *
Very type (NP2)	-2.00	0.15	-13.25	< .001 *
Prompt type (pronoun)	1.03	0.12	8.41	< .001 *
Group × Verb type	0.09	0.12	0.72	0.47
Group × Prompt type	0.39	0.11	3.48	< .001 *
Verb type × Prompt type	0.18	0.10	1.69	.09
Group × Verb type × Prompt type	0.22	0.70	2.54	.01 *

Note. All factors were sum-coded. The L1 group, NP1 verb, and free prompt were used as the reference levels (value = -1) for the factors of group, verb type, and prompt type, respectively. Significant effects at a $p \leq .05$ level are marked with a *.

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Table 3.8

Proportion of Subject Pronouns in the Free Prompt Condition in Experiment 3.2

	L1		L2	
	Verb type		Verb type	
Referent	NP1 verb	NP2 verb	NP1 verb	NP2 verb
NP1	0.75 (116/155)	0.43 (12/28)	0.51 (82/161)	0.62 (13/21)
NP2	0.05(2/40)	0.16 (42/257)	0.04 (1/25)	0.03 (5/198)

Note. The numbers within parentheses represent the frequency of pronouns divided by

the frequency of pronouns and names.

Figure 3.1. Graph showing a three-way interaction among group as the focal variable, and verb type and prompt type as the moderating variables in Experiment 3.1.
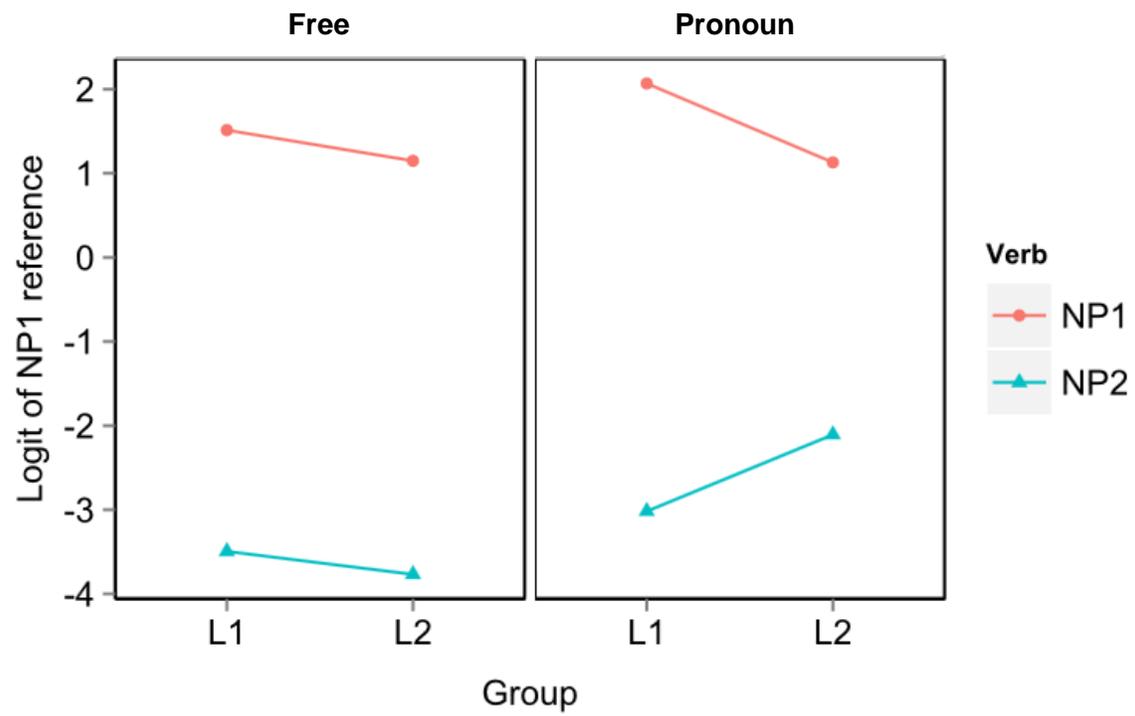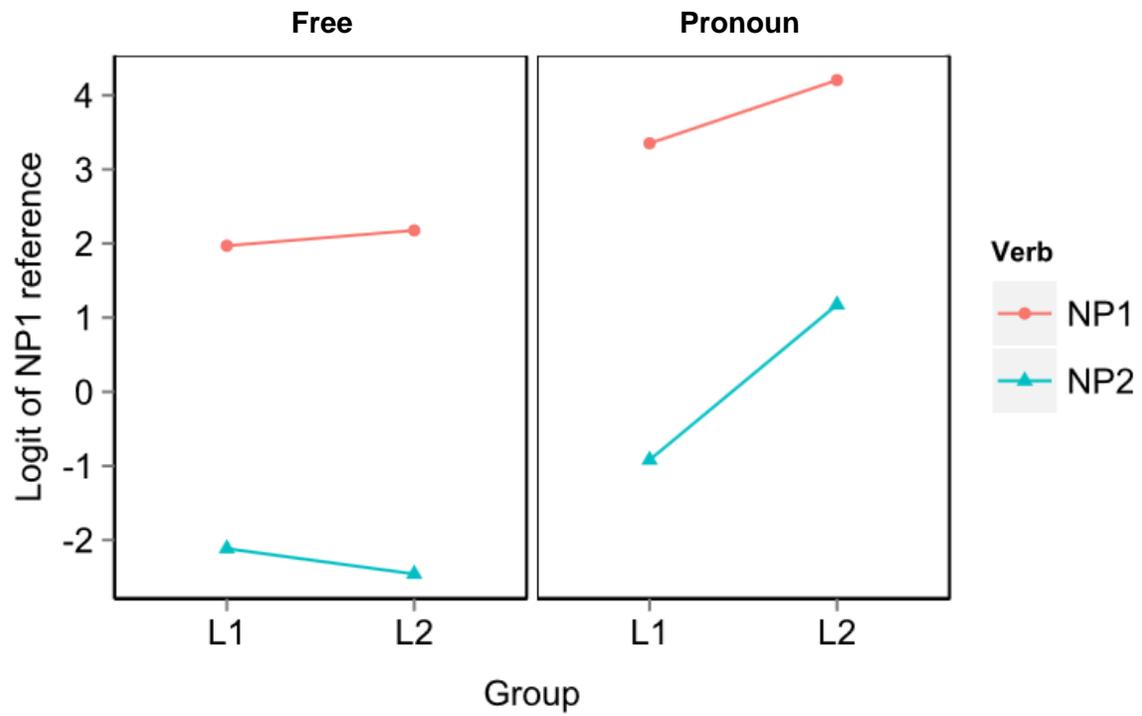
Figure 3.2. Graph showing a three-way interaction among group as the focal variable, and verb type and prompt type as the moderating variables in Experiment 3.2.

Conclusion

This dissertation reports two studies that investigated IC and IR in coreference processing. The first study examined whether intentionality of an event affects native English speakers' re-mention biases. In two sentence-completion experiments, we manipulated the strength of event intentionality by contrasting conditions with bare verbs and conditions with either intentionality-strengthening adverbs such as *deliberately*, or intentionality-weakening adverbs such as *accidentally*. In the experiment on IC, we found that intentionality has an effect on a referent's re-mention bias, but this effect was modulated by verbs' original IC biases. Specifically, for action verbs with no NP1 bias, reinforcing intentionality increases NP1 references. However, for action verbs with an NP1 bias, intentionality does not have an effect, perhaps due to a ceiling effect. Similar patterns were found in the experiment on IR: reinforcing intentionality increases NP2 references only for actions verbs with no NP2 bias. The present study thus extends previous research on intentionality in discourse comprehension by showing that intentionality affects IC and IR re-mention biases in language comprehenders' establishment of coreference. It also adds to the growing body of literature showing that IC and IR biases are a discourse phenomenon deriving from readers' causal inferences about the explanation for or the consequence of an event.

The second study investigated advanced L1-Chinese L2-English speakers' use of IC and IR biases in the establishment of coreference. In two sentence-completion experiments, participants wrote continuations to sentence fragments containing either an

NP1-biasing verb or an NP2-biasing verb and ending with either a free prompt or a pronoun prompt. We found that, in both the IC and IR contexts, L2 speakers showed the same re-mention biases as L1 speakers in the free prompt condition: NP1 following NP1-biasing verbs and NP2 following NP2-biasing verbs, indicating that L2 speakers are able to use the IC and IR information to predict the referent to be re-mentioned. Moreover, L2 coreference resolution is influenced by the form of reference. Like L1 speakers, L2 speakers produced more NP1 references in the pronoun prompt condition than in the free prompt condition. However, L2 speakers exhibited a "subject bias" in pronoun resolution by producing more NP1 references after NP2-biasing verbs than L1 speakers, suggesting that L2 speakers rely on the subjecthood cue activated by the pronoun to a greater extent than L1 speakers. Overall, the study reveals that L2 speakers are able to generate predictions about the next-mentioned referent based on discourse-level information. The "subject bias" shown by L2 speakers in their resolution of pronouns indicates that when there are multiple sources of information available, L2 speakers may experience difficulty in integrating these various levels of information and thus tend to resort to the information that is easy to process, such as the subjecthood cue associated with pronouns.

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Appendix A

Verbs Used in Experiment 2.1

AP verbs (NP1 bias)	follow, battle, harm, meet, marry, disobey, tail, nuzzle, kiss, repay, deceive, cheat, trail, provoke, echo, betray, telephone, call
AP verbs (neutral bias)	hit, cuddle, greet, strike, placate, remunerate, grab, film, pass, leave, interrupt, dominate, confide in, kill, fool, hug, consult, floor
AE verbs	congratulate, thank, praise, reward, applaud, commend, sue, penalize, punish, celebrate, scold, condemn, censure, acclaim, excuse, scorn, criticize, prosecute
SE verbs	distract, bother, confuse, exhaust, amuse, frighten, disappoint, intimidate, scare, infuriate, madden, inspire, annoy, irritate, please, agitate, anger, attract

Appendix B

Verbs Used in Experiment 2.2

AP verbs	corrupt, guide, protect, free, spank, advise, caution, instruct, abandon, correct, employ, visit, interrupt, kiss, question, feed, betray, deceive, chase, strike, defy, approach, catch, confide in, rush to, dominate, pursue, consult, pass, trail, fight, follow, carry, disobey, track, kill
AE verbs	prosecute, commend, compliment, excuse, bless, scold, criticize, scorn, reward, applaud, mock, condemn, thank, accuse, praise, pardon, punish, congratulate
SE verbs	comfort, enrage, confuse, annoy, insult, astonish, bug, alarm, relax, excite, frighten, surprise, exhaust, irritate, stimulate, discourage, bother, please

Appendix C

C-test Used in Experiments 3.1 & 3.2

On this page you will find three small texts in total. Each text contains gaps where

parts of some words have been left out (no whole words are missing, though). In the

blanks provided, please complete the words so that the sentences and texts make sense.

Note that in each blank, you should only complete one word; do not add extra words.

Text 1:

We all live with other people's expectations of us. These are a refle_____ of

th_____ trying to under_____ us; th_____ are predic_____

of wh_____ they th_____ we will think, d_____ and feel.

Gene_____ we acc_____ the sta_____ quo, but these

expec_____ can be ha_____ to han_____ when they

co_____ from our fami_____ and can be diff_____ to

ign_____ , especially wh_____ they come from our par_____.

Text 2

The decision to remove soft drinks from elementary and junior high school vending

machines is a step in the right direction to helping children make better choices when it

comes to what they eat and drink. Childhood obe_____ has bec_____ a

ser_____ problem in th_____ country a_____ children

cons_____ more sugar-based fo_____ and sp_____ less

ti_____ getting the nece_____ exercise. Many par_____ have

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quest_____ schools' deci_____ to al_____ vending machines

which disp_____ candy and so_____ drinks. Many schools,

tho_____ , have co_____ to re_____ on the mo_____

these machines generate through agreements with the companies which makes soft drinks

and junk food.

<u>Text 3</u>

Don't get me wrong. I love magazines. I've been addicted to them since my teenage

years. There's some_____ about wom_____ magazine

superfi_____ that I of_____ enjoy. But oh b_____ , they are

ju_____ so, so frustr_____ predictable. I rec_____ you

co_____ throw o_____ together very eas_____ in five

min_____. Take the co_____ for example: the cover

im_____ : get a he_____ and shou_____ shot of a

smi_____ , heavily make-uped and airbr_____ model (or

optio_____ a fam_____ person).

Appendix D

Verbs Used in Experiment 3.1

NP1-biaisng verbs	apologize to, telephone, lie to, betray, confess to, cheat, harass, harm, attract, anger, annoy, bother, frighten, please, astonish, stimulate
NP2-biasing verbs	congratulate, thank, praise, condemn, reward, punish, correct, scold, envy, admire, respect, fear, pity, distrust, worry about, dislike

Appendix E

Verbs Used in Experiment 3.2

NP1-biaisng verbs	envy, admire, fear, pity, trust, worry about, dream about, dislike, appreciate, kill, miss, like, love, fancy, worship, hate
NP2-biasing verbs	apologize to, telephone, lie to, betray, confess to, cheat, harass, harm, attract, anger, annoy, bother, frighten, please, astonish, stimulate