Title: Misleading bias-driven expectations in referential processing and the facilitative role of contrastive accent

Abstract

Probabilistic preferences are often facilitative in language processing and may assist in discourse prediction. However, occasionally these sources of information may lead to inaccurate expectations. The current study investigated a test case of this scenario. An eye-tracking experiment examined the interpretation of ambiguous personal pronouns in the context of implicit causality biases. We tested whether reference resolution may be facilitated online by contrastive accent in cases of a bias-inconsistent referent. Implicit causality biases directed looks to the biased noun phrase; however, when the name of the bias-inconsistent antecedent was accented (e.g., *JOHN envied Bill because he…*), this tendency was modulated. Contrastive accent seems to dampen the occasionally confusing prediction of implicit causality biases in referential processing. This demonstrates one way in which the spoken language comprehension system copes with occasional misguidance of otherwise helpful probabilistic information.

Keywords: pronoun, implicit causality bias, contrastive accent, eye-tracking, visual worlds

Introduction

The process of pronoun resolution is one of the most studied processes in psycholinguistics. This process is intriguing mainly because successful reference

resolution is crucial for discourse processing (Garnham, 2001) yet pronouns carry very little information regarding their referential identity. In fact, multiple factors and sources of information contribute to the successful resolution of pronominal reference (Arnold, 1998). The current project focused on two very different sources of information which have been shown to influence referential processing but have not been studied together. One is a verb bias labeled Implicit Causality (IC) bias (Garvey & Caramazza, 1974) and the other is sentence prosody, in particular, contrastive accent. Two examples of IC biased verbs are *amazed* and *admired* (see (1) below). With *amazed*, people usually perceive the subject, *John*, as the amazing one, while the object, *Bill*, is the one experiencing amazement (McDonald & MacWhinney, 1995). It appears that something about John is causing the amazement. With *admired* however, it is usually assumed that the reason for admiration has to do with Bill's qualities (McDonald & MacWhinney, 1995). IC biased verbs attribute the cause of the event to either the subject (first noun phrase - NP1) or the object (second noun phrase - NP2) of the sentence (Caramazza, Grober, Garvey, & Yates, 1977; Garnham & Oakhill, 1985; Garnham, Oakhill, & Cruttenden, 1992; Garnham, Traxler, Oakhill, & Gernsbacher, 1996; Koornneef & Van Berkum, 2006; Long & De Ley, 2000; Stewart, Pickering, & Sanford, 2000; Van Berkum, Koornneef, Otten, & Nieuwland, 2007; Vonk, 1985a, 1985b).

(1) John amazed/admired Bill because he…

As much as IC biases can be influential in reference resolution, they can also be misleading on occasion. This may be true in a case where the referent of the pronoun is the less likely, yet acceptable, non-biased NP, as in (2).

(2) John envied Bill because he was poor.

Even though the verb *envied* is an NP2-biasing verb, in example (2), the end of the sentence indicates that the referent of the pronoun is in fact NP1. We were interested to know whether another source of information could inform the listener regarding this unlikely turn of events. Considering previous findings regarding the facilitative role of prosody in ambiguity resolution, and particularly the role of contrastive accent in reference resolution (see reviews by: Carlson, 2009; Cutler, Dahan, & Donselaar, 1997; Wagner & Watson, 2010), we thought it would make a good candidate to serve a facilitative role in the scenario described above. More specifically, we were interested in testing whether contrastively accenting the non-biased NP (*John* in example 2 above) can indicate that the referent of the pronoun is not the one biased by the verb. A facilitation of this sort may lead to smoother processing of less common but absolutely possible utterances. This type of situation can be avoided by simply naming the explicit referent instead of using a pronoun, however prosodic information may be able to achieve the same goal without the speaker having to opt for a more explicit referential form which may incur unnecessary processing costs (Almor, 1999). Moreover, it has been demonstrated that people produce pronouns, even when they are free to use other forms, regardless of bias (in)consistency (Fukumura & van Gompel, 2010). In order to investigate the possibility that prosody can play

such a facilitative role, we used the eye-tracking visual world paradigm which has been used successfully in the past to study issues in reference resolution (e.g., Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Kaiser, Runner, Sussman, & Tanenhaus, 2009) including in the context of IC biases (Cozijn, Commandeur, Vonk, & Noordman, 2011; Pyykkonen & Jarvikivi, 2010) and reference-related prosodic manipulations (Arnold, 2008; Ito & Speer, 2008; Venditti, Trueswell, Stone, & Nautiyal, 2003; Weber, Braun, & Crocker, 2006).

Implicit Causality biases

Implicit causality biases have been traditionally identified by asking participants to complete sentence fragments as in (1) above. The specific verb's bias is identified based on whether the majority of responses treated NP1 or NP2 as the referent of the pronoun. The biases of a large number of verbs in multiple languages have been identified this way (Au, 1986; Brown & Fish, 1983; Cozijn et al., 2011; Ferstl, Garnham, & Manouilidou, 2011; Fiedler & Semin, 1988; Garnham & Oakhill, 1985; Garvey & Caramazza, 1974; Garvey, Caramazza, & Yates, 1976; Goikoetxea, Pascual, & Acha, 2008; Greene & McKoon, 1995; Grober, Beardsley, & Caramazza, 1978; Guerry, Gimenes, Caplan, & Rigalleau, 2006; Koornneef & Van Berkum, 2006; Long & De Ley, 2000; McKoon, Greene, & Raycliff, 1993; Pyykkonen & Jarvikivi, 2010; Stewart et al., 2000; Van Berkum et al., 2007; Vonk, 1985a, 1985b). Recently, Ferstl, Garnham and Manouilidou (2011) conducted a large scale study testing the IC bias of 305 English verbs by analyzing the responses of nearly 100 participants in a web-

based sentence completion experiment. For the most part, the biases identified in previous studies were confirmed.

A great deal of the research on IC verb biases has focused on how this information influences pronominal reference processing as well as the precise timing of its influence during online sentence comprehension. It has been shown, using several research methods, that when the referent of the pronoun is indeed the one biased by the verb, processing is easier/smoother than when the referent is the non-biased NP (Caramazza et al., 1977; Cozijn et al., 2011; Featherstone & Strut, 2010; Garnham & Oakhill, 1985; Garnham et al., 1992; Garnham et al., 1996; Koornneef & Van Berkum, 2006; Long & De Ley, 2000; Pyykkonen & Jarvikivi, 2010; Stewart et al., 2000; Van Berkum et al., 2007; Vonk, 1985a, 1985b). For example, with an NP2-biasing verb such as *envied* in example (3), it is more straightforward to process the sentence when it ends with the word *rich* (3a), implying NP2 as the referent of the pronoun, consistent with the bias of the verb, than it is when the last word is *poor* (3b), implying NP1 as the referent of the pronoun, inconsistent with the bias of the verb.

(3) a. John envied $Bill_1$ because he_1 was rich.

b. $John_1$ envied Bill because he_1 was poor.

Recent eye-tracking visual world paradigm studies demonstrated that IC verb biases begin playing a role in referential processing quite early on during the sentence (Cozijn et al., 2011; Pyykkonen & Jarvikivi, 2010). In these studies, fixations of the protagonists of the event, displayed visually on the screen, were

taken as an indication of their relative preference as referents of the pronoun. Some of the findings suggest that IC bias information can be activated almost as early as it becomes available, not long after the verb and NP2 are heard and before the conjunction *because* (Pyykkonen & Jarvikivi, 2010). These studies have demonstrated that IC bias information is influential in pronoun resolution prior to referential disambiguation downstream and therefore may play a predictive role regarding the pronoun's referent. Prosodic information is also often available prior to lexical disambiguating information in referential ambiguities (Ito & Speer, 2008; Weber et al., 2006) as well as structural ambiguities (Pauker, Itzhak, Baum, & Steinhauer, 2011; Steinhauer, Alter, & Friederici, 1999), and can potentially interact with IC bias information in order to improve processing efficiency. Prosodic information has previously been shown to play a facilitative role when interacting with structural biases in the context of parsing ambiguities (Itzhak, Pauker, Drury, Baum, & Steinhauer, 2010).

Prosody and reference resolution

Accenting[1] patterns of temporarily ambiguous anaphors (full NPs or pronouns) have been shown to influence referential interpretation (Arnold, 2008; Brown-Schmidt, Byron, & Tanenhaus, 2005; Dahan, Tanenhaus, & Chambers, 2002; Eberhard, Spivey-Knowlton, Sedivy, & Tanenhaus, 1995; Ito & Speer, 2008; Sedivy, Tanenhaus, Chambers, & Carlson, 1999; Venditti et al., 2003; Weber et al., 2006). In Dahan et al. (2002), target words were temporarily ambiguous because the available alternatives shared the first syllable

[1] The acoustic characteristics of accented words in English are longer syllable duration, greater intensity and pitch change (with a local maximum/minimum signaling prominence) (Ladd, 2008).

(bacon/bagel). When applied directly to the ambiguous NP, accent was shown to change the referential interpretation (prior to lexical disambiguation) such that without accent participants were likely to interpret the word as referring to a previously mentioned object but with accent the expectation was for the other, previously unmentioned object. An eye-tracking study by Ito and Speer (2008) has demonstrated that accent can influence referential processing even when applied to a modifier and not directly to the noun itself. Eye fixations converged on the target object faster when the adjective, which already provided contrastive information, was also accented (relative to when it was unaccented). This finding suggests that contrastive accent can facilitate reference resolution by indicating the appropriate referent before disambiguating lexical information is available. It shows that referential contrast can be conveyed by accenting a modifier and not just the noun itself (see also Bogels, Schriefers, Vonk, & Chwilla, 2011 for ERP evidence).

Changes in accenting patterns have also been shown to influence the interpretation of pronominal anaphors. It has been previously suggested that accenting the pronoun itself in sentences such as *John hit Bill and then he/HE*[2] *hit George* can lead to a change in referent (Akmajian & Jackendoff, 1970; De Hoop, 2004; Kameyama, 1999; Oehrle, 1979; Smyth, 1994; Solan, 1980; Taylor, Stowe, Redeker, & Hoeks, 2009; Venditti, Stone, Nanda, & Tepper, 2001, 2002; Venditti et al., 2003). When the pronoun is not accented, it refers to the subject NP (NP1) but when it is accented, it is said to refer to the object NP (NP2). Emerging

[2] Capital letters signify an accented word

evidence suggests that accenting the pronoun in such cases can indeed modulate the referential interpretation of pronouns (Brown-Schmidt et al., 2005; Solan, 1980; Taylor et al., 2009; Venditti et al., 2001, 2002; Venditti et al., 2003). In the context of IC biases, the effect of accent on the pronoun itself does not seem to have a straight forward effect; in our previous study accenting the pronoun was not interpreted as contradicting the bias of the IC verb. While participants were not able to ignore the prosodic manipulation, its effect on pronoun interpretation did not consequently yield a switch in reference, as outlined above. We wanted to explore the possibility that a clearer contrast with regard to the referent's identity could be achieved by accenting the non-biased NP as a means to contrast it with the biased one. Thus, indicating that the non-biased NP is the referent of the pronoun in bias-inconsistent sentences.

Many years ago, Akmajian and Jackendoff (1970) suggested that different accent patterns applied to possible antecedent names could affect co-referentiality. In their example, repeated here in (5) below, when neither of the names is accented, the pronoun remains ambiguous as in (5a). However, they maintained that accenting *George* leads to co-referencing the pronoun *him* with the other character -*Tom*. On the other hand, they proposed that accenting *Tom* leads to co-referencing the pronoun *him* with *George*. In this example, the contrast conveyed by accenting either of the names seems to juxtapose one of the two characters mentioned in the sentence with other unnamed (but assumed) people. In (5b) *George* is contrasted with other potential thesis advisors, while in (5c) *Tom* is contrasted with other potential students. The contrast allows one to identify who

is considered as a possible advisor/student and who is doing the thinking/considering, that is, which character is the co-referential antecedent of the pronoun.

(5) a. That George would be Tom's thesis advisor never occurred to him.

b. That GEORGE would be Tom_1's thesis advisor never occurred to him_1.

c. That $George_1$ would be TOM's thesis advisor never occurred to him_1.

In another study that examined the effects of accent on co-referencing, Carlson, Dickey, Frazier and Clifton (2009) examined sluicing sentences, as in (6), in which the material elided by the wh-remnant (*who else*) represents an indefinite NP which may be parallel to the subject or the object of the previous clause and is therefore ambiguous. For example, in (6a) it is ambiguous whether *we couldn't find out who else the captain talked with* (object interpretation) or *who else talked with the co-pilot* (subject interpretation). There is, however, a preference towards the object interpretation in these cases (Carlson et al., 2009). Participants in their study listened to different versions of this sentence including ones in which the subject or the object was accented. They were then requested to select one of two unambiguous paraphrases of the sluiced sentence denoting which interpretation they adopted (the subject or the object interpretation). When the object was accented (in line with the already present preference) participants selected the object interpretation just under 90% of the time on average; however,

when the subject was accented, the object interpretation selections were reduced by 40%. This suggests that accenting patterns can change later interpretation of reference-like ambiguities, as suggested by Akmajian and Jackendoff (1970). Here again, the contrast evoked by accent seems to juxtapose the accented character with other unmentioned ones (in 6b, for example, the captain is contrasted with other people who may have talked with the co-pilot).

(6) a. The captain talked with the co-pilot, but we couldn't find out who else.

b. The CAPTAIN talked with the co-pilot, but we couldn't find out who else.

c. The captain talked with the CO-PILOT, but we couldn't find out who else.

Finally, it has also been proposed that contrastive accent on one of the characters' names would in fact contrast the two mentioned characters with one another in terms of their co-reference with a later appearing anaphor (Cowles, Walenski, & Kluender, 2007). Cowles and colleagues (2007) presented participants with short discourses, as in (7), in which the target NP was either accented or unaccented. They used a cross-modal production task in which participants were asked to produce one of the names from the discourse (*Anne* or *Sarah*) appearing on the screen right after hearing the ambiguous pronoun. Reaction time for target word production was used as the dependent variable, assuming that the more prominent name (i.e., the one likely to be taken as the pronoun's referent) should be named faster. The cleft structure of the second

sentence in the discourse already conveys contrast, however this structure by itself was not sufficient to influence referential interpretation and did not yield faster reaction times for the clefted element (*Anne*) relative to the other name (*Sarah*) (see Cowles et al., 2007 Experiment 1). When the name appearing first in the cleft sentence was accented, the contrast achieved was strong enough to allow for faster reaction times to the prominent name (*ANNE* in the example) relative to the non-prominent name (which was not accented, *Sarah* in the example). This demonstrates that contrasting two potential referents of the pronoun, by means of accenting the intended referent, may influence their relative accessibility, as reflected in probe reaction times. The fact that the character whose name was accented was primed by the pronoun suggests that it was considered as the pronoun's referent more than the other character.

(7) A new movie opened in town.

It was Anne/ANNE who called Sarah.

But later that night she couldn't go to the movie after all.

Considering the findings outlined here, and particularly those of Cowles et al. (2007), we wanted to examine the possible role of accent in pronoun resolution in the context of IC verb biases. The current study focused on testing whether contrastively accenting the name of the non-biased NP can facilitate referential processing in cases where the non-biased NP is indeed the referent of the pronoun. That is, we examined whether in a sentence like (8) containing an NP2-biasing verb, accenting the non-biased NP (i.e., NP1- *John*) would provide an indication regarding the correct (but unpredicted based on IC bias) referent.

(8) John/JOHN envied Bill because he was poor.

To this end we used eye-tracking and the visual world paradigm. In this paradigm participants look at visual stimuli (e.g., pictures) which correspond to the auditory stimuli presented simultaneously. Changes in attention to different parts of the visual display can be related to specific aspects of the unfolding linguistic stimuli and thus reflect its processing (see Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). We analyzed accuracy in reference resolution, reaction times and eye fixation preferences at key points in orally presented sentences.

Methods

Participants

Sixty four healthy native English speakers with no self-reported history of neurological or speech-language disorders participated in this study. The data of two participants were lost because of equipment malfunction. One participant was not able to complete the experiment and the data of one more participant were excluded because we later learnt that he was familiar with the research paradigm and background. The remaining sixty participants were aged 18-29 (20 females, mean age 21.5, SD= 2.3). Participants were recruited via an ad on the university classifieds and they received 20$ as compensation for their time. We recorded movements of the right eye of all the participants but calibration was binocular.

Materials

Auditory materials

Experimental stimuli

An initial set of IC biased verbs was selected from several past studies that examined verb biases (Au, 1986; Brown & Fish, 1983; Caramazza et al., 1977; Garnham et al., 1996; Garvey et al., 1976; Grober et al., 1978; Long & De Ley, 2000; Stewart et al., 2000). The selected verbs had to satisfy the following criteria: each verb item displayed the same bias across studies and the bias score of the verb was higher than 70% in at least one study. Verbs with particles (e.g., calm down) and di-transitive verbs (e.g., sell) were excluded. The biases of the verbs were confirmed by two sentence completion norming studies (one written and one auditory). The results of these norming studies confirmed previously reported biases other than a few exceptions. The final list of verbs included 24 NP1-biased verbs with an average bias score of 94% (min:73%, max:100%) and 24 NP2-biased verbs with an average bias score of 92% (min: 78%, max:100%).

Forty eight unique experimental items (based on the selected 48 IC bias verbs), were created (see Table 1 for an example). Each of them revolving around an event based on a different verb (e.g., *envied* in the example). Each discourse was comprised of a context sentence and a critical sentence, followed by a question. The critical sentence appeared in one of three prosodic conditions; in one experimental condition NP1 was accented (the subject of the sentence), in another condition NP2 was accented (the object), and in the control condition none of the words were contrastively accented. In addition, sentence ending was consistent or inconsistent with the verb IC bias (making for a total of 288 experimental discourses, six versions per verb item) (see Appendix for a full stimuli list). The auditory materials were paired with visual materials comprised

of images of the two protagonists of the event (described in detail below, see example in Figure 1).

[Insert Table 1 here]

In order to ensure that each participant was exposed to only one version per item, the 6 versions made for each verb appeared in 6 separate experimental lists of 48 items each, with 16 trials per prosodic condition, 24 trials per each IC bias type, and 24 trails per bias-consistent ending / bias-inconsistent ending. Therefore, there were 6 material sets consisting of 48 experimental items each, in addition to 40 filler sentences, resulting in a total of 88 trials per set. Each participant saw only one of the lists. Within each set the trials appeared in a pseudo-randomized order with respect to image display order (NP1 picture displayed on the left of the screen and NP2 on the right, and the other way around). In addition, there were only two or fewer trials of the same prosodic condition in a row, only two or fewer trials of the same bias-consistency condition in a row, and only two or fewer trials of the same IC bias type in a row. Filler trials appeared at least every two experimental trials. The digitized stimuli were transferred to disk and analyzed using Praat (acoustic analysis software, Boersma & Weenink, 2008) in order to confirm that the intended accent patterns were produced. The following acoustic parameters were measured for all the accented NPs and their unaccented counterparts in the other Accent conditions:

- The duration of the entire word.

- The peak amplitude of the vowel estimated based on an average of the three highest amplitude pitch periods.
- The peak fundamental frequency, estimated based on an average of the same three pitch periods.

Mean duration (in ms), F0 (in Hz) and intensity (in dB) of NP1, NP2 and the pronoun are reported in Table 2. Each of the acoustic measures of each of these phrases was compared in separate ANOVAs across the three Accent conditions (No-Accent; NP1-Accented; NP2-Accented); the results are presented in Table 2. In trials in which NP1 was accented, it had significantly higher pitch and was significantly longer and louder than in trials in which it was not accented. In trials where NP2 was accented, it had significantly higher pitch and was significantly longer and louder than in trials in which it was not accented. The pronoun did not differ on either of the acoustic measures across Accent conditions.

Bear in mind that accent is relative within a sentence. Therefore, depending on which word is accented, others may be reduced in the acoustic dimensions of F0, duration and amplitude. For this reason, we also found some acoustic differences among phrases in the No-Accent condition relative to their unaccented counterparts in the other two conditions, e.g., NP1 in the No-Accent condition vs. in the NP2-Accented condition, as follows: NP1 had higher F0 and was longer in the No-Accent condition than in the NP2-Accented condition (but they did not differ significantly in amplitude). This is due to the reduction of NP1 in the NP2-Accented condition because of an upcoming accent, relative to the typical declination pattern of statements, starting with a high F0 (as in the No-

Accent condition). Importantly, NP1 in the NP1-Accented condition differed on all three measures when compared with its counterpart in the No-Accent condition as mentioned above. NP2 had higher F0 and amplitude in the No-Accent condition than in the NP1-Accented condition (but they did not differ significantly in duration). This is a result of a slight reduction of NP2 in the NP1-Accented condition relative to the neutral No-Accent condition. Again, despite this difference, when comparing the acoustic measures of NP2 in the NP2-Accented condition with those in the No-Accent condition, they differ on all three measures such that the accented NP2 is longer, has higher amplitude and higher F0.

[Insert Table 2 here]

In order to verify that the relevant accent patterns could be identified perceptually, ten native English speakers, naïve to the purpose of the experiment, were each asked to listen to half of the recorded sentences (including fillers) presented via Praat (Boersma & Weenink, 2008) in a random order, and to click on the accented word in each sentence. The choices for selection were each word of the sentence, appearing in writing in separate boxes on the screen, or '0' to indicate that no word was accented. On average, the participants in the verification study responded accurately 96.3% of the time (SD=1.7%).

Filler sentence stimuli

Filler sentences, built around a different set of verbs, had a similar structure to that of the experimental sentences, however, instead of the connector *because* other connectors were used (e.g., *before, although, while, but* and *yet*).

Though these sentences contained personal pronouns, the question at the end of the trial did not require pronoun resolution (in contrast with the experimental stimuli). Half of the filler sentences contained an accented word but never an accented pronoun.

Visual stimuli

A set of neutral face pictures in color was used in the study, ten of which were male faces and ten female. Some of the pictures were a subset of the pictures in Paulmann and Pell (2009), and some were purchased from iStockphoto.com. Pictures depicting NP1 appeared on the right of the screen in half of the trials on the left in the other half. Each picture appeared with its name written below the picture (see Kaiser et al., 2009). Every picture had the same name throughout the experiment. A sample of the visual display is presented in Figure 1.

[Insert Figure 1 here]

Procedure

All participants first completed a practice block of six trials which were not included in the experiment, following a nine-point calibration procedure (testing the fixation of nine target points presented randomly on the screen). In addition, participants completed a language background questionnaire, a verbal working memory test and a hearing screening. The working memory test was included since previous research has shown that working memory capacity plays a role in discourse inferences, including those relevant to anaphor interpretation

(Daneman & Carpenter, 1980; Whitney, Ritchie, & Clark, 1991). The working memory test used here was an auditory word recall task (adopted from Lehmna & Tompkins, 1998; Tompkins, Blosie, Timko, & Baumgaertner, 1994) in which participants were presented with a set of spoken sentences and then asked to recall the last word of each sentence. Memorising the last words of the sentences was made difficult by a true/false judgment task following each sentence. The number of sentences in each set increased gradually (from 2 sentences per set to 5 sentences per set). The experiment was divided into four blocks of 22 trials each (including fillers) with a short break between blocks.

The experiment was programmed and presented with Experiment Builder (SR research, Ontario, Canada). Participants were seated in front of a display computer and wore a head-mounted EyeLink eye-tracker (SR research, Ontario, Canada). Auditory stimuli were presented via insert earphones at a comfortable volume according to participants' preference. Trials proceeded as follows: a fixation point appeared in the centre of the screen (for drift correction), two face pictures and their names replaced the fixation point and were displayed for one second before the sound file began playing. The pictures remained on the screen for the duration of the trial. Participants were asked to respond to the question at the end of the trial once it has finished playing. Selecting one character or the other as the response to the question was done with a game controller; a left key on the controller selected the left picture on the screen and a right key selected the right picture. Behavioral responses (reaction type and response type) as well as eye movements (every 4ms) were recorded by the EyeLink II system.

Data Analysis

Eye fixation data were processed using EyeLink Data Viewer and Microsoft Excel and then statistically analyzed in R Project for Statistical Computing (R Development Core Team, 2009). Sampling reports were produced with Data Viewer (SR Research, Ontario, Canada), which included information regarding fixation location (one of two interest areas corresponding to the pictures) and whether the eye was in a blink or a saccade (for each sampling point, in each trial for each participant).

In order to avoid drawbacks associated with traditional statistical methods regarding the treatment of participants and linguistic items as random effects (Baayen, Davidson, & Bates, 2008), we analyzed our data using linear mixed effects regression models. Accuracy (NP selected as the pronoun's referent), reaction time (RT) and eye movement data were analyzed using linear mixed effects (LME) regression models within the lme4 package of R (version 2.13.2 for Windows OS; Baayen, 2008; Baayen et al., 2008; R Development Core Team, 2009). Participants and items were added to all models as random effects. Experimental factors were included in the models as fixed effects (see results for details regarding the different models). In order to estimate the significance of the resulting t values of the fixed effects and interactions, we tested them using a Monte Carlo Markov Chain procedure (MCMC) (Baayen, 2008). For the analyses of response type there were only two possible answers, therefore we applied a binomial analysis which provided z scores and their corresponding p values.

Fixation proportions

Fixation proportions of each NP (NP1 and NP2) were calculated for each trial in each time window of analysis. These fixation proportions were calculated by dividing the number of sampling points in which each NP was fixated by the total number of sampling points in the time window of interest. For example, in order to calculate the fixation proportions of NP1 (per participant per trial) in the first 200ms following pronoun onset, we divided the number of sampling points it was fixated during this time window by a total of 51 sampling points (250 Hz sampling rate, one sample point every 4ms plus the sampling point at 0ms, i.e., pronoun onset). So if participant A in trial 1 fixated NP1 in 30 of the sampling points, and NP2 in 12 of the sampling points, during the entire time window, then NP1 fixation proportions were: 30/51=0.59, and NP2 fixation proportions were 12/51=0.24. This resulted in a fixation proportion value per NP per trial per participant per time window of analysis.

Fixation preference ratio

In order to focus on fixations of the two characters solely, we calculated an estimate of fixation preference for each picture following Salverda et al. (2007). This preference ratio was calculated by dividing the fixation proportion of each NP (within a particular time window) as described above, by the total of fixation proportions of both NPs. For instance, NP1 fixation preference ratio during the first 200ms following the pronoun was calculated by dividing the fixation proportion of the NP1 in this time window by the total of fixation proportions of both NP1 and NP2 in this time window. Following the example

above, if fixation proportions for participant A in trial 1 were: NP1: 0.59, and NP2: 0.24, then NP1's fixation preference ratio was: 0.59/(0.59+0.24)=0.71. The values for this ratio range between 0 and 1. In this example, a value higher than 0.5 reflects a greater degree of fixating NP1 than NP2, and a value below 0.5 reflects a greater degree of fixating NP2 than NP1. The fixation preference ratio of NP2 was calculated and analyzed as well.

For one analysis focusing on the effect of accent after the onset of the pronoun we calculated the fixation preference ratio of the biased NP (fixations of NP1 with NP1-biasing verbs and fixations of NP2 with NP2-biasing verbs pooled together) and the non-biased NP (fixations of NP2 with NP1-biasing verbs and fixations of NP1 with NP2-biasing verbs pooled together). The same calculation procedure described above for NP1 and NP2 fixation preference ratios was applied here in order to obtain the fixation preference ratios of the biased and the non-biased NP.

Results

Behavioral results

Referent choice - accuracy

Participants consistently selected the NP implied by the sentence ending as the referent of the pronoun (90% of the time on average, SD=7%). Accuracy (NP selected in response to pronoun resolution question) was tested in a model containing an Accent by IC bias-consistency (bias-consistent ending as baseline) by IC bias type (NP1 bias as baseline) 3-way interaction term testing for all main

effects and their interactions. In addition, two control variables were included: trial number and image display order (NP1 picture displayed on the left of the screen and NP2 on the right or the other way around). The Accent factor included three levels: No-Accent, Biased NP Accented, and Non-biased NP Accented. The baseline for this factor was the No-Accent level in one analysis and the Biased NP Accented in another analysis. This was done in order to test all possible comparisons (since each of the non-baseline levels is normally compared against the baseline level, but not against each other). Not surprisingly, the main effect of IC bias-consistency was significant such that responses to trials with bias-inconsistent endings (M = 84%, SD = 10%) were less accurate than responses to trials with bias-consistent endings (M = 96%, SD = 6%) (b = 2.1, SE = 0.4, $p < 0.001$). The effect of Accent was significant as well, showing higher accuracy when the non-biased NP was accented (M = 90%, SD = 9%) relative to the No-Accent condition (M = 90%, SD = 8%) (b = 1.1, SE = 0.4, $p < 0.05$)[3]. The main effect of IC bias type was also significant, showing higher accuracy in trials with NP2-biasing verbs (M = 93%, SD = 5%) than in those with NP1-biasing verbs (M = 87%, SD = 10%) (b = 1.8, SE = 0.8, $p < 0.05$). None of the interactions with this factor was significant. The interaction of Accent and IC bias-consistency was significant in two cases: the difference in accuracy between bias-consistent and bias-inconsistent trials was smaller when the non-biased NP was accented (8% difference on average) relative to the No-Accent condition (14% difference on average) (b = 1.2, SE = 0.5, $p < 0.05$) and relative to the condition in which the

[3] Though the means are the same the ranges of accuracy scores are different (No-Accent condition : 100%-56%; Non-biased Np accented: 100%-68%) and the two levels were indeed found to be significantly different.

biased NP was accented (13% difference on average) (b = 1.1, SE = 0.5, p < 0.05). This stemmed from higher accuracy on bias-inconsistent trials when the non-biased NP was accented.

Reaction time

We tested a model with the 3-way interaction of Accent by IC bias-consistency by IC bias type (No-Accent as baseline, bias-consistent as baseline, NP1 bias as baseline) testing for main effects as well as all possible interactions. The control factors were trial number and image display order. The Accent factor in this analysis contained three levels (No-Accent; Biased NP Accented; Non-biased NP Accented). The analysis was run once with the No-Accent level as baseline and once with the Biased NP Accented level as baseline in order to test all possible comparisons. Only the main effect of IC bias-consistency was significant. Bias-consistent trials (mean = 864ms, SD = 385ms) were responded to faster than bias-inconsistent ones (mean = 1303ms, SD = 517ms) (b = 440.34, SE = 93.22, pMCMC < 0.0001). The effects of Accent and IC bias type were not significant; nor were there any interactions.

Behavioural results summary

Reaction times and reference choice (accuracy) results show an effect of bias consistency suggesting less processing difficulty when the IC bias of the verb was borne out. The interaction of accent and bias-consistency in the accuracy results reflected a lower rate of response errors when the non-biased NP was accented in the bias-inconsistent sentences (relative to the other conditions).

Eye tracking results

Fixation preference ratios

NP2 region

Considering previous findings showing an effect of IC bias before the conjunction *because* (Pyykkonen & Jarvikivi, 2010), we tested the effect of IC bias type in several time windows following the onset of NP2. Two models tested the effects of verb IC bias type on fixation preferences of NP1 and NP2 separately. Since we were only looking to replicate the early IC bias effect, at this region of the sentence, the analysis here focused only on the No-Accent level of the Accent factor. The models included verb IC bias type (NP1 bias as baseline) as a fixed effect, as well as the control variables of trial number and image display order. In addition, two more control variables were included in order to factor out differences directly related to the magnitude of the bias of individual verb items used in the experiment. These additional control factors characterized the magnitude of the bias associated with each particular verb item. The first was an estimate of verb IC bias magnitude (e.g., the degree to which the verb "call" biased participants to prefer NP1 as its referent in a causality context) as reflected by written sentence completion responses. The second one was an estimate of verb IC bias magnitude as reflected by spoken sentence completion responses. Both measurements were collected from different sets of participants in a norming study conducted separately (described above under *Auditory materials*). The analyses failed to reveal an effect of verb IC bias type at this point in the sentence. This may be due to the high individual variability in the current data set. We

examined the possibility that differences in working memory capacity among participants may have contributed to differences in processing IC bias information. Participants ranged from 64% to 100% success rate in an auditory word recall task (with a mean of 83%). However, despite some trends, no significant effects were found and therefore it was not possible to identify a clear relationship between working memory and the other experimental factors. In addition, the simultaneous appearance of bias information and reference-relevant prosodic information, may have led to a large variability in looks at this point in the sentence having some participants respond more to accenting patterns and other more to IC bias information.

Because and pronoun region

At the region of the conjunction *because* and the pronoun two models tested the effects of verb IC bias type and Accent on fixation preferences of NP1 and NP2 separately. The models included an interaction term of IC bias type by Accent as the fixed effects as well as four control variables (as described above in the NP2 region). The time windows that were tested followed the onset of the conjunction *because* (0-200ms and 200-400ms) and the onset of the pronoun (0-200ms and 200-400ms). The effect of verb IC bias type was significant for both NP1 fixation preference and NP2 fixation preference analyses. NP1 fixation preference was significantly higher with NP1-biasing verbs than with NP2-biasing verbs (after the onset of the pronoun- 0-200ms: b = 0.07, SE = 0.04, pMCMC < 0.05, and 200-400ms: b = 0.1, SE = 0.04, pMCMC < 0.05). Correspondingly, NP2 fixation preference was higher with NP2-biasing verbs than with NP1-

biasing verbs (at 200-400ms after the onset of *because*- b = 0.09, SE = 0.04, pMCMC < 0.05; and after the onset of the pronoun- 0-200ms: b = 0.09, SE = 0.04, pMCMC < 0.01, and 200-400ms: b = 0.1, SE = 0.04, pMCMC < 0.01).

In order to focus on the effect of the Accent factor, we pooled together fixation preferences of the biased NPs (NP1 with NP1-biasing verbs and NP2 with NP2-biasing verbs); similarly, we pooled together fixation preferences of the non-biased NPs (NP1 with NP2-biasing verbs and NP2 with NP1-biasing verbs). The idea in these analyses was to explore whether the relatively lower fixation preference of the non-biased NP increased in trials in which the non-biased NP was accented relative to the No-Accent condition. To this end, we tested models with the non-biased NPs' fixation preference as the dependent variable and Accent as a fixed effect (in addition to four control variables as described above: trial number, image display order and written and auditory bias magnitude measures). The Accent factor contained three levels: No-Accent, Biased NP Accented, and Non-biased NP Accented. The baseline of the Accent factor was the No-Accent level (comparing it to the other two levels). The time windows that were tested followed the onset of the conjunction *because* (0-200ms and 200-400ms) and the onset of the pronoun (0-200ms and 200-400ms, 400-600ms). Figure 2 displays fixation preferences of the biased and non-biased NPs under these three Accent conditions. Overall, fixation preferences for the biased NP are, of course, higher than fixation preferences for the non-biased NP. However, the degree to which the NPs are fixated seems to be modulated by the different accent patterns such that the non-biased NP is fixated the least in the No-Accent

conditions, a little more when the biased NP is accented, and the most when the non-biased NP is accented. Fixation preference of the non-biased NP was significantly higher when the non-biased NP was accented earlier in the sentence relative to the No-Accent condition (after the onset of the pronoun at 200-400ms: b = 0.04, SE = 0.02, pMCMC = 0.05; and at 400-600ms: b = 0.06, SE = 0.02, pMCMC < 0.05). When the baseline was changed to the level of Biased NP Accented (comparing it to the other two levels), none of the comparisons was significant. Fixation preference of the biased NP was lower when the non-biased NP was accented relative to the No-Accent condition (after the onset of the pronoun at 400-600ms: b = 0.04, SE = 0.04, pMCMC = 0.05).

[Insert Figure 2 here]

In order to test whether this effect was found in both bias types (NP1 bias and NP2 bias) we added the factor of IC bias to an interaction term with the Accent factor. With this model, at 200-400ms following the onset of the pronoun, the effect of IC bias type was significant such that fixation preference of the biased NP was higher with NP2-biasing verbs than with NP1-biasing verbs (b = 0.14, SE = 0.04, pMCMC < 0.001) and correspondingly, fixation preference of the non-biased NP was lower with NP2-biasing verbs than with NP1-biasing verbs (b = 0.12, SE = 0.04, pMCMC < 0.005). These two IC bias type effects essentially reflect the overall higher fixation preference of NP2 clearly visible in Figure 3. With this model, the effect of Accent was no longer significant in this time window. At 400-600ms after the onset of the pronoun the same IC bias type effect was found as in the 200-400ms time window (biased NP fixation

preference: b = 0.1, SE = 0.04, pMCMC < 0.01; non-biased NP fixation preference: b = 0.09, SE = 0.04, pMCMC < 0.05). The effect of Accent was significant in this time window, showing higher fixation preference of the non-biased NP when the non-biased NP was accented relative to the No-Accent condition (b = 0.07, SE = 0.03, pMCMC < 0.05). In the corresponding analysis of the biased NP fixation preference, the effect of Accent was marginally significant, showing a decrease in fixation preference of the biased NP when the non-biased NP was accented relative to the No-Accent condition (b = 0.06, SE = 0.03, pMCMC < 0.07). Figure 3 displays fixation preferences of the biased and non-biased NPs under the different accent conditions with NP1-biasing verbs (panel A) and with NP2-biasing verbs (panel B). These plots portray the different fixation preference patterns unfolding under the different IC bias type conditions, time-locked to the onset of *because* and resynchronized for the onset of the pronoun (following: Altmann & Kamide, 2009; Brown-Schmidt, 2012). Overall, it appears that at the onset of the pronoun, participants are looking more at NP2, thus with NP2-biasing verbs participants are already looking more at the biased NP (NP2) when they begin hearing the pronoun. With NP1-biasing verbs however, participants begin switching their looks more towards the biased NP (NP1 in this case) and away from the non-biased NP (NP2). The modulation of these fixation preferences, however, was similar in both cases in the sense that fixation preference of the non-biased NP was slightly, but significantly, higher when the non-biased NP was accented relative to the No-Accent condition.

[Insert Figure 3 here]

Discussion

The study presented here examined a special case of a pivotal aspect of discourse understanding, namely, the co-indexing of a pronoun and its referent. . There is extensive literature showing that syntactic and semantic considerations heavily determine sentence processing, however, the current study highlights the role of other types of information in sentence comprehension, particularly in the process of referential processing in causality structures. The interaction of two very different sources of information, inherent verb biases and prosodic cues, and their contribution to the process prior to lexical disambiguation was directly tested. The findings suggest that both of these types of information are available and influential during the dynamic process of pronoun resolution. Different properties of antecedents have been shown to affect their likelihood to be pronouns' referents, for example: subjecthood, topichood and semantic plausibility (Arnold, 1998). The relative contribution of different factors is likely structure dependent. In some cases, as the sentences studied here, probabilistic information regarding co-reference (IC bias) seems to play a significant role. In line with pervious eye-tracking findings (Cozijn et al., 2011; Pyykkonen & Jarvikivi, 2010), IC verb bias information was shown to have an effect on the process prior to lexical disambiguation. In addition, the current study sheds more light on a particular case in which IC verb biases are, in effect, misleading. In some (likely infrequent) cases, IC biases are not borne out and instead it is the non-biased NP that is the referent of an upcoming pronoun. However, it is likely that the spoken language comprehension system has a means to deal with these situations in order to ensure smooth processing in spite of the unexpected

occurrence. The current investigation focused on the possibility that contrastive accent can play such a facilitative role.

Indeed, the findings presented here suggest that prosody can play a facilitative role in the process of reference resolution as previously shown with NP anaphors (Arnold, 2008; Brown-Schmidt et al., 2005; Dahan et al., 2002; Eberhard et al., 1995; Ito & Speer, 2008; Sedivy et al., 1999; Venditti et al., 2003; Weber et al., 2006) and pronominal anaphors (Brown-Schmidt et al., 2005; Cowles et al., 2007; Solan, 1980; Taylor et al., 2009; Venditti et al., 2001, 2002; Venditti et al., 2003). As demonstrated with sluicing sentences (Carlson et al., 2009) and cleft structures (Cowles et al., 2007), here too, accenting a potential antecedent's name influenced the interpretation of an anaphor appearing downstream. Specifically for an IC bias context, contrastively accenting the non-biased NP can influence the process of pronoun resolution in a facilitative way, namely, it seems to point the system in the right direction and away from associating the pronoun with the biased NP. Overall, response accuracy was lower with bias-inconsistent trials; however, participants were more accurate in their response in such trials when the non-biased NP carried contrastive accent (in comparison with the accent neutral condition). In other words, selecting the non-biased NP as the referent of the pronoun seems to have been made easier thanks to the contrastive accent applied to the non-biased NP. In addition, online eye tracking evidence supports this conclusion since fixation preference of the non-biased NP following the onset of the pronoun was increased when the non-biased NP was accented in comparison with the accent-neutral condition. Though this

modulation was rather subtle, the results point towards a facilitative role of contrastive accent in the less probable event in which the non-biased NP is in fact the referent of the pronoun. This is in line with previous research showing the role of contrastive accent as an efficient indicator of reference change relative to an unaccented counterpart (e.g., Dahan et al., 2002; Ito & Speer, 2008; Weber et al., 2006). Similarly to Cowles et al. (2007), we were able to demonstrate that differing accent patterns applied to potential antecedent names early in a sentence may affect the interpretation of a later-appearing anaphor. The eye-tracking evidence provided in the current study, however, demonstrates such use of prosodic information online prior to lexical disambiguation. This is important because it highlights the proactive role that prosody can play in referential processing. The use of prosodic information from earlier in the sentence was triggered by the appearance of the pronoun. This information allowed the system to appropriately adjust its predictions regarding the referential identity of the pronoun without having to rely solely on late lexical disambiguation.

Nonetheless, it must be noted that the contrastive accent effect revealed here was of a relatively modest magnitude. Although there was a statistically significant increase in the non-biased NP fixation preference ratio when the non-biased NP was contrastively accented (relative to the No-Accent condition) we suspect that this modulation was limited in magnitude due to some of our materials. In particular, in the condition where the non-biased NP was accented, the scope of the contrast implied by the accent is not entirely unambiguous. The possibility always remains that the contrast intended by accenting *John* in *JOHN*

envied Bill… reflects an assertion that it was John and not other (unmentioned) people who was envious of Bill. This interpretation of accent may have dampened the effect of accent in relation to the referential ambiguity of the pronoun. Importantly, the presence of a condition in which the biased NP was accented, which was included in order to ensure a fully counterbalanced experimental design, may have steered interpretations in this direction even more. That is, when the biased NP was accented (e.g., *John envied BILL…*), interpreting the accent as contrasting the two characters in terms of their potential role as the pronoun's referent would have made little sense. Since Bill is already strongly implied by the bias as the pronoun's referent, it is less likely that a speaker would produce an accent on Bill in order to contrast the NP with John in terms of their referential roles. It would be much more plausible to interpret accent here as contrasting Bill with other (unmentioned) people of whom John could be envious. It appears, then, that the possibility of interpreting the contrastive accent in our materials in a way other than contrasting the potential referents of the pronoun may have weakened the facilitative role of accent in question. Had the experiment not included the condition in which the biased NP was accented, or if the materials were such that the possible scope of contrast was restricted to the one related to the referential ambiguity, we might have seen a stronger effect of accent in the process of pronoun resolution. A richer context may restrict the likely contrasts, as is probably the case in natural communication, and in such case the use of accent to portray the reference-related contrast discussed here may be clearer and more effective.

Alternatively, there may be other configurations of sentence prosody which are better suited for achieving the desired facilitative effect than the particular manipulation used in our materials. One such possibility would be to accent both the non-biased NP and the pronoun in the same sentence, for example*: JOHN envied Bill because HE was poor*. A somewhat similar prosodic manipulation was shown to change the interpretation of ambiguous gapping ellipsis sentences (Carlson et al., 2009), although in this case the ambiguity was more structural than referential in nature. Another aspect that should be examined are characteristics of global sentence accentuation patterns which have been suggested to play a role in pronominal resolution (Jasinskaja, Kolsch, & Mayer, 2007).

Conclusion

In sum, contrastive accent seems to play a facilitative role in reference resolution, steering the system away from blindly following a lexical bias which is often, but crucially not always, reliable. The influence of contrastive accent is apparent upon processing the pronoun and prior to disambiguating information, allowing adjustment of reference assignment predictions at early stages of processing. The results revealed an influence of prosody, albeit small, supporting its role in reference resolution. The significance of this finding lies in its demonstration that prosodic information can facilitate language processing in the context of a probabilistic cue. Thus, probabilistic cues can be relied upon since even in the rare cases when they are misleading there are means that can lower the likelihood of misinterpretations. With better control of materials in terms of

contrast scope, as well as addressing the role of additional prosodic cues, future studies may reveal an even stronger influence.

Table 1 - Example of discourse stimulus materials

Context sentence:	*John and Bill both care about money a lot*
Critical sentence:	
Bias-consistent ending:	
NP1 Accented	***JOHN*** *envied* Bill when they were young because he came from a rich family*
NP2 Accented	*John envied* ***BILL*** *when they were young because he came from a rich family*
No-Accent	*John envied Bill when they were young because he came from a rich family*
Bias-inconsistent ending:	
NP1 Accented	***JOHN*** *envied Bill when they were young because he came from a poor family*
NP2 Accented	*John envied* ***BILL*** *when they were young because he came from a poor family*
No-Accent	*John envied Bill when they were young because he came from a poor family*
Question:	*Who came from a rich family? / Who came from a poor family?*

*The verb *envied* in the example is an NP2-biasing verb.

	Mean duration (ms)	Mean F0 (Hz)	Mean amplitude (dB)
Acoustic measures of **NP1**			
No-Accent	323 (SD = 68)	214 (SD = 15)	71 (SD = 1)
NP1-Accented	527 (SD = 99)	253 (SD = 22)	72 (SD = 3)
NP2-Accented	301 (SD = 60)	205 (SD = 13)	70 (SD = 1)
Main effect of Accent condition	$F(2,190) = 570$, $p < 0.0001$	$F(2,190) = 387$, $p < 0.0001$	$F(2,190) = 46$, $p < 0.0001$
Significant post-hoc comparisons	NP1-Accented > No-Accent ($p < 0.0001$) NP1-Accented > NP2-Accented ($p < 0.0001$)	NP1-Accented > No-Accent ($p < 0.0001$) NP1-Accented > NP2-Accented ($p < 0.0001$)	NP1-Accented > No-Accent ($p < 0.0001$) NP1-Accented > NP2-Accented
Acoustic measures of **NP2**			
No-Accent	282 (SD = 66)	176 (SD = 11)	68 (SD = 2)
NP1-Accented	286 (SD = 62)	163 (SD = 8)	67 (SD = 3)
NP2-Accented	520 (SD = 105)	251 (SD = 21)	71 (SD = 2)
Main effect of Accent condition	$F(2,190) = 524$, $p < 0.0001$	$F(2,190) = 964$, $p < 0.0001$	$F(2,190) = 144$, $p < 0.0001$
Significant post-hoc comparisons	NP2-Accented > No-Accent ($p < 0.0001$) NP2-Accented > NP1-Accented ($p < 0.0001$)	NP2-Accented > No-Accent ($p < 0.0001$) NP2-Accented > NP1-Accented ($p < 0.0001$)	NP2-Accented > No-Accent ($p < 0.0001$) NP2-Accented > NP1-Accented
Acoustic measures of the p**ronoun**			
No-Accent	130 (SD = 39)	174 (SD = 8)	65 (SD = 2)
NP1-Accented	129 (SD = 41)	171 (SD = 19)	65 (SD = 3)
NP2-Accented	130 (SD = 39)	172 (SD = 20)	65 (SD = 2)
Main effect of Accent condition	n.s.	n.s.	n.s.
Significant post-hoc comparisons	-	-	-

Figure 1

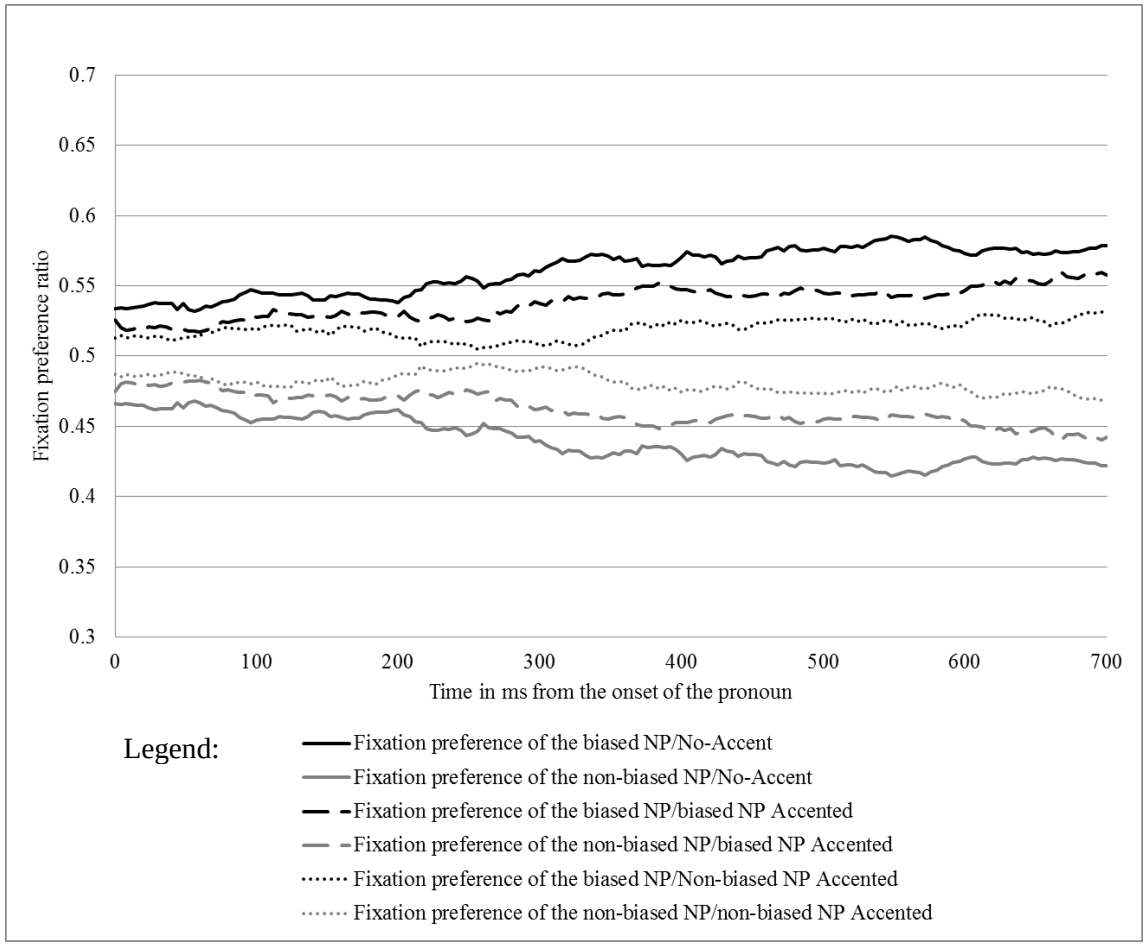
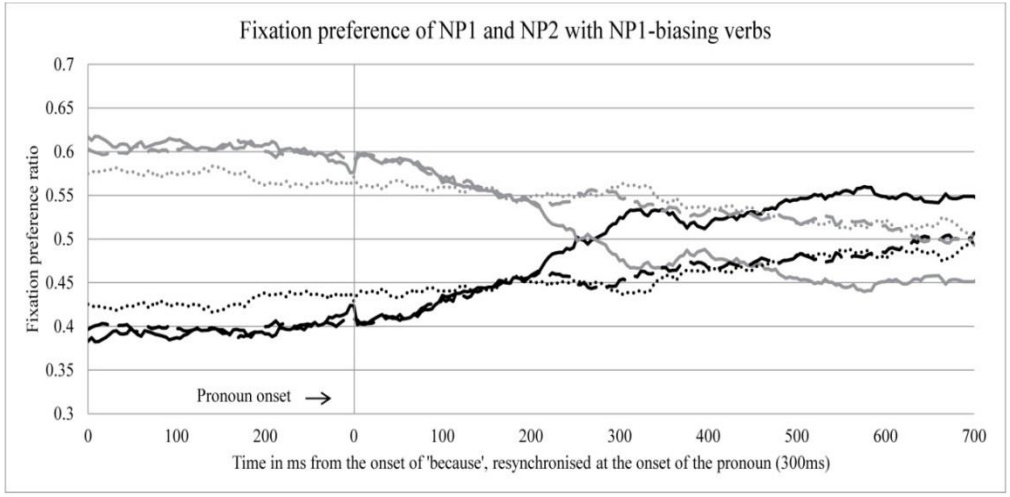
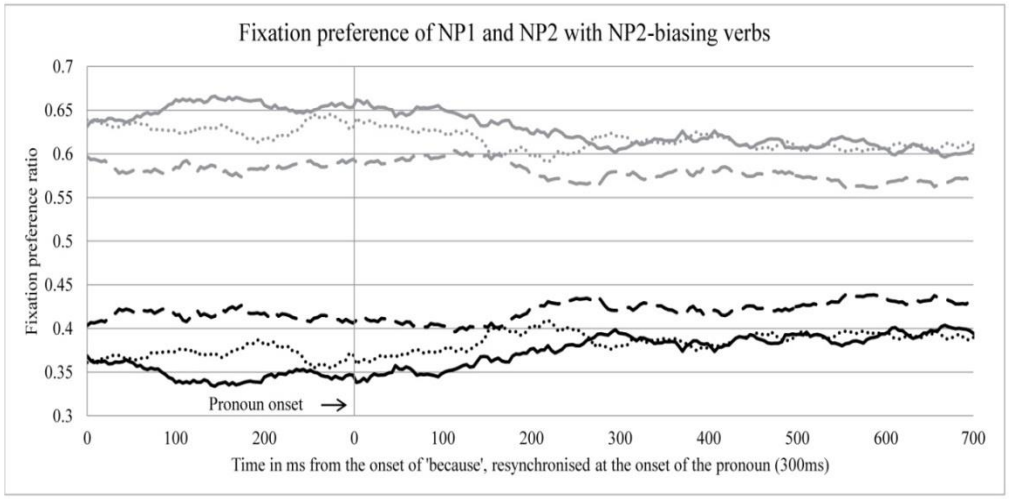

0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
Fixation preference ratio
0
100
200
300
400
500
600
700
Time in ms from the onset of the pronoun
Legend:
Fixation preference of the biased NP/No-Accent
Fixation preference of the non-biased NP/No-Accent
Fixation preference of the biased NP/biased NP Accented
Fixation preference of the non-biased NP/biased NP Accented
Fixation preference of the biased NP/Non-biased NP Accented
Fixation preference of the non-biased NP/non-biased NP Accented

Figure 2

A



B



Legend:

- Fixation preference of NP1/No-Accent
- Fixation preference of NP1/NP1-Accented
- Fixation preference of NP1/NP2-Accented
- Fixation proportions of NP2/No-Accent
- Fixation proportions of NP2/NP1-Accented
- Fixation proportions of NP2/NP2-Accented

Figure 3

* The x axis, representing time in ms, is resynchronized for the onset of the pronoun.

Figure captions:

Figure 1

Sample of visual display

Figure 2

Fixation preference ratios of the biased and the non-biased NPs following pronoun onset

Figure 3

Fixation preference ratios for NP1 and NP2 following the onset of *because*

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Appendix

Discourse stimuli sets. In each discourse, the second sentence contained an ambiguous pronoun (he/she). The the prosodic manipulation concerned the character names appearing at the beginning of the sentence such that either the first name, the second name or neither was accented.

NP1 BIASED VERBS	
1. *Confided in*	
Consistent	Jill and Meg were very close growing up. Jill confided in Meg when times were rough because she needed to share with someone close. Who needed to share with someone close?
Inconsistent	Jill and Meg were very close growing up. Jill confided in Meg when times were rough because she was the only one who listened. Who was the only one who listened?

2. Followed	
Consistent	Ben and Zach recently started going to the same college. Ben followed Zach around all week because he felt lost in the college. Who felt lost in the college?
Inconsistent	Ben and Zach recently started going to the same college. Ben followed Zach around all week because he knew the college very well. Who knew the college very well?
3. Frightened	
Consistent	Meg and Lynn met each other at a Halloween party last year. Meg frightened Lynn at first sight because she had a creepy ghost costume on. Who had a creepy ghost costume on?
Inconsistent	Meg and Lynn met each other at a Halloween party last night. Meg frightened Lynn at first sight because she is afraid of ghosts. Who is afraid of ghosts?
4. Amused	
Consistent	Lynn and Sue used to work long shifts together at the airport.

	Lynn amused Sue all the time because she made fun of the boss. Who made fun of the boss?
Inconsistent	Lynn and Sue used to work long shifts together at the airport. Lynn amused Sue all the time because she always needed cheering up. Who always needed cheering up?
5. *Confessed to*	
Consistent	Zach and Matt decided to help each other lose weight. Zach confessed to Matt about the cookies because he felt bad about breaking the diet. Who he felt bad about breaking the diet?
Inconsistent	Zach and Matt decided to help each other lose weight. Zach confessed to Matt about the cookies because he promised not to be judgmental. Who promised not to be judgmental?
6. *Scared*	
Consistent	Matt and Jeff renovated the apartment together yesterday. Matt scared Jeff the whole time because he didn't use the drill properly.

	Who didn't use the drill properly?
Inconsistent	Matt and Jeff renovated the apartment together yesterday. Matt scared Jeff the whole time because he is afraid of drills. Who is afraid of drills?
7. Telephoned	
Consistent	Sue and Beth planned to go to a concert together on Saturday. Sue telephoned Beth the day before because she found out that it was canceled. Who found out that it was canceled?
Inconsistent	Sue and Beth planned to go to a concert together on Saturday. Sue telephoned Beth the day before because she needs reminders often. Who needs reminders most times?
8. Delighted	
Consistent	Beth and Pam organized a dinner party together last week. Beth delighted Pam after the meal because she made a delicious cake. Who made a delicious cake?

Inconsistent	Beth and Pam organized a dinner party together last week. Beth delighted Pam after the meal because she didn't expect the delicious cake. Who didn't expect the delicious cake?
9. Disappointed	
Consistent	Pam and Deb decided to redecorate the house together. Pam disappointed Deb in the end because she hardly dedicated time to the project. Who hardly dedicated time for the project?
Inconsistent	Pam and Deb decided to redecorate the house together. Pam disappointed Deb in the end because she worked much harder than expected. Who worked much harder than expected?
10. Angered	
Consistent	Keith and Ed looked after the neighbor's dog last weekend. Keith angered Ed constantly because he would not clean up after the dog. Who would not clean up after the dog?
Inconsistent	Keith and Ed looked after the neighbor's dog last weekend.

	Keith angered Ed constantly because he had to do all the cleaning. Who had to do all the cleaning?
11. Intimidated	
	Ruth and Claire played basketball on opposing teams. Ruth intimidated Claire in most games because she was an aggressive player. Who was an aggressive player?
	Ruth and Claire played basketball on opposing teams. Ruth intimidated Claire in most games because she was not a good offensive player. Who was not a good offensive player?
12. Annoyed	
Consistent	Ed and Vince started planning a fundraiser for their hockey team last night. Ed annoyed Vince during the meeting because he kept repeating the same ideas. Who kept repeating the same ideas?
Inconsistent	Ed and Vince started planning a fundraiser for their hockey team last night.

	Ed annoyed Vince during the meeting because he had no patience for repetitions. Who had no patience for repetitions?
13. Impressed	
Consistent	Claire and Ann joined a gymnastics class recently. Claire impressed Ann in the first practice because she could already do a somersault. Who could already do a somersault?
Inconsistent	Claire and Ann joined a gymnastics class recently. Claire impressed Ann in the first practice because she couldn't even do a somersault. Who couldn't even do a somersault?
14. Troubled	
Consistent	Ann and Jill each got a new music player for the holidays. Ann troubled Jill after a while because she was playing the music very loudly. Who was playing the music very loudly?
Inconsistent	Ann and Jill each got a new music player for the holidays. Ann troubled Jill after a while because she knew how damaging loud music is.

	Who knew how damaging loud music is?
15. Bored	
Consistent	Jill and Lynn got together for coffee last Monday. Jill bored Lynn the entire time because she kept talking about the weather. Who kept talking about the weather?
Inconsistent	Jill and Lynn got together for coffee last Monday. Jill bored Lynn the entire time because she disliked discussing the weather. Who disliked discussing the weather?
16. Deceived	
Consistent	Meg and Sue owned a jewelry store together. Meg deceived Sue last April because she was greedy and manipulative. Who ran off with the money?
Inconsistent	Meg and Sue owned a jewelry store together. Meg deceived Sue last April because she was naïve and trusting. Who was naïve and trusting?
17. Infuriated	
Consistent	Vince and Tom shared most of their clothes.

	Vince infuriated Tom last Saturday because he completely ruined the new jacket. Who completely ruined the new jacket?
Inconsistent	Vince and Tom shared most of their clothes. Vince infuriated Tom last Saturday because he found the new jacket completely torn. Who found the new jacket completely torn?
18. Called	
Consistent	Tom and Scott always looked out for each other in school. Tom called Scott late last night because he heard about the crazy bully. Who heard about the crazy bully?
Inconsistent	Tom and Scott always looked out for each other in school. Tom called Scott late last night because he had to be warned about the bully. Who had to be warned about the bully?
19. Fascinated	
Consistent	Beth and Deb decided to cook an Italian meal yesterday. Beth fascinated Deb during the cooking because she made

	spaghetti from scratch. Who made spaghetti from scratch?
Inconsistent	Beth and Deb decided to cook an Italian meal yesterday. Beth fascinated Deb during the cooking because she never saw spaghetti made from scratch. Who never saw spaghetti made from scratch?
20. Amazed	
Consistent	Scott and Roy went training together at the gym. Scott amazed Roy during the training because he was so strong and determined. Who was so strong and determined?
Inconsistent	Scott and Roy went training together at the gym. Scott amazed Roy during the training because he never saw such determination. Who never saw such determination?
21. Apologized	
Consistent	Roy and Ben had a nice glass window in their room until the ball broke it into pieces. Roy apologized to Ben for the accident because he felt guilty about

	the whole thing. Who felt guilty about the whole thing?
Inconsistent	Roy and Ben had a nice glass window in their room until the ball broke it into pieces. Roy apologized to Ben for the accident because he never forgives without an apology. Who never forgives without an apology?
22. Lied to	
Consistent	Ben and Matt accidently stumbled upon the pile of presents in the closet on Tuesday. Ben lied to Matt about it because he didn't want to ruin the surprise. Who didn't want to ruin the surprise?
Inconsistent	Ben and Matt accidently stumbled upon the pile of presents in the closet on Tuesday. Ben lied to Matt about it because he was not supposed to see it. Who was not supposed to see it?
23. Competed	
Consistent	Zach and Jeff both played chess regularly. Zach competed with Jeff almost every week because he wanted to have a better technique. Who wanted to have a better technique?

Inconsistent	Zach and Jeff both played chess regularly. Zach competed with Jeff almost every week because he was very easy to beat. Who was very easy to beat?
24. Inspired	
Consistent	Keith and Vince shared a dream to learn how to play the drums. Keith inspired Vince later on because he became a famous drummer. Who became a famous drummer?
Inconsistent	Keith and Vince shared a dream to know how to play the drums. Keith inspired Vince later on because he saw that it was possible. Who saw that it was possible?

NP2 BIASED VERBS

1. Hated	
Consistent	Tom and Roy used to go skiing together as kids. Tom hated Roy during that time because he always pushed people on the hill. Who always pushed people on the hill?
Inconsistent	Tom and Roy used to go skiing together as kids. Tom hated Roy during that time because he didn't appreciate the constant pushing. Who didn't appreciate the constant pushing?
2. Envied	
Consistent	Pam and Ruth both cared a lot about money. Pam envied Ruth when they were young because she came from a rich family. Who came from a rich family?
Inconsistent	Pam and Ruth both cared a lot about money. Pam envied Ruth when they were young because she came from a poor family. Who came from a poor family?
3. Pitied	
Consistent	Scott and Ed both really wanted to learn to play guitar.

	Scott pitied Ed for some time because he couldn't afford the lessons. Who couldn't afford the lessons?
Inconsistent	Scott and Ed both really wanted to learn to play guitar. Scott pitied Ed for some time because he had an easier time learning it. Who had an easier time learning it?
4. Despised	
Consistent	Zach and Keith both worked as computer technicians. Zach despised Keith after some time because he always pulled mean scams. Who always pulled mean scams?
Inconsistent	Zach and Keith both worked as computer technicians. Zach despised Keith after some time because he knew about the mean scams. Who knew about the mean scams?
5. Liked	
Consistent	Jeff and Vince met at a cocktail party last week. Jeff liked Vince right away because he kept telling funny jokes. Who kept telling funny jokes?

Inconsistent	Jeff and Vince met at a cocktail party last week. Jeff liked Vince right away because he really enjoyed hearing jokes. Who really enjoyed hearing jokes?
6. Congratulated	
Consistent	Ben and Scott got their black belts in Karate last week. Ben congratulated Scott on the occasion because he worked really hard for it. Who worked really hard for it?
Inconsistent	Ben and Scott got their black belts in Karate last week. Ben congratulated Scott on the occasion because he felt compelled to do so. Who felt compelled?
7. Loved	
Consistent	Ann and Beth got to know each other when they were roommates. Ann loved Beth whole-heartedly because she was so sweet and lovable. Who was so sweet and lovable?

Inconsistent	Ann and Beth got to know each other when they were roommates. Ann loved Beth whole-heartedly because she felt a strong sisterly bond. Who felt overflowing with love?

8. Detested

Consistent	Ruth and Meg used to exchange stamps with each other. Ruth detested Meg after some time because she wasn't being fair any more. Who wasn't being fair anymore?
Inconsistent	Ruth and Meg used to exchange stamps with each other. Ruth detested Meg after some time because she felt taken advantage of. Who felt taken advantage of?

9. Admired

Consistent	Vince and Roy liked to train in boxing when they were in college. Vince admired Roy back in those days because he knew how to take a punch. Who knew how to take a punch?
Inconsistent	Vince and Roy liked to train in boxing when they were in college. Vince admired Roy back in those days because he valued good

	punching skills. Who valued good punching skills?
10. Corrected	
Consistent	Tom and Jeff went over their chemistry homework together yesterday. Tom corrected Jeff on the first question because he got the answer wrong. Who got the answer wrong?
Inconsistent	Tom and Jeff went over their chemistry homework together yesterday. Tom corrected Jeff on the first question because he knew the right answer. Who knew the right answer?
11. Loathed	
Consistent	Jill and Pam worked at the same shoe shop a couple of years ago. Jill loathed Pam quite early on because she gossiped about all the girls. Who gossiped about all the girls?
Inconsistent	Jill and Pam worked at the same shoe shop a couple of years ago. Jill loathed Pam quite early on because she didn't like the constant

	gossiping. Who didn't like the constant gossiping?
12. Honored	
Consistent	Roy and Ed were both firefighters. Roy honored Ed at the party because he saved a cat from a fire. Who saved a cat from a fire?
Inconsistent	Roy and Ed were both firefighters. Roy honored Ed at the party because he wished to express the station's gratitude. Who wished to express the station's gratitude?
13. Distrusted	
Consistent	Scott and Matt were supposed to start a car rental business last year. Scott distrusted Matt however because he had been dishonest before. Who had been dishonest before?
Inconsistent	Scott and Matt were supposed to start a car rental business last year. Scott distrusted Matt however because he had been lied to before. Who had been lied to before?

14. Praised	
Consistent	Deb and Lynn tried out for the cheerleading team. Deb praised Lynn in front of the girls because she was a good performer. Who was a good performer?
Inconsistent	Deb and Lynn tried out for the cheerleading team. Deb praised Lynn in front of the girls because she enjoyed giving nice compliments. Who enjoyed giving nice compliments?
15. Noticed	
Consistent	Ann and Sue were both at the beach last Saturday. Ann noticed Sue in the crowd because she was wearing a red bikini. Who was wearing a red bikini?
Inconsistent	Ann and Sue were both at the beach last Saturday. Ann noticed Sue in the crowd because she was finally wearing glasses. Who was finally wearing glasses?
16. Trusted	
Consistent	Beth and Claire used to lend each other books when they lived in

	Toronto. Beth trusted Claire with the books because she has proven to be trustworthy. Who has proven to be trustworthy?
Inconsistent	Beth and Claire used to lend each other books when they lived in Toronto. Beth trusted Claire with the books because she knew whom to trust. Who knew whom to trust?
17. Comforted	
Consistent	Lynn and Pam were very close when they were neighbors. Lynn comforted Pam after the fire because she needed someone to talk to. Who needed someone to talk to?
Inconsistent	Lynn and Pam were very close when they were neighbors. Lynn comforted Pam after the fire because she wanted to be supportive. Who she wanted to be supportive?
18. Scolded	
Consistent	Tom and Ben were each supposed to vacuum a part of the house

	yesterday. Tom scolded Ben this morning because he didn't vacuum the living room. Who didn't vacuum the living room?
Inconsistent	Tom and Ben were each supposed to vacuum a part of the house yesterday. Tom scolded Ben this morning because he started feeling very aggravated. Who started feeling very aggravated?
19. Feared	
Consistent	Meg and Deb got lost in the woods last summer. Meg feared Deb at the time because she was known to have a short temper. Who was known to have a short temper?
Inconsistent	Meg and Deb got lost in the woods last summer. Meg feared Deb at the time because she has been traumatized before. Who has been traumatized before?
20. Criticized	
Consistent	Claire and Deb were both on the environmental committee this

	semester. Claire criticized Deb at the last meeting because she always arrived very late. Who always arrived very late?
Inconsistent	Claire and Deb were both on the environmental committee this semester. Claire criticized Deb at the last meeting because she was requested to do so. Who was requested to do so?
21. Rushed to	
Consistent	Ruth and Lynn were supposed to visit the museum yesterday. Ruth rushed to Lynn in the parking lot because she needed to get CPR. Who needed to get CPR?
Inconsistent	Ruth and Lynn were supposed to visit the museum yesterday. Ruth rushed to Lynn in the parking lot because she knew how to do CPR. Who knew how to do CPR?
22. Hired	
Consistent	Zach and Vince knew each other since law school.

	Zach hired Vince last October because he was the best candidate.
	Who was the best candidate?
Inconsistent	Zach and Vince knew each other since law school.
	Zach hired Vince last October because he felt obliged to do so.
	Who felt obliged?
23. Sued	
Consistent	Pam and Ann used to be friends until the incident with the camera.
	Pam sued Ann last November because she stole the digital camera.
	Who stole the digital camera?
Inconsistent	Pam and Ann used to be friends until the incident with the camera.
	Pam sued Ann last November because she was forced to do so.
	Who was forced?
24. Believed	
Consistent	Keith and Tom were both suspected of stealing the trophy.
	Keith believed Tom all along because he was known to be honest.
	Who was known to be honest?
Inconsistent	Keith and Tom were both suspected of stealing the trophy.
	Keith believed Tom all along because he had every reason to.
	Who had every reason?