Gender and dominance in action: World view and emotional affect in language processing and use

by

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Abstract

This dissertation examines the association between the emotional dominance of verbs and the perception, or inference, of character gender. In the context of this dissertation, emotional dominance is described as the perceived level of power, or control, exerted by a verb. I hypothesize that when actions are perceived as having higher levels of control, and thus a character has a high level of control over the verbal event (in an active, transitive sentential construction), there is a stronger association with male characters. Accordingly, when a verb is perceived to have a lower level of emotional dominance, there is a stronger association with female characters. Throughout the dissertation, the validity of this claim and the possible sources of such a cognitive association are explored through a multi-methodological and multi-modal approach. This investigation begins with a corpus-based analysis into patterns of co-occurrence between verbs and gender-marked verbal arguments. I continue through a series of five experimental psycholinguistic experiments that focus on the association between emotional dominance and character gender through two modalities: implicit causality bias and gender stereotypical roles and occupations. A sentence completion task utilizing implicit causality bias provides evidence that participants are more likely to assign cause to male characters for actions perceived as being high dominance, and to female characters for actions perceived as low dominance. Throughout four reading tasks, I find converging evidence that the association between gender and dominance significantly affects measures of reading time. Significant interactions are reported based on the dominance of verbs and the gender of stereotypical roles and occupations, gender-marked pronouns and implicit causality bias focussed characters. Throughout all four reading studies, this association appears through

faster processing times between low dominance and female characters and high dominance and male characters. The evidence suggests that the activation of this association may occur early in processing and that it can be used incrementally throughout discourse processing to update the mental representation. These findings provide initial evidence that, at least for native speakers of North American English, the emotional dominance of verbs may play a role in how language users perceive gender. A better understanding of the association between emotional dominance and character gender may provide a greater understanding of the processes involved in interpreting factors that affect verbal argument structure, inference production, and the mental representation of language.

Preface

This thesis is an original work by Caelan Marrville. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Verbs and Gender during auditory and visual sentence processing", No. Pro00053260, 20 December 2012 and Project Name "Effects of emotional dominance during online sentence completion task", No. Pro00066201, 18 July 2016.

The research conducted in this dissertation was completed in collaboration with Dr. Juhani Järvikivi and Dr. Antti Arppe. Dr. Järvikivi assisted in concept formulation for the dissertation and experimental design and data analysis throughout the experimental psycholinguistic chapters. Dr. Arppe assisted with computational techniques and data analysis in the corpus linguistic chapter. Dr. Järvikivi, Dr. Arppe and Dr. Herbert Colston assisted in the manuscript editing. I was responsible for experiment design, data collection, analysis, and manuscript composition. No part of this dissertation has been previously published.

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I would not have accomplished this without the inspiration of my high school Latin teacher, Mr. John McIntyre, who instilled in me a passion for language.

I owe a great deal to my mother and father for teaching me to, first and foremost, do what makes me happy, and for providing me with the opportunities that made this possible. Thank you, too, to my sister for always lending an ear.

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Chapter 1

Introduction

The motivation for the research undertaken in this dissertation comes from an effort to understand how language users process emotional properties of words and how this emotional content influences the perception of people and events in discourse. From a linguistic perspective, the task of reading, for example, is a complex process that requires cognitive attention starting from the recognition of printed characters and words, to the mental construction of an abstract representation of what has been read. Throughout the task, readers make use of additional sources of information beyond the letter forms and linguistic structure of text in order to facilitate processing. The mental narrative of language incorporates general world knowledge stemming from encyclopaedic information, personal attitudes and life experiences in order to help enrich our mental representation and facilitate processing (*e.g.*, Gernsbacher, 1996; Graesser, Singer & Trabasso, 1994). The over-arching research goal proposed in this dissertation is to investigate the emotional characteristics of words and how, taken as a probabilistically learned association between language and emotion, readers access this emotional content while making inferences, and how such inferences affect the interpretation of an utterance and are reflected in the end product of production processes.

This dissertation will investigate emotional properties in relation to verbs, specifically looking into the role of the emotional dimension of dominance (Osgood, Suci & Tannenbaum, 1957). We will show that emotional dominance may affect the perception of the gender of characters expressed in written discourse during reading comprehension. We will further show that patterns in dominance and gender may

be reflected in corpus-based language and when language users produce sentences though a completion task. The proposed research seeks to contribute to our understanding of 1. the factors influencing the inference-based structure of a reader's mental narrative during text comprehension; 2. how the emotional dimension of dominance is processed in verbs; 3. the nature of gender in inference processing; 4. whether inferences based on the dominance of a verb may influence gender assignment to characters in the reader's mental representation; and if so, 5. the time course through which readers have access to dominance-based information.

We will begin with a review of the relevant literature, focussing on the effects of emotion and gender information on the processing of verbs, especially during inference production. To investigate the role of emotional dominance, we will focus on two well established linguistic phenomena that have been found to affect the processing of gender inference, namely, gender-based stereotypes in role and occupation names and implicit causality bias. In what follows, we will use gender-based stereotypes and implicit causality bias in order to assess effects of emotional dominance in the inference of a character's gender during discourse processing.

1.1 Language processing

This dissertation assumes the perspective that language draws on general cognitive processes and mechanisms (Bybee & Beckner, 2010; Gernsbacher, 1991, 1996). The capacity to use language relies on mechanisms integrated into the functions of cognition, and is not part of a modular, independent structure. Therefore the language task - from processing to production - relies on skills, cognitive processes and anatomical mechanisms that humans rely on for every day, non-linguistic tasks. The processes that underlie the capacity to understand and utilize language are integrated into and have evolved throughout the development of human cognition. For example, in an embodied approach to language and cognition, language is processed and relies on neural systems for perception, action and emotion (Glenberg, Webster, Mouilso, Havas & Lindeman, 2009). Evidence suggests that the neurological systems used in perception, action and emotion affect many

language processes, including lexical access (Borghi, Glenberg & Kaschak, 2004), syntactic analysis (Chambers, Tanenhaus & Magnuson, 2004), and sentence comprehension (Zwaan & Taylor, 2006). Concepts are mapped to anatomical sensorimotor processes and modality-independent representations (Mahon, 2015; Zwaan, 2014). None of these neurological systems are language-independent, but part of a more system-wide structure.

Throughout this dissertation we will take the perspective that as a reader or listener receives segmental input from the language source, it is processed immediately and is adapted into a mental representation of the discourse (Canal, Garnham & Oakhill, 2015; Curiel & Radvansky, 2014; Gernsbacher, 1996; Huff, Meitz & Papenmeier, 2014; Zwaan, 2014, 2016; Zwaan & Radvansky, 1998; Zwaan, Radvansky, Hilliard & Curiel, 1998). We adopt a framework where sentence processing is done online and incrementally, which enables language users to elaborate and make inferences as language input is processed (Altmann & Kamide, 1999; Arnett & Wagers, 2017; Caplan, Hildebrandt & Waters, 1994; de Hoop & Lamers, 2006; Fukumura & van Gompel, 2015; Kamide, Altmann & Haywood, 2003; Kehler, Kertz, Rohde & Elman, 2008; Kurby & Zacks, 2012; Troyer, Hofmeister & Kutas, 2016).

During discourse processing, language users create a mental representation of the information they are receiving. Depending on how extensive their knowledge and experience of a topic or fluency in a language, the representation can be more or less concrete (Zwaan, 2014). The representation can be diverse and include a first-person simulation of events, a shallow representation based on interconnected word-level conceptions, or a rudimentary interpretation of the information (Just & Carpenter, 1987; Singer, Graesser & Trabasso, 1994; Taylor & Zwaan, 2009; van Dijk & Kintsch, 1983; Zwaan, 2016). Mental representations of discourse (*i.e.*, situation models) have been theorized to function differently for abstract and concrete subject matter and may involve the activation of sensorimotor representations through mental simulation (Barsalou & Wiemer-Hastings, 2005; Zwaan, 2016). Barsalou (1999) notes that mental simulation (*i.e.*, through situation models) should not be equated to mental imagery, as mental imagery is a conscious and highly demand-

ing process. Mental simulation should be assumed to be a subconscious and routine process of cognition.

Though situation models are constructed along at least five key dimensions, including time, space, the protagonist, the causation and motivation of characters and events (Zwaan, Langston, Graesser & Magliano, 1995), for the purpose of our research, we are most interested in character shifts. Character shifts are changes to the mental representation particularly focussed on how language users perceive a character, including physical features, but also motivations, drive and actions. As Curiel & Radvansky (2014) summarize, readers regularly track events across time and location by orienting situations around a central character (Radvansky, Spieler & Zacks, 1993). Information about event sequences, causal structure and the goals of actions and reactions are often understood through reference to a character. Therefore, shifts in a reader's perspective toward a character (in our case, based on their gender) can lead to major changes in the interpretation of a described situation.

Updating the situation model can occur incrementally (Gernsbacher, 1990; Zwaan, Magliano & Graesser, 1995), where parts of the model are updated as new information is processed, and globally, where incremental information requires a new model to replace an existing one (Kurby & Zacks, 2008, 2012). Part of the argument in favour for this subconscious production of mental representation during language comprehension comes from evidence that language users make elaborative, or predictive, inferences during comprehension.

Zwaan & Pecher (2012) report results of replication studies where effects have been found using a sentence-picture verification task (Connell, 2007; Stanfield & Zwaan, 2001; Zwaan, Stanfield & Yaxley, 2002). While hearing a sentence, participants make inferences regarding characteristics of referenced items on the basis of orientation (Stanfield & Zwaan, 2001), shape (Zwaan et al., 2002), and colour (Connell, 2007). For example, compare the sentences *The eagle was in the sky* and *The eagle was in the nest*. After hearing these sentences, participants saw a line drawing of an eagle, either with its wings stretched wide, or with its wings drawn in. Participants were asked whether one of the images was contained in the previ-

ous sentence. Zwaan et al. (2002) and Zwaan & Pecher (2012) report a significant match effect, where participants had a greater chance of reporting that the image was contained in the previous sentence when the image referenced the shape implied by the story. Participants associated the image of a bird with its wings spread wide with the sentence *The eagle was in the sky* because the sentence implies that the bird was in flight. This is cited as evidence that during language processing, readers mentally reproduce a simulated model of what they are processing.

Further evidence for the incremental processing of language comes from studies of selectional restrictions while tracking eye movement during sentential processing. Selectional restrictions are the semantic constraints that verbs impose on the thematic roles of noun phrases within their argument structure (Caplan et al., 1994; Chomsky, 1965). For example, the verb *eat* requires an animate agent. Throughout our research on interpersonal verbs, we will refer to the semantic agent, or syntactic subject as noun phrase one (NP1) and the semantic patient, or syntactic object as noun phrase two (NP2), as in *NP1 [verbed] NP2*.

Altmann & Kamide (1999) used a visual world paradigm to track eye movement during auditory sentence processing. They found that listeners begin to infer the likely identity of a post-verb noun phrase (NP2) after hearing the verb. When looking at images containing a boy, a toy train set, a toy car, a balloon and a birthday cake, listeners were statistically more likely to look to the cake when hearing *The boy will eat* than when hearing *The boy will move*. Altmann & Kamide (1999) reason that since only one of the objects in the image met the selectional restriction of the verb *eat* (*i.e.*, the restriction that the item be edible), the probability of looking at the target (the cake) prior to the onset of the post-verb NP2 was greatly increased. Kamide et al. (2003) continue this line of research, incorporating restrictions on noun phrases into their experiment. In a follow-up visual word experiment, listeners were statistically more likely to look at images of a motorbike after hearing *The man will ride*, than to look at images of a carousel. They concluded that the restrictions on *man*, combined with the restrictions of *ride* lead readers to infer that the most probable continuation of the sentence would include an item in the scene that is likely to be ridden, and has a higher probability to be

ridden by an adult. After the off-set of the target word(s), listeners were already making probability-based predictions about the likely target. As each word in an utterance is processed, it is incrementally worked into the mental narrative of the discourse. Hence, listeners infer probable future content based on current content. Although, whether population (*e.g.,* children, adults, second language learners), task, or cognitive resources affects incremental inference production, as well as its strategic or automatic use in discourse processing, is still under debate (Huettig, 2015). This is just a brief example of how, due to the incremental processing of language, language users are able to predict, or make inferences, about the content of an utterance. In what follows, we will explore how language users perform this task within the domains of emotion and gender.

1.2 Emotional affect

For the purpose of this research, we assume a three dimensional theory of emotion, defined by dominance, valence, and arousal (Osgood et al., 1957). In this theory, dominance is defined as the degree of control or power provoked from a particular item, valence as the degree of happiness, or positivity/negativity provoked, and arousal as the degree of excitement provoked (Kuperman, Estes, Brysbaert & Warriner, 2014; Osgood et al., 1957; Russell & Mehrabian, 1977; Warriner, Kuperman & Brysbaert, 2013). Table 1.1 contains examples of verbs by valence, arousal and dominance.

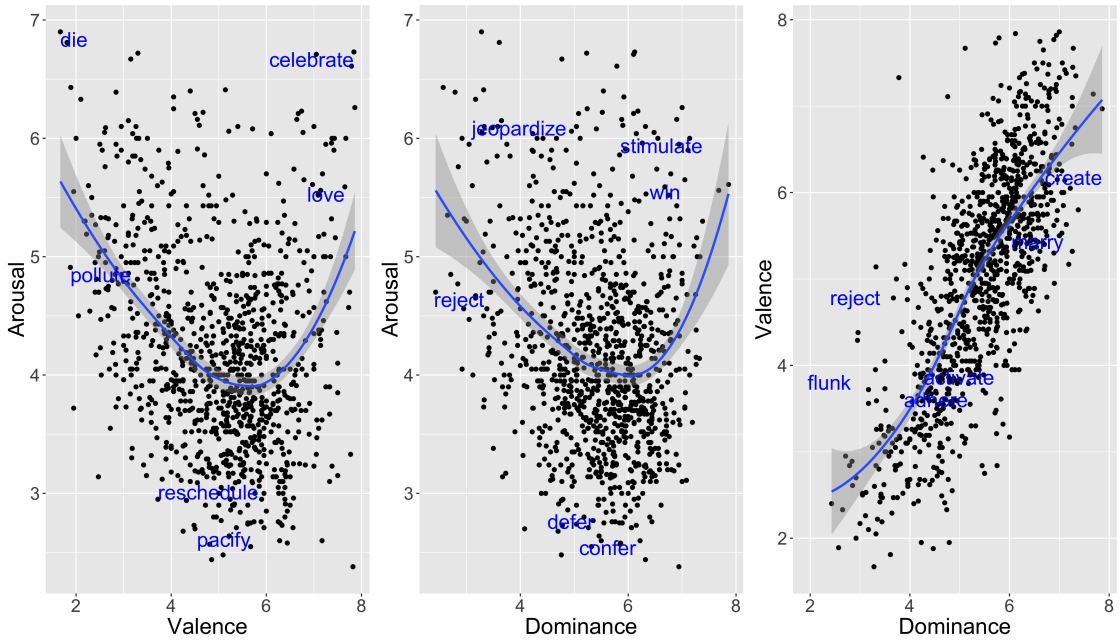
Table 1.1: Sample of verbs from the extreme high and low values for each of the three dimensions of emotional affect

	Valence		Arousal		Dominance	
High	create	7.86	die	6.90	win	7.86
	celebrate	7.84	provoke	6.72	rejoice	7.68
	excite	7.79	succeed	6.71	outsmart	7.38
Low	die	1.67	relax	2.38	reject	2.43
	kill	1.81	confer	2.48	addict	2.84
	pollute	1.88	pacify	2.55	foreclose	2.92

Warriner et al. (2013) report on the relationships between these three dimensions of emotional affect amongst all content words in their study. Figure 1.1

presents those relationships using a selection of verbs from the database. Though this dissertation focusses specifically on the emotional affect of verbs, the trends presented in our verb-only data (Figure 1.1) are also representative of the relationships presented at the word level by Warriner et al. (2013). Arousal and valence have a U-shaped relationship; both low valence (*die*) and high valence (*create*) words are more exciting than words with valences near the mean (*confer*). Arousal and dominance, too, have a U-shaped relationship where low dominance (*jeopardize*) and high dominance (*win*) items are more exciting than those near the mean (*defer*). Dominance and valence, on the other hand, have a positive correlation. As dominance increases, so does valence; low dominance verbs are perceived as being more negative and high dominance verbs are perceived as more positive.

Figure 1.1: Scatter plots of the dimensions of emotional affect (left: Arousal/Valence, middle: Arousal/Dominance, right: Valence/Dominance)



The mean ratings for emotional affect come from the norms of valence, arousal, and dominance by Warriner et al. (2013). In their study, Warriner et al. (2013) collected ratings for the three dimensions of emotional affect for a set of nearly fourteen thousand content words. Only the most high frequency words known by seventy percent of participants or more in a previous study (Kuperman, Stadthagen-Gonzalex & Brysbaert, 2012) were selected. Participants were asked to rate items

on a scale of 1 (unhappy / controlled / calm) to 9 (happy / in control / excited). In their study, each participant was asked to rate words along only one of the three dimensions. The project resulted in a database consisting of norming data for these three dimensions of emotion and was created for use in research on mood, word recognition, memory and sentiment analysis (Warriner et al., 2013). Table 1.1 contains examples from the database, and represents a sample of verbs from the extreme ends of each of the dimensions.

Throughout this dissertation, we investigate these three dimensions of emotion and how the dimensions of emotional affect influences the processing of character gender. All reported measures of emotional affect come from the database of the norms of valence, arousal and dominance (Warriner et al., 2013). We look specifically at how verbs are affected by these dimensions of emotion. Primarily, we focus on emotional dominance and how the perceptual rating of the relative dominance/submissiveness associated with a verb can influence readers' perception of the character performing the action of the verb.

1.3 Verb-based inference

Language users make inferences surrounding discourse based on the lexical semantics of verbs. Readers encode structured event representations (*i.e.*, situation models - see Section 1.1) that capture specific information about the characters, themes and instruments that are most likely to participate in events or states described by verbs, and based on the probabilistic co-occurrence and lexical semantics of verbs, readers utilize structured real-world knowledge incrementally during sentence processing (Paczynski & Kuperberg, 2012). Inferences are made based on contextual representation and can facilitate the processing of semantically congruous input (Altmann & Kamide, 1999; de Hoop & Lamers, 2006; Gerrig & McKoon, 1998; Kuperberg, 2013; Kuperberg & Jaeger, 2016; Kuperberg, Paczynski & Ditman, 2011; Levy, 2008; Mitsugi & MacWhinney, 2016; Myers & O'Brien, 1998; Ryskin, Qi, Duff, Brown-Schmidt, Ryskin, Duff & Brown-schmidt, 2016; Sedivy, Tanenhaus, Chambers & Carlson, 1999; Staub, 2015; Tanenhaus & Trueswell, 1994; Wlotko &

Federmeier, 2015). Multiple sources of information, including visual information, the linguistic context and lexical biases all concurrently affect the interpretation of an utterance. As Ryskin et al. (2016) have said, it has been well established that particular verbs bias a user's preferences in interpreting discourse (*e.g.*, Boland, 1997; Kuperberg, 2013; Paczynski & Kuperberg, 2012; Snedeker & Trueswell, 2004; Spivey & Tanenhaus, 1998).

Take for example the sentence, *The pianist played his music while the bass was strummed by the guitarist during the song*. *Guitarist* is semantically related to the general message of the sentence and therefore conforms to the expectations based on a reader's real-world knowledge about the likelihood of the selected agent performing the action of *strumming* (Paczynski & Kuperberg, 2012). Reading times in this context are faster for *guitarist* than, for example, *gravedigger*, because the latter violates real-world knowledge-based expectations about the likely character performing the act of strumming. Furthermore, reading times are also inhibited for the target word when *guitarist* is replaced by *drum*. Though *drum* is semantically related to the context sentence, it violates the animacy selectional restriction and leads to an unlikely event representation.

There is evidence that this inference-based facilitation can cause readers to make active predictions whereby the mental representation is updated and a level of commitment is made to an expected outcome or set of semantic features in advance of receiving the actual input (Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort, 2005). Semantic information and general world knowledge can influence the semantic processing of incoming words through the semantic constraints and real world knowledge-based restrictions that a verb places on its arguments (for example, Paczynski & Kuperberg, 2012, discuss animacy restrictions for certain verbal argument structures as a subset of real-world knowledge).

Semantic memory-based processing frameworks (Federmeier, McLennan, Ochoa & Kutas, 2002; Kintsch, 1972; Kuperberg, 2013; Paczynski & Kuperberg, 2012; van Dijk & Kintsch, 1983) entail a three-way interaction between the mental representation, multiple types of stored information at different grains of representation, and the semantic features of an incoming word. Multiple types of information

work together throughout the processing of sentences (Kuperberg, 2007). Stored semantic information may influence processing of incoming text through the semantic constraints of the words (*e.g.*, the constraints that a verb places on its arguments). Evidence of this process has been confirmed, where researchers found longer regression durations during eye-tracking when words violated real-world knowledge (*i.e., spaghetti*, in the sentence *The man used a blow-dryer to dry the thin spaghetti yesterday evening*) and longer first fixation durations for sentences containing selectional restriction violations (*The man used a photo to blackmail the thin spaghetti yesterday evening*) (Warren & McConnell, 2007). This suggests that readers make inferences based on real-world knowledge derived from both the selectional restrictions of a verb as well as event and state knowledge. Additional cognitive processing is required when such inferences are not realized in discourse.

Paczynski & Kuperberg (2012) stated that since these sources of semantic information can co-occur in discourse, they must interact in order to process incoming information. Words used to describe likely events tend to be (or become) stored within semantically related networks. The mental representation of discourse may interact with such a network, as well as with probability-based co-occurrence information in order to determine what words are related to a particular event or state and help to build expectations about a given context incrementally. We theorize that emotional dominance information may be accessed during discourse processing. If there is a cognitive association between the emotional dominance of verbs and gender originating from their co-occurrence in discourse, then such a relationship has likely become stored within a semantic network where verbal dominance can activate gender-based inferences. In such a network, when words are related to one another (*e.g., waiter, wine* and *menu*), semantic activation can spread, facilitating processing (Paczynski & Kuperberg, 2012). Upon presentation of a verb, emotional dominance may influence semantic networks by providing probabilistic information regarding the likely gender of characters. In a semantic memory-based approach, semantic features (*i.e.*, the dimensions of emotional affect) can affect stored co-occurrence probabilities (ex. the likelihood that the character performing a low dominance action is a female), which in turn, influence the

contextual mental representation.

1.4 Gender stereotype-based inference

Real world event and state knowledge is accessed in the production of inferences during incremental language processing. Therefore inference production during discourse processing can be based on any manner of real world event and state knowledge, semantic features or probabilistic co-occurrence associated with a word. Clark & Haviland (1977) described inferences, such as those garnered through gender stereotypes, as an incremental process integrating newly processed information into the contextually driven mental representation (*e.g.*, bridging inferences). Evidence has shown that gender information can be activated by gender stereotypes based on general world knowledge (Banaji & Hardin, 1996; Canal et al., 2015; Doherty & Conklin, 2017; Gabriel, Behne & Gygax, 2017; Garnham, Oakhill & Reynolds, 2002; Garnham & Yakovlev, 2015; Gygax & Gabriel, 2008; Irmen & Schumann, 2011; Molinaro, Su & Carreiras, 2016; Nieuwland, 2014; Oakhill, Garnham & Reynolds, 2005; Reynolds, Garnham & Oakhill, 2006; Siyanova-Chanturia, Pesciarelli & Cacciari, 2012). For example, a gender stereotype regarding a particular role or occupation name may arise from statistically-driven probabilities. Caliskan, Bryson & Narayanan (2017) used corpus analyses in a study involving associations between gender and occupation names. They found that the strength of association between occupation names in corpus data positively correlated with the percentages of female employees in those occupations based on census data. Because there are more women who are nurses, and more men who are electricians, a gender stereotype can develop whereby language users assume the gender of a nurse to be female and an electrician to be male. Researchers have found that readers automatically make inferences regarding character gender upon presentation of stereotypical gender roles (Oakhill et al., 2005). It appears to be more cost effective to make gender inferences upon presentation of a stereotypical role name, despite the additional cognitive load when such an inference is incorrect.

Banaji & Hardin (1996) performed a judgement task in order to investigate stereotyping based on social role names. Participants saw a prime that was related to a particular gender (*nurse, father*) or was neutral with respect to gender (*parent, person*). The prime was followed by a target pronoun. Banaji & Hardin (1996) found an automatic gender stereotype through faster responses when pronouns were consistent with the stereotypical gender of a noun (for example, *he* presented after the primes *doctor*, *father* and *king*).

Using a similar methodology, Oakhill et al. (2005) created a task where participants were asked to say whether two terms (*e.g., uncle/nurse*) could refer to the same person. They investigated the relationships between gender definitional role names (*e.g., uncle* is by definition male) and gender stereotypical role names (*e.g., nurse* is stereotypically female) in order to explore the automaticity of gender activation during the processing of gender stereotyped role names. In their judgement task, they found results which supported the findings of Banaji & Hardin (1996). Response times were significantly inhibited when target gender stereotypical stimuli mismatched the definitional gender of the paired role name. Because this experiment did not require participants to use gender-marked pronouns, the study is used as evidence that gender information is available automatically and not only when a reader attempts to resolve an antecedent from a following pronoun.

Inference has been widely studied through the use of anaphora because, since gender is generally explicitly marked in English anaphoric expressions, it prompts readers to link pronouns to antecedents in previous discourse. The process of linking an object to an anaphoric reference (in the case of our research, a stereotyped role name and a pronoun) is a two stage process (Canal et al., 2015). Based on lexical and semantic features of the pronoun, a loose connection is made between a pronoun and a role name. This initial stage of bonding is an automatic process, where, if available, multiple potential referents can be bonded to the same pronoun. In the second stage, the character and the pronoun are resolved and if necessary, the mental representation is updated to reflect the proper association between person and pronoun. During anaphoric reference, the inference regarding the gender of a character is only necessarily made after the presentation of the

pronoun and therefore, based only on this evidence, some have claimed that an inference is made only upon the reading of the pronoun (Duffy & Keir, 2004). Others have argued that it is not possible to say whether an inference is made solely after the presentation of the pronoun, or whether anticipation begins immediately after the presentation of the stereotyped occupation through the use of gender biases entailed in noun's semantic features (Canal et al., 2015; Garnham et al., 2002; Gygax & Gabriel, 2008; Oakhill et al., 2005).

Can the features of a word lead readers to make inferences about gender without requiring anaphoric reference? A growing body of evidence suggests that the gender of a character is incorporated into the mental representation of text even in cases where it is not explicitly stated (for example, Banaji & Hardin, 1996; Esaulova & Von Stockhausen, 2015; Garnham et al., 2002; Pyykkönen, Hyönä & van Gompel, 2009). This is consistent with research that has found that readers activate various sources of real world knowledge in order to construct mental representations of discourse (Canal et al., 2015; Esaulova & Von Stockhausen, 2015; Garnham et al., 2002; Gygax & Gabriel, 2008; Kuperberg, 2007, 2013; Oakhill et al., 2005; Paczynski & Kuperberg, 2012).

Pyykkönen et al. (2009) used stereotyped occupation names to investigate if inferences are made, not for the sake of coherence between current and previously processed discourse, but immediately as they are read. They argued that during processing, the semantic features of words immediately activate related semantic networks. To investigate the time course of processing the gender-based semantic features, Pyykkönen et al. (2009) used auditory stimuli via a visual-world eye-tracking paradigm to probe how generally used gender-stereotyped nouns (*i.e.*, nouns used in contexts without anaphoric reference) are processed. They found that when participants heard gender-stereotyped nouns, they were more likely to look at images of characters on screen that matched the gender stereotype, even when the title did not refer to a particular character in the story (Pyykkönen et al., 2009). Stereotype information is activated and used to update the mental representation incrementally throughout discourse processing. Listeners made use of the stereotype information as soon as it was available, as evidenced by the gaze to-

wards gender-consistent characters when hearing gender-stereotyped occupations without the need of an anaphoric reference. This is consistent with reading studies that have found immediate and incremental activation of gender stereotype-based activation of gender information (Carreiras, Garnham, Oakhill & Cain, 1996; Irmen & Schumann, 2011).

If proper names (*Jim, Karen*) or definitional role names (*father, aunt*) that are associated to a particular gender through social norms are made conventionally explicit, information about the gender of those characters is automatically incorporated into the mental model (Canal et al., 2015; Carreiras et al., 1996; Molinaro et al., 2016; Osterhout, Bersick & Mclaughlin, 1997; Su, Molinaro, Gillon-Dowens, Tsai, Wu & Carreiras, 2016). For example, when encountering a name like *John* or a social role such as *father*, readers incorporate male characteristics into their mental representation of that character. Due to social convention, the intended gender of a given name is an inherent quality of the word itself and the association between a name and a character's gender can be considered a use of general world knowledge (Carreiras, Garnham & Oakhill, 1993; Carreiras et al., 1996; Garnham & Oakhill, 1985).

Because role and occupation (*pedestrian, neighbour, architect, teacher*) names are neither generally morphologically marked for gender in English, nor are the lexical entries as closely tied to gender identity as proper names, researchers have investigated their processing in order to understand how readers make elaborative inferences about gender (Carreiras et al., 1993, 1996; Gabriel, Gygax, Sarrasin, Garnham & Oakhill, 2008; Garnham et al., 2002; Gygax & Gabriel, 2008). Role and occupation names provide an interesting means of exploring the processing of gender stereotypes during the inference of a character's gender. Carreiras et al. (1996) argue that when discourse does not explicitly identify the gender of a participant, as in the case of role and occupation names such as *doctor* or *nurse*, general world knowledge of gender stereotypes is used to provide a character's gender in mental representation. Gender is inferred through the semantic association between the stereotypical gender linked to the role name and maintains until otherwise contradicted by new information (Carreiras et al., 1996). They concluded that incongru-

ence between gender stereotype and referential pronoun leads readers to update their mental representation, and that this procedure necessitates additional processing, leading to longer reading times. Carreiras et al. (1996) claim that inference into the gender of a character based on a role name in this manner is evidence that inferences based on gender stereotypes are made elaboratively.

Event related potential (ERP) studies have found evidence of an effect when the definitional gender (the role name entails the gender of a character as part of its meaning, as in, *queen*) mismatches the gender of a reflexive pronoun, such as in the sentence *The queen prepared himself*. In their study, Osterhout et al. (1997) found that both definitional and stereotypical mismatch stimuli elicited a P600 response after participants read the reflexive pronoun. Canal et al. (2015) report that this is the response expected in cases of mismatching definitional agreement during grammatical processing (*i.e.*, a syntactic processing error) (Molinaro, Barber & Carreiras, 2011).

Su et al. (2016) used gender stereotyped Chinese role names (*surgeon, cheerleader*) to investigate how gender stereotype-based gender information is utilized by readers in an ERP experiment. After introducing a gender stereotyped role name, target sentences continued with a gender-marked reflexive pronoun (*herself, himself*). For example, *After the performance, the cheerleader commented in himself/herself for doing not badly*. During pronoun resolution in gender mismatching conditions, researchers found a P200 attention related congruity effect for male pronouns and a P600 integration difficulty congruity effect for female pronouns. Because in Chinese the male reflexive pronoun can be used as the default non-gender marked option, only the female pronoun provides evidence of two-stage model of anaphor resolution, because of the difficulty in integration during resolution.

They argue that because of the non-existing character to reference the gender mismatched reflexive pronoun, the error is syntactic because there is no anaphoric reference for the reflexive pronoun to bond. The same P600 response, though weaker, was found for stereotypical gender role and occupation names (Osterhout et al., 1997). Canal et al. (2015) posit that stereotypical gender information is based

on pragmatic world knowledge (*i.e.*, the probability of a particular role name being male or female) and that this knowledge is activated at the presentation of the role name. The P600 indicates that syntactic processing of the pronoun's relationship with the role name signals a processing error while referencing the role name to the pronoun. In a replication study, Canal et al. (2015) found the same response for definitional role names as Osterhout et al. (1997), but different results for the stereotypical role names. They found that gender perception (measured through a battery of tests measuring social perceptions of gender) could predict the processing of stereotypical role names. The weak P600 was present only for more explicitly sexist participants, while those whose scores were less explicitly sexist elicited a negative deflection (Nref). The Nref has been associated with the re-processing of anaphoric reference in the mental representation (Nieuwland, 2014; Nieuwland & Van Berkum, 2006; Van Berkum, Koornneef, Otten & Nieuwland, 2007).

This suggests two things. First, that the gender associations between definitional and stereotypical gender roles are processed differently and second, it appears that individual differences may predict how participants interpret gender associations in stereotypical gender roles. The P600 response suggests a gender association with definitional role names and appears to be more closely entrenched in meaning. Because a reflexive pronoun cannot be linked to a yet unmentioned character Canal et al. (2015), they take the P600 effect for definitional roles to represent a failure to link the anaphor and antecedent. This differs from the Nref response found for stereotypical role names, which has been associated with participants searching the mental representation to bond anaphor and role name. The difference in processing between more and less explicitly sexist participants provides evidence of differences in processing stereotypical gender roles in mental representation. Those participants who were less sexist, appear to have actively searched mental representation for a less probable but possible referent, while those who were more sexist appear to have processed the gender mismatch as an ungrammatical error.

1.4.1 Gender as a prominence feature

Expanding on these ideas, Esaulova & Von Stockhausen (2015) have hypothesized that gender in language (definitional (*king/queen*), stereotypical (*soldier/nurse*), or grammatical (*actor/actress*)) may play a role as a prominence feature (de Hoop & Lamers, 2006); that gender may act as a constraint on verbal arguments at the syntactic level. In the theory of prominence features, high prominence items (or nouns) are more likely to occur in a subject or agent (NP1) position, while those with low prominence are more likely to occur in an object or patient (NP2) position. Traditional concepts of prominence features have used evidence for the incremental processing of language, where users make probabilistic predictions about syntax and semantics based on a set of constraints, including animacy, case and agreement (Esaulova & Von Stockhausen, 2015). Drawing back to the topic of selectional restrictions seen in Section 1.3, let us consider animacy as an example of a prominence feature. Animate nouns are considered to hold a higher rank on the hierarchy of animacy, and therefore nouns that are animate are more likely to act as NP1 position characters. This is because animate entities better fill the role of semantic agents. In a sentence such as *The guitarist strummed the bass*, the animacy of *guitarist* gives it a probabilistic advantage to serve as NP1 in the sentence. At the presentation of *guitarist*, readers are more likely to make predictions for the *guitarist*'s thematic role to be the NP1, rather than the NP2. Esaulova & Von Stockhausen (2015) state that while incrementally processing an utterance, these hierarchical prominence features are utilized to interpret the grammatical function of verbal arguments and predict the thematic roles.

Much like animacy, Esaulova & Von Stockhausen (2015) argue that gender can influence the assignment of thematic roles to characters (agent/subject/NP1 or patient/object/NP2). Through a series of eye-tracking experiments, they found that reading times were fastest when the gender (either grammatical gender or stereotypical gender) matched a later anaphoric reference. For example, in a word-by-word translation that preserves the German word order, reading times were faster when the pronoun gender matched the gender stereotype of the role name

of the character, as in *Often had the electrician good ideas, regularly planned he new projects* (Esaulova, Reali & von Stockhausen, 2014). In both French and German, role and occupation names that were stereotypically male (*i.e.*, *electrician*) were more quickly integrated into NP1 roles during sentence processing than neutral role names, which were integrated more quickly than female role names (Esaulova et al., 2014). Results of this study provide evidence that information regarding gender based solely on general world knowledge (*i.e.*, societal gender stereotypes) is during incremental sentence processing. Male characters are perceived to be more prominent than female characters.

Tying their theory to concepts of status and power, Esaulova et al. (2014) concluded that the results of processing experiments in gender and thematic roles reflected cognitive evidence for social stereotypes about the roles of men and women. The gender bias was taken to reflect reader expectations regarding gender stereotypes and social hierarchies of power, where faster processing times were reported for male-biased role and occupation names in the NP1 position (considered to be the syntactic subject and the semantic agent or theme), and faster processing times were reported for female-biased role and occupation names and grammatically female nouns in the NP2 position. They contended that because of the socially perceived higher status and power of men, readers are quicker when incorporating characters that are perceived to be male into the NP1 position, since males hold a higher hierarchical rank in the prominence feature of gender (Esaulova & Von Stockhausen, 2015).

The idea that male characters better suit the NP1 position suggests that male characters may be perceived as more agentive than female characters. From the perspective of the *transitivity hierarchy* (Hopper & Thompson, 1980), male characters may be viewed as meeting a greater number of the prototypical agent properties than female characters. For example, male characters may be perceived more volitional, sentient and in-control of their actions that cause an effect on their receiver (or theme/(prototypical) patient).

Considering both prominence features and the transitivity hierarchy together, highly transitive agents (those who have a greater number of prototypical agent

features) may be considered more discourse prominent than less prototypical agents or more prototypical patients (see Hopper & Thompson, 1980; Kako, 2006; Pyykkönen, Matthews & Järvikivi, 2010). Male characters may implicitly be perceived as better agents than female characters. If this is the case, then male NP1 characters in sentences with high dominance verbs may be considered better agents than female characters paired with high dominance verbs. Thus, reading times for male characters performing high dominance events would be faster than those for female characters performing high dominance events, and vice-versa.

1.5 Emotion-based inference

Past research on the effects of emotion in language processing has investigated the role of emotion on lexical processing. The majority of work that has been done investigating emotional affect has been focussed on valence. Studies have shown that reaction times (Schacht & Sommer, 2009) are improved for both emotionally negative and positive stimuli when compared to emotionally neutral stimuli measured through ERP during visual world processing. Processing advantages for emotion information are said to come from intrinsic motivational relevance - positive and negative stimuli represent survival-relevant information and attract attention (Bayer, 2011; Kryuchkova, Tucker, Wurm & Baayen, 2012). This suggests that, although readers do not actively and continuously score discourse by its affective valence, readers are unconsciously aware of the emotional content of words.

In an EEG study, Van Berkum, Holleman, Nieuwland, Otten & Murre (2009) investigated the brain's response to statements that disagreed with a person's value system. In the study, participants completed an attitude survey to gather their opinions towards drugs, medical ethics, social conduct and other social and political issues. Statements in the survey either agreed or disagreed with participants' personal attitudes. They found that disagreement between a statement and values was observable as early as 200-250ms after the first word that indicated discord between the statement and a participant's personal values. A positive peak in electrical brain activity was measured at the key word in the statement, *I think eu-*

*thanasia is an **unacceptable/acceptable...***, for both individuals who identified with a strict Christian value system (*unacceptable*) and for individuals with an opposing value system (*acceptable*). Researchers concluded that the effect was likely a late positive potential (LPP), which has been found to be elicited by visual and auditory stimuli with emotional content, and which generates a stronger response for negatively valenced stimuli (Cacioppo, Larsen, Smith & Berntson, 2004). Baumeister, Bratslavsky, Finkenauer & Vohs (2001) stated that the LPP is indicative of a general negativity bias in human cognition.

Van Berkum et al. (2009) concluded that participants took strong value-inconsistent statements to be aversive and therefore needed additional processing attention. This is evidence for a link between the neural systems for language and emotion-based valuation (Van Berkum et al., 2009). As has been indicated, valence has a strong association to survival-relevant information, which Van Berkum et al. (2009) argue makes it a plausible primary component of meaning. If valence is a component of meaning, affective valuation of word-by-word processing is an integral part of comprehension. It is yet unclear the necessity or time course of access to emotional dominance, though we hypothesize that given the three dimensional relationship between valence, arousal and dominance, it is likely that emotional dominance is akin to valence, in that it is accessible early in processing and can be used incrementally in the process of language comprehension.

Readers are able to infer emotion-based information during discourse processing but it is yet unclear the level of specificity at which this emotion information is available (Gygax, Oakhill & Garnham, 2003). In order to address the issue of the specificity of emotion-based inferences, Gygax et al. (2003) used a self-paced reading paradigm in which subjects read short paragraphs about fictional characters. For example,

> *"How many things like this can happen in one day?" Don asked himself. First, he was beaten out of a new job by a younger man. If that was not enough, on the way home, he wrecked his car. Then, when he got home, he found out his wife wanted a divorce. All he could do was sit in his living room and stare into space.*

Following the paragraph, a final sentence was presented to subjects that contained an emotion word associated with the emotional state that was likely to be felt by the main character in the story.

*Don could not believe how **depressed** he felt.*

Researchers varied the emotion word by emotional valence. For example, participants were presented with one of the following emotion words: the initial emotion: *depressed* (expected emotion in the story context), a synonym: *miserable* (synonym that matches the expected emotion), a similar emotion: *useless* (similar but not synonymous) and an incongruent emotion: *happy* mismatches the story context).

If participants are able to infer specific emotions while reading, Gygax et al. (2003) expected reading times for sentences containing matching emotions to be faster than those for sentences containing matching-synonym or matching-similar emotions, and that all three conditions would be faster than the mismatching condition. They found that reading times between the three different matching conditions were not statistically different but were all significantly faster than the mismatched emotion word. These results were taken in support of an interpretation where readers infer general emotion information, rather than that of a specific emotion. Thus, although emotion-based inferences are made and incorporated into the mental representation of text during reading in an on-line and automatic process, Gygax et al. (2003) believe that readers do not infer the necessary subcomponents of a particular emotion needed to specify it from the similarly related matching options due to the cognitive processing costs of such an inference. They concluded that although readers do infer some emotion information from text, it is not enough to identify and select a specific emotion. It seems plausible that readers are minimally aware of the dimension of emotional valence, though whether readers are aware of emotional arousal or dominance remains unclear. Of these, our current research focuses on the role of dominance.

1.6 Implicit Causality Bias

Throughout this dissertation, implicit causality bias will be used as a tool in order to investigate the use of emotional dominance in the inference of character gender. In what follows, we will outline the implicit causality bias and how it has been used experimentally to investigate inference processing. Implicit causality bias refers to an unconscious bias to attribute the underlying cause of an event to one of two grammatical arguments of a verb (either NP1 or NP2). This bias is generated automatically through inference and is based on a verb's meaning (Crinean & Garnham, 2006). For example, we see a difference in bias in the two sentences below, where (1) has an NP1 bias (*Jenny*) and (2) has an NP2 bias (*Jenny*) (Garvey & Caramazza, 1974, 1975). In both cases, *Jenny* serves as the cause of *Paul*'s fear, though the order of presentation of the characters in the two sentences is opposite. This is due to the different implicit causality biases of *frighten* (NP1 biased) and *fear* (NP2 biased).

(1) *Jenny frightened Paul because she was a bully.*

(2) *Paul feared Jenny because she stole his lunch money.*

Research on implicit causality bias has a long history (Garnham, Traxler, Oakhill & Gernsbacher, 1996; Garvey & Caramazza, 1974, 1975; Greene & McKoon, 1995) and implicit causality has received recent attention in the field of psycholinguistics (for instance, Bott & Solstad, 2014; Järvikivi, van Gompel & Hyönä, 2017; Kehler et al., 2008; Koornneef, Dotlačil, van den Broek & Sanders, 2016; Pyykkönen & Järvikivi, 2010). Bott & Solstad (2014) refer to implicit causality bias as a measure of the co-reference patterns derived from the explanatory preferences of a verb. These explanatory preferences are assigned through a verb's semantics and its sentential arguments. The implicit causality bias is derived from expectations about upcoming discourse and is utilized during language processing to make predictions about a verb, its arguments and their default explanations in causal discourse. Thus, the implicit causality bias of a verb triggers an expectation that an explanation of the causal relationship is upcoming.

Individual verbs carry a particular implicit causality bias, though it is modulated by the semantic class of the verb (Brown & Fish, 1983; Crinean & Garnham, 2006; Ferstl, Garnham & Manouilidou, 2011). The systematic differences between classes of verbs are based on the semantic properties of the verbs' arguments (Brown & Fish, 1983). They identified differences between action verbs (*agent-evocator, agent-patient*) and psychological verbs (*stimulus-experiencer, experiencer-stimulus*) (see 3 and 4 below for examples). For action verbs, the *agent* is perceived as the character which causes the action, while the *patient* is perceived as the character undergoing the state or change caused by the agent. The *evocator*, on the other hand, is still the recipient of an agent's action, though the action is caused by a state or behaviour of the *evocator*. For psychological verbs, the *stimulus* is perceived as the character that gives rise to a particular experience, and the *experiencer* is perceived as the character who actually undergoes the experience. Brown & Fish (1983) stated that action verbs attribute cause to the agent NP, while psychological verbs attribute cause to the stimulus NP. Implicit causality studies regularly assume an active, transitive sentence structure in which the bias falls towards the NP1 position for *agent-patient* and *stimulus-experiencer* verbs, and towards NP2 for *agent-evocator* and *experiencer-stimulus* verbs. Bott & Solstad (2014) further developed this theory, adding that for a subset of verb classes, including *agent-patient* verbs (*e.g., kill*), there is no clear preference for one argument over the other and therefore, some verbs do not carry an implicit causality bias. This can be seen in the examples (3) and (4).

(3) Action verbs:
   a. (*agent-patient*) Meghan deceived Philip because *she/he*... (NP1 or no bias)
   b. (*agent-evocator*) Meghan blamed Philip because *he*... (NP2 bias)

(4) Psychological verbs:
   a. (*experiencer-stimulus*) Meghan detested Philip because *he*... (NP2 bias)
   b. (*stimulus-experiencer*) Meghan annoyed Phillip because *she*... (NP1 bias)

Implicit causality bias is, fundamentally, a pragmatic inference subject to subsequent revision processes and not a hard grammatical constraint. Language users

can access the implicit causality bias rapidly while processing verbs (Featherstone & Sturt, 2010; Järvikivi et al., 2017; Koornneef et al., 2016; Koornneef & Van Berkum, 2006; Long & De Ley, 2000; Pyykkönen & Järvikivi, 2010). Timed reading, sentence completion, visual world and plausibility judgement tasks have confirmed implicit causality effects during comprehension tasks (for example, Au, 1986; Brown & Fish, 1983; Featherstone & Sturt, 2010; Ferstl et al., 2011; Garnham et al., 1996; Hartshorne, 2014; Hartshorne, O'Donnell & Tenenbaum, 2015; Hartshorne, Sudo & Uruwashi, 2013; Järvikivi et al., 2017; Kehler et al., 2008; Koornneef et al., 2016; Koornneef & Van Berkum, 2006; Long & De Ley, 2000; McKoon, Greene & Ratcliff, 1993; Niemi, Hartshorne, Gerstenberg & Young, 2016; Pyykkönen & Järvikivi, 2010). When a clausal NP following a fragment agrees with the implicit causality bias of a verb, as in (5), comprehension is faster than when an NP disagrees with a verb's implicit causality bias, such as in (6). This is known as a *congruence effect* (Garnham & Oakhill, 1985).

(5) *John disappointed Mary because he failed to pass the test.*

(6) *John disappointed Mary because she held very high standards.*

The increased processing cost for bias-incongruent sentences suggests that when a causal character mismatches the expected identity, readers must revise their mental representation of the discourse. It appears to be the case that when readers process a verb, they make a pragmatic inference as to which character is more likely to be its cause. This inference is what we refer to as the implicit causality bias. The linguistic structure of discourse provides an initial re-mention expectation as to the identity of the causal character which is used in the interpretation of the up-coming pronoun (Hartshorne, 2014; Koornneef & Van Berkum, 2006). When this expectation results in a less plausible interpretation of the sentence, the initial inference is revised in the mental representation.

Bott & Solstad (2014) have said that an implicit causality bias can be observed because, for the subset of implicit causality verbs, an important piece of information can optionally be specified that identifies a causal explanation for the action. Therefore, the biased argument (NP1 or NP2) acts as a place holder for a

semantically more complex explanation that can optionally be introduced through a *because* clause. Though causal connectives are not required to activate implicit causality information, effects surface more rapidly when a connective is present (Koornneef et al., 2016). This causal clause is expected to indicate the unspecified property of the character that caused the initial action. Bott & Solstad (2014) conclude that if an explanation can be included, it should be the default strategy for providing explanatory information regarding the cause of an event. Though the activation of an implicit causality bias places little cognitive demand on working memory (Koornneef et al., 2016), updating a mental representation after having violated the bias congruence does place greater demand on processing, leading to additional cognitively taxing operations (Bott & Solstad, 2014).

Thus, implicit causality verbs are considered special because they trigger explanations as their discourse continuation by default (Kehler et al., 2008). Implicit causality verbs can also violate the general preference to resolve anaphora to NP1 (the first mentioned character) in order to maintain a particular bias (Gernsbacher and Hargreaves, 1988). Such a bias can be thought of as a feature of causal directionality encoded in the lexical semantics of interpersonal verbs (Garvey & Caramazza, 1974). Yet lexical semantics represent just one contributing factor to the implicit causality bias. For example, Corrigan (2001) provided evidence that nouns perceived as more agentive are more likely to be the cause of events and thereby affect an implicit causality bias derived solely from verb semantics. The agentivity of a noun can modify the effect of implicit causality bias of a verb. Comparing the causal authority of *grandmother* and *warrior*, he found it significantly more likely for the warrior to be the causal character than the grandmother.

1.6.1 Time course of implicit causality

In the implicit causality literature, there are two different accounts which take the time course of activation of implicit causality information into consideration. The *Clausal Integration Account* of implicit causality bias states that the bias affects understanding during the later stages of semantic clausal integration, where implicit causality information in the main clause is integrated with the explicit causal in-

formation in the subordinate clause (Garnham et al., 1996; Stewart, Pickering & Sanford, 2000). Through this framework, implicit causality does not affect the activation of the potential antecedents until there is enough information to determine whether the subordinate clause is in agreement or disagreement with the implicit causality bias in the main clause (Pyykkönen & Järvikivi, 2010). In a strong version of this account, integration of the two clauses does not occur until the end of the second clause (Garnham et al., 1996). Evidence in favour of this account comes from studies where implicit causality effects were found at the end the sentence, once the main clause and causal clause had been integrated (Garnham et al., 1996; Stewart et al., 2000). In a self-paced reading study, Stewart et al. (2000) found facilitation through a congruence effect when the implicit causality bias matched the causal character in the pronoun. In their study, sentences were divided into two segments. For example, in the sentence *Daniel apologised to Joanne because he had been behaving selfishly*, the sentence was fragmented directly after the pronoun *he*. Reading times for the second fragment were significantly faster when the implicit causality bias of the main clause verb matched the identity of the pronominal character.

The clausal integration account differs from the *Immediate Focusing Account*, in which implicit causality information is used as early as the presentation of a verb to focus one of the characters. Through this approach, implicit causality information affects pronoun reference resolution immediately upon encountering a pronoun (Koornneef & Van Berkum, 2006; McKoon et al., 1993; Van Berkum et al., 2007).

Koornneef & Van Berkum (2006) performed self-paced reading and eye-tracking experiments in Dutch. They designed stimuli so that mid-sentence pronouns were either consistent or inconsistent with the implicit causality bias of a preceding verb. For example, *Linda praised David because he had been able to complete the difficult assignment with very little help.* and *David praised Linda because he had been able to complete the difficult assignment with her help only*. Because the Dutch equivalent of *she* is ambiguous in number (*i.e.*, singular/plural), they varied the consistency of the bias by changing the argument structure of the male and female characters (*David verbed Lisa*, or *Lisa verbed David*). In both studies, bias-inconsistent pronouns

slowed down reading one or two words after the critical pronoun. They concluded that verb-based implicit causality information is accessed rapidly enough to impact the interpretation of a pronoun early in the reading process.

Pyykkönen & Järvikivi (2010) conducted a Finnish visual world eye-tracking experiment where they hypothesized that if implicit causality information is activated in the early stages, more fixations should be triggered to the character consistent with the bias immediately after the verb. If, on the other hand, implicit causality information is not activated until the later phase of integration, fixations to implicit causality consistent and inconsistent subjects and objects should not differ (Pyykkönen & Järvikivi, 2010). Implicit causality effects were found 900 ms after the verb onset. This is indicative of participants looking more often to the bias-congruent character, prior to the presentation of the pronoun, or even the causal connective *because*. Further effects were found 600-900 ms before the presentation of the pronoun, though no significant effect from implicit causality was found directly after the pronoun (300-600 ms). They conclude that other factors may interact with the availability and use of implicit causality information during ambiguous pronoun resolution. Implicit causality does not focus all referents to the same extent, but is mutually available along with other information, such as first mention, subjecthood, and topicality when a pronoun needs to be resolved (Pyykkönen & Järvikivi, 2010). Of key interest is the fact that they observed an implicit causality effect after presentation of the verb, prior to the presentation of either the causal connective *because* or the pronoun, indicating an early effect of implicit causality.

In a following Finnish visual world eye-tracking study, Järvikivi et al. (2017) found further evidence in favour of an early focusing effect of implicit causality, whereby effects were found from 500ms after the onset of the pronoun. Implicit causality effects were found at or before other early effects (*i.e.*, subject bias and first mention preference (Gernsbacher, 1989; Gernsbacher & Hargreaves, 1988)). Because the effect of implicit causality bias of the verb occurred before the end of the causal clause, Järvikivi et al. (2017) take this as evidence contrary to the clausal integration account; implicit causality affects pronoun processing at the point at

which pronoun selection begins.

More recently researchers have begun to approach implicit causality from the perspective that both the immediate focussing and clausal integration accounts are necessary to explain the bias to its greatest extent (Bott & Solstad, 2014; Koornneef et al., 2016; Koornneef & Sanders, 2013). Both accounts have their strengths. While immediate focussing better accounts for the time course of activation of the implicit causality bias, a weaker version of the clausal integration account better describes the manner through which implicit causality information is used during discourse processing (Koornneef et al., 2016; Koornneef & Sanders, 2013; Pyykkönen & Järvikivi, 2010). This interpretation of implicit causality is supported through an incremental integration account (Kehler et al., 2008; Koornneef & Sanders, 2013; Koornneef & Van Berkum, 2006; Pyykkönen & Järvikivi, 2010). Through such a framework, early and late effects of implicit causality both play a role in processing. The time course of activation of implicit causality information is addressed through the process of focussing, while the processing of causal relationships between clauses is addressed through the process of integration. Through such a perspective, the implicit causality bias is activated upon presentation of the verb and throughout sentential processing, additional factors determine how implicit causality information continues to be utilized.

Koornneef et al. (2016) found early pronoun focussing effects in a series of Dutch eye-tracking studies. Across their experiments, they found delays in processing due to bias inconsistencies three to five words after the pronoun while looking at first fixation (the first fixation on a word) and first gaze (sum of all fixations on the first word on the first pass) durations, as well as effects for measures of regression path (sum of all fixations before moving onto the next word) duration. The first fixation and first gaze durations are taken as early effects during focussing, while the regression path durations are taken as evidence of later processing during integration. These effects were present after the pronoun in sentences with and without the causal connective *because*, though implicit causality effects were stronger and more rapid in stimuli containing the causal connective. Through such a framework, early and late effects of implicit causality both play

a role in processing. The time course of activation of implicit causality information is addressed through the process of focussing, while the processing of causal relationships between clauses is addressed through the process of integration.

1.6.2 Factors affecting the implicit causality bias

Additional experimental evidence has suggested that implicit causality bias can be affected by intrinsic general world knowledge. As mentioned previously, Corrigan (2001) has shown that characteristics of a noun phrase can affect the bias, where nouns that are perceived as more agentive are more often perceived by participants to be the cause of an event (compare *grandmother* and *warrior*). In fact, researchers have identified many factors than can influence the direction of the implicit causality bias (Ferstl et al., 2011; Franco & Arcuri, 1990; Hartshorne, 2014; Lafrance, Brownell & Hahn, 1997; Rudolph, 1997).

Research in attention, memory, decision making and social judgement have shown that mood is able to modulate how the brain processes information. Mood is considered a state of being that carries a slow-changing affective valence that has little cognitive content compared to event-triggered emotions (for example, rage or surprise), which carry intense, rapid changes in emotional affect (Van Berkum, De Goede, Van Alphen, Mulder & Kerstholt, 2013). Mood has been found to adjust the operational principles of the mind in a manner that increases the adaptive value of behaviour. Good moods promote a broad, big picture style of thinking that relies on heuristics, while bad moods promote a narrower, conservative focus that relies on finer-grained details (Van Berkum et al., 2013). Van Berkum et al. (2013) conducted an EEG study where researchers modified the mood of participants to either a good or bad mood, after which participants read implicit causality sentences, such as, *Sarah feared Joe because he was fully aware of her ignorance*. They found a reliable congruence effect for bias-inconsistent materials in the good mood condition (*Joe feared Sarah because **he** was fully aware of her popularity*). Participants used implicit causality information to predict the causal character in a subsequent clause only when they were in a good mood. This suggests that a good mood encourages the use of heuristics to anticipate a pronoun referent, while a bad mood

reduces this heuristic anticipation.

Social hierarchy has been found to affect the bias, where a character whose social status is higher (compare *secretary*, *co-worker* and *employer*) is more likely to be the cause of an event or state (Lafrance et al., 1997). In a causal attribution task, Hartshorne (2014) found that social hierarchy and affective valence (how positively or negatively an event is perceived) can both affect the implicit causality bias. For example, compare the positive valence (*The boss applauded the employee*) and the negative valence (*The general distressed the soldier*). They found that social hierarchy affected causal attribution, where high social class characters (*boss, general*) had a stronger implicit causality bias than lower social class characters (*employee, soldier*), but only for negative valence events and that no such effect was found for positive valence events.

Franco & Arcuri (1990) also found that the emotional valence of verbs could affect the bias. When a verb carried a negative affective valence, the NP1 bias was stronger than it was for positive valence verbs. Participants were more likely to assign cause to the subject of a sentence (NP1) when that character's actions carried a negative consequence. These effects were later confirmed by Ferstl et al. (2011), who argued that the bias could be modulated by affective valence.

They also found that character gender could affect the bias. Ferstl et al. (2011) used a sentence continuation task, where participants were given a sentence fragment and asked to complete the sentence (*e.g., Bill accused Kate because ...*). Sentence continuations that began with a pronoun referring back to one of the two characters signalled which of the two characters was selected as the cause of the event (*e.g., Bill accused Kate because he knew she was up to no good.*). In their study, Ferstl et al. (2011) found that the gender of the character selected as the causal continuation were male-biased for negative valence sentence fragments. Positive events were more likely to be perceived as female-caused and negative events were more likely to be perceived as male-caused. Without taking valence into account, Lafrance et al. (1997) found that the gender of a character could influence the implicit causality bias in such a way that, in general, male characters were more likely to be the cause of a state or event. Hartshorne (2014) argued that while they too

found an effect of gender during a re-mention task, participants were strongly influenced by character gender (where male characters were perceived as more causal) only for a subset of the verbs

These studies have indicated that interpersonal verbs do seem to carry a particular bias in the attribution of cause, but that this bias can be influenced by characteristics of the verbs, the noun phrases themselves and general world knowledge.

1.6.3 Thematic roles in implicit causality research

In the study of implicit causality, researchers have attributed specific verb biases to over-arching taxonomies along a variety of criteria (Au, 1986; Brown & Fish, 1983; Rudolph, 1997; Rudolph & Försterling, 1997). Brown & Fish (1983) began by dividing verbs into *actions* and *states* and made specific predictions about verbs' implicit causality biases belonging to these two classes. Action verbs attributed cause to the *agent* role, while mental state verbs attributed cause to the *stimulus*. As explained by Ferstl et al. (2011), this lead to the development of a finer-grained taxonomy (*revised action-state taxonomy*), which split interpersonal verbs into four categories dependent upon each verbs' thematic role. The four categories included: Agent - Patient (*AgPat*), Agent - Evocator (*AgEvo*), Stimulus - Experiencer (*StimExp*) and Experiencer - Stimulus (*ExpStim*) (Rudolph, 1997; Rudolph & Försterling, 1997). Table 1.2 contains examples of verb in the revised action-state taxonomy.

AgPat and *AgEvo* class verbs are considered *action* verbs, while *StimExp* and *ExpStim* verbs are *psychological* class verbs. Investigation into thematic roles in implicit causality research has found that thematic roles can affect the bias, through which *AgPat* and *StimExp* verbs carry a stronger bias towards the first of the two noun phrases (NP1) and *AgEvo* and *ExpStim* verbs carry a stronger bias towards the second of the two noun phrases (NP2) (Crinean & Garnham, 2006).

For example, take the sentence *Sam hit Jennifer because he was angry*. Hartshorne et al. (2015) explain that since agents (*i.e., Sam*) are by definition causal actors and patients (*i.e., Jennifer*) must therefore suffer some consequence as the result of the agent's action, *AgPat* verbs should be NP1 biased in implicit causality. Because an action verb, such as *hit*, involves an agent performing an action that, by definition,

has some sort of an effect on a patient, *hit* must intrinsically be classified as an *AgPat* class verb, whereupon the agent (NP1) is considered the cause of the action. Through this reasoning, it is logical and indeed studies have confirmed, that the thematic role of a verb can be used to predict a verb's implicit causality bias (*c.f.* Brown & Fish, 1983; Crinean & Garnham, 2006).

Table 1.2: Verbs by thematic role and implicit causality bias

Role	IC-Bias	Sample Verbs	Example
Agent-Patient	NP1	*hit, poison, seduce, wake*	*Julie hit Ben because she was angry.*
Agent-Evocator	NP2	*defend, chase, allow, train*	*Michael defended Erin because she was weak.*
Stimulus-Experiencer	NP1	*offend, irritate, charm, embarrass*	*Ben offended Julie because he was ignorant.*
Experiencer-Stimulus	NP2	*detest, miss, mourn, support*	*Erin detested Michael because he was rude.*

1.6.4 VerbNet class in implicit causality research

There is strong evidence for a relationship between thematic role and implicit causality bias, though critics have argued that thematic roles are too loose an approximation and lead to over-generalizations (Hartshorne et al., 2015). For example, we can continue our discussion of *AgPat* verbs. As explained above, *AgPat* verbs are theorized to carry an NP1 bias, and yet there are many *AgPat* verbs that studies have shown are actually NP2 biased (*e.g.*, *criticize* has been found to have an NP2 bias - as in, *Mark criticized Mary because* ***she*** *was not behaving respectfully.*) (Hartshorne et al., 2015).

Another method of classification, proposed by Hartshorne (2014), uses an updated version of the Levin verb classes (Levin, 1993), which classifies verbs based on both their semantics and syntactic structures. The most extensive set of Levin verb classes has been collected in VerbNet (Kipper, Korhonen, Ryant & Palmer, 2006), an online verb lexicon which classifies verbs as an extension of the Levin verb classes and contains information regarding the thematic roles, selectional restrictions and frames for English verbs. Hartshorne (2014) analyzed the implicit causality biases of a selection of verbs belonging to a subset of eleven Verb-

Net classes and found that the VerbNet class was a better predictor of the subset of verbs' implicit causality biases than the predictions of previous taxonomies. Hartshorne et al. (2015) replicated the same findings during a forced choice task, where participants had to choose which of two characters was more likely to be the cause of a particular action. They found that verbs which share syntactic class, as represented in the VerbNet classes, are more likely to share the same implicit causality bias. They concluded that the same underlying semantic structures that lead to the construction of the VerbNet verb classes can also guide the encoding of causality bias (Hartshorne et al., 2015). Though Hartshorne et al. (2015) only investigated five of the VerbNet classes, they found that the underlying features of the VerbNet classes had robust effects on the implicit causality bias.

VerbNet class may, therefore, be used to gain a more fine-grained understanding of how the implicit causality bias may function and may be able to systematically predict the implicit causality bias for a larger set of VerbNet classes with greater accuracy than thematic roles. For these reasons, our analyses will take both thematic role and VerbNet class into account as factors in modelling the verbs' implicit causality bias in order to determine which taxonomy best accounts for the biases.

1.6.5 Moral values in implicit causality research

In a forced choice task, Niemi et al. (2016) demonstrated that implicit causality can be used as a measure of morally relevant causal attribution. They found that participants' selections (*he/she* as sentence continuations) predicted causal judgements that selected the NP2 for events involving harm or force (*i.e.*, the victim of the verb) and that participants who had higher hostile sexism ratings in pre-tests (Glick & Fiske, 1996) were accurately predicted to select specifically female NP2 characters as the cause of NP1 male events involving harm or force. As noted by Malle, Guglielmo & Munroe (2014), blame and condemnation are commonly placed on the perceived cause of negative events. Niemi et al. (2016) argued that the implicit causality bias aligns with a participant's beliefs and values, where either the subject was perceived as necessary and sufficient to act as a cause for an

event, or the object was perceived to likely have allowed, controlled or deserved the event (*cf.*, White (2006); causal powers are mapped to agents (NP1) and causal liabilities to patients (NP2)).

Using the psychological concepts of binding values (a system of moral values that disapproves of disloyalty, disobedience and impurity) and individualizing values (a system of moral values that endorse caring and fairness) (Graham, Nosek, Haidt, Iyer, Koleva & Ditto, 2011) - Niemi et al. (2016) predicted that participants who were strongly bound to binding values would attribute cause to the victim (NP2) and that such an effect would provide evidence to the claim that the implicit causality task activates moral motivations during causal attribution. Additionally, they hypothesized that participants with higher ratings of hostile sexism would be more likely to select female NP2 characters as the cause of male NP1 hostile events. Underpinning this claim was the notion that those holding hostile sexist perceptions were likely to view violence against women as victim-precipitated (Niemi et al., 2016).

Using measures of agent (NP1) and patient (NP2) contribution, they found that the higher the degree of belief that an NP2 character controlled, allowed or deserved an event and the lower the degree of belief that an NP1 character was necessary and sufficient to account for the action, was associated with a higher probability that the NP2 character would be selected as the cause of the event involving harm or force (Niemi et al., 2016). This is in line with work by Niemi & Young (2016) who found that greater participant belief in binding values predicted a greater attribution of blame on victims. This bias between binding values and NP2 bias continued across both NP1 male and NP1 female conditions. They also found that hostile sexism played a role in the NP2 bias for events involving harm or force under NP1 male, NP2 female conditions only, concluding that participants who showed a higher level of hostile sexism through questionnaire response (Ambivalent Sexism Inventory, Glick & Fiske (1996)), showed a trend towards victim-precipitated man-on-woman violence.

These findings have implications on the theory of moral cognition (Gray, Schein & Ward, 2014) through which it has been argued that immoral events are imple-

mented in an agent-harms-patient structure. Niemi et al. (2016) concluded that because binding values focus moral values which can include harm in the perseverance of loyalty, respect for authority and pursuit of purity, binding values differ from other views of morality that promote unconditional care (*i.e.*, a view in which harm to patients would always be considered wrong). This provides explanation as to why those with high binding values showed a stronger tendency to assign cause to the NP2 character.

Ideology is linked to the perception of victimhood (Niemi & Young, 2016). Psychologists have reported a higher degree of positive support for victims and victim identification as representative of socially and politically progressive ideologies (Duarte, Crawford, Stern, Haidt, Jussim & Tetlock, 2015), while scrutiny of victims' obligations and personal experiences is connected to conservatism (Anderson, Cooper & Okuamura, 1997). Therefore political orientation - a factor contributing to the content of a person's moral values (Graham et al., 2011) - can be used as a predictive tool to identify a person's attitudes toward victims. Niemi & Young (2016) found that moral values can influence judgements of victim responsibility. They found a correlation between binding values (*i.e.,* conservatism) and victim stigmatization, and individualizing values (*i.e.,* progressivism) and sensitivity to victim injury.

1.7 Dissertation Goals

The purpose of this dissertation is to investigate the manner in which emotional dominance can affect the perception of character gender and inference production involving those characters. We have reviewed evidence that readers are influenced by a wide variety of variables, yet the use of emotional dominance has previously not been investigated. Impressionistically, men are more often associated to high dominance actions, and women with low dominance actions. To what extent does the presence of a high dominance verb, such as *protect*, lead a reader to make inferences about the gender of a character who *protects*? Throughout a series of corpus analyses, a production task and processing experiments, we will investigate this

question by examining the dominance of verbs in relation to gender stereotypes and their implicit causality biases. We propose to answer the following questions: (1) how does dominance affect the processing of language?; (2) do readers use dominance in order to make inferences about the gender of characters?; and (3) when is dominance information accessed during reading?; that is, at what point does emotional dominance information activate?; and (4) is there evidence to support our hypothesized perception of dominance in actual language usage?

In Chapter 2 we begin with a corpus-based experiment to investigate the relationship between verbs, their emotional affect and their arguments. Here we hypothesize that usage trends and semantic associations in corpora may be reflective of cognitive association in the mental representation. Evidence of a pattern in the emotional dominance of verbs and the gender of characters in corpus data may be reflective of human behaviour observed in psycholinguistic experimentation. Chapters 3 through Chapters 5 will continue to explore the associations between emotional dominance and gender through various psycholinguistic methodologies. In Chapter 3, we utilize an online crowd-sourcing website to investigate the relationships between emotional affect and the implicit causality bias. Through the chapter, we maintain a dual interest in how emotional dominance can affect the implicit causality bias and how it can affect the perception of character gender. Chapter 4 focusses on the relationship between emotional dominance and gender. Using self-paced reading and eye-tracked reading paradigms, occupation and role names are used to inquire as to how processing is affected by emotional dominance and how it relates with perceived gender stereotypes. Lastly, Chapter 5 continues using the same self-paced and eye-tracked reading paradigms to research the effects of emotional dominance on the processing of character gender in implicit causality constructions. By utilizing both gender stereotype and implicit causality modalities, across multiple methodologies, we receive the benefit of approaching our research question from multiple perspectives (Arppe & Järvikivi, 2007). We intend to report thorough experimental evidence of the relationship between verb-based emotional dominance and the perception of gender.

1.8 Experimental Stimuli

In our investigation of emotional dominance, we have used a selection of four hundred and twenty English verbs. A selection of these verbs will be utilized in each of the experiments. Verbs were chosen from a subset of twenty-six VerbNet verb classes (Kipper et al., 2006). Table 1.3 contains a sample list of the verbs used in this dissertation, including their mean scores for each of the three dimensions of emotional affect.

Table 1.3: Sample of target verbs and their mean dominance, valence and arousal

Verb	Dominance	Valence	Arousal
worry	3.17	2.10	6.33
admire	7.33	7.35	5.00
envy	3.16	3.05	4.35
delight	7.29	8.21	5.02
calm	7.44	6.89	1.67
thrill	6.09	7.37	7.19
blame	3.33	2.94	4.81

Target verbs were cross-referenced with the norms of valence, arousal, and dominance database (Warriner et al., 2013) in order to control for emotional dominance and valence in the stimuli. The final set of four-hundred and twenty verbs was selected in order to include a balanced selection of stimuli by semantic class and emotional dominance and valence, while sampling from a relatively wide breadth of VerbNet classes. Appendix A.1 in contains a complete list of the four hundred and twenty verbs with mean measures of dominance, valence and arousal.

Chapter 2

Corpus-based investigation of verbal dominance

2.1 Introduction

Subjectively, we may feel that male characters may be more commonly associated with higher dominance actions (such as *provoke, anger, hit*), while female characters may be associated with lower dominance actions (such as *cry, dismay, worry*). Language users may be aware of such impressions through common gender stereotypes (*i.e*, the view that men are more violent, or perhaps that women are more helpless). The dimension of emotional dominance provides a method through which to investigate such stereotypes. By controlling for relatively equal levels of emotional valence, emotional dominance can be used to distinguish conceptually related groups of verbs (*e.g., provoke, anger, hit* are high dominance, low valence, and *cry, dismay, worry* are low dominance, low valence). Yet, no research has been conducted to identify whether such a relationship exists, or quantify the measures of a relationship between the emotional dimension of verbal dominance and the gender of characters. Corpus linguists have argued that corpora can act as an approximate source of information regarding experience and exposure to language, which can play a role in the cognitive processing and mental representation of language (Ellis, 2014; Ellis, Simpson-Vlach, Römer, Brook O'Donnell & Wulff, 2015; Gablasova, Brezina & McEnery, 2017; Rebuschat & Williams, 2012). For these reasons, we adopt a corpus linguistic approach to the exploration of emotional affect and the interplay between verbs and character gender.

Researchers have found that the lexical bias of a verb results from the relative frequencies of meanings with which a verb appears (Hare, Elman, Tabaczynski & McRae, 2009; Roland & Jurafsky, 2002; Ryskin et al., 2016). Using a visual world eye-tracking task to evaluate the role of syntactic and semantic information on the structural biases of verbs, Ryskin et al. (2016) concluded that the co-occurrence information and syntactic structures based on language experience may have a bidirectional relationship. That is, both the meaning of an utterance and the co-occurrence frequencies of a verb and its argument structure may affect the probabilistic weighting of different concepts in the mental representation of verbs. Researchers biased participants by teaching them biases on a set of natively bias-neutral verbs (modifier bias - *choose the cow with the flower*; instrument bias - *bop the cow with the flower*). They tracked participants' eye movements while listening to sentences that contained an ambiguous prepositional *with*-phrase, after hearing modifier-trained or instrument-trained verbs. Eye movements indicated that participants' interpretation of the *with*-phrase was guided by the trained verb biases (see also, Chambers et al., 2004).

This evidence suggests that distributional information about a verb can affect both the argument structure-based preferences of a verb and its meaning (Ryskin et al., 2016). The co-occurrence frequency of a target word and its context represent a great deal of information about a word, including grammatical dependencies (Padó & Lapata, 2003), selectional restrictions and arguments (Erk & Padó, 2008). As Firth (1957, p.11) once famously wrote, "You shall know a word by the company it keeps". From such a perspective, knowing the distributional properties of a verb and the structures with which it is frequently used may be integral to properly understanding the interpretation of a verb's lexical biases. A corpus-based analysis of verb and argument co-occurrence patterns can be beneficial in examining the gender bias of verbs and the relationship between emotional affect and gender stereotypes.

The degree to which a verb takes female or male characters as subject arguments may be indicative of a property of semantic processing. If a verb carries a distributionally motivated gender bias based in a corpus of real-world occurrence,

that co-occurrence pattern may reflect a stronger cognitive association between a verb and its gender preference. The distributional association between verb and gender may therefore lead readers to have expectations regarding the gender of characters, simply based on the probability of their co-occurrence. Since words that more commonly co-occur have stronger cognitive associations (Erk & Padó, 2008; Padó & Lapata, 2003; Roland & Jurafsky, 2002; Ryskin et al., 2016), expectations related to gender and emotional dominance of verbs may affect online language processing and modulate reading times. By investigating emotional affect as a factor in verb-based gender bias, we attempt to identify the structures through which such an association may develop. An awareness of the distribution of gender preferences for verbs that takes into account the dimensions of emotional affect can strengthen our understanding of the relationship between dominance and gender, thus allowing researchers to make better, more fine-grained predictions about how, when and why emotional affect may affect cognition.

We begin by compiling a corpus to investigate emotional dominance through the exploration of real-world usage statistics between verbs and the gender of characters. By investigating the relationship between verbs and emotional affect (valence, arousal and dominance) in corpora, we intend to provide clearer insight into aspects of social cognition and the psychological effects of emotional dominance. In this chapter, we seek to investigate the relationship between the gender of characters and the emotional dimensions of affect for a set of interpersonal verbs. In what follows, we answer the following research questions: (1) Is there a gender bias for subject position noun phrases (NP1) unique to particular verbs?; (2) If such a gender bias exists, what factors contribute to a verb's gender bias? and; (3) What is the relationship between the dimensions of emotional affect and a verb's gender bias?

2.1.1 Semantic Vector Space Models

As noted by researchers (*e.g.*, Geeraerts, 2010), there has been an empirical turn in linguistics that has led researchers to embrace corpus data in the use of advanced statistical analyses in order to substantiate theoretical hypotheses. Distributional

models of semantics have become the most accepted method to model lexical semantics in the field of natural language processing (Heylen, Speelman & Geeraerts, 2012). Distributional modelling techniques, such as Semantic Vector Space Models (SVM), are able to structure word meaning based on the frequency distributions of co-occurrence across large corpora and have gained popularity in the modelling of human behaviour from psycholinguistic experimentation (Erk & Padó, 2008; Heylen et al., 2012; Hollis & Westbury, 2016; Padó & Lapata, 2003; Turney & Pantel, 2010).

The development of SVM, including Google's word2vec software (Mikolov, Chen, Corrado & Dean, 2013), evolved from the study of artificial intelligence and cognitive science (Turney & Pantel, 2010). These kinds of models were developed first in the 1980's but due to the sparcity of the multi-dimensional space of SVM, could not be practically applied. As methods have developed in modern computing to reduce the dimensionality of SVM, their application has continued to expand.

Since their introduction, the use of SVM in both cognitive science and linguistics has been strongly tied to the *distributional hypothesis*, which states that words that occur in similar contexts tend to have similar meanings (Deerwester, Dumais & Harshman, 1990; Firth, 1957; Harris, 1954). Importantly, SVM are derived from event frequencies, which, in the context of this chapter, is the frequency of a word's occurrence within the corpus. Though critically, SVM have a tendency to carry a "black box" status, whereby an analysis of the semantic properties and relations that lead to the results of a model are difficult to analyze (Heylen et al., 2012).

Baroni & Lenci (2011) have argued that in order to address the lexical semantics of such models, additional approaches need to be included to test specific aspects of the information captured by SVMs. Heylen et al. (2012) suggest that performing an analysis of the output of SVM can provide more clarity into the models. To overcome the "black box" nature of SVM, they suggest visualizing model output, as they did in the comparison of Belgian and Netherlandic Dutch synonyms for *monitor* (Heylen et al., 2012). Similarly, Rayson, Mariani, Anderson-Cooper, Baron, Gullick, Moore & Wattam (2017) discuss the benefits of data visualization

across the field of corpus linguistics to aid researchers in coping with the size and complexity of modern corpus data. For this reason, we will model verb similarity patterns for the four hundred and twenty target verbs using SVM and accompany our analysis with graphics aimed at visualizing how the model determines verb similarity.

Word-Embedding Association Test

Recent work by Caliskan et al. (2017) used word embeddings in a semantic vector space model to calculate a Word-Embedding Association Test (WEAT) between two sets of vectors. They describe the WEAT to be analogous to the Implicit Association Test (IAT) (Greenwald & Banaji, 1995; Greenwald, McGhee & Schwartz, 1998), which measures the response time in psycholinguistic experiments when participants are asked to pair two concepts they find similar. For example, they report that the response time for participants pairing flowers and concepts of pleasantness are faster than participants pairing insects and concepts of pleasantness. The faster the IAT, the stronger the similarity association is between items. Similarly, they take the WEAT to be a measure of similarity between two concepts within corpora. The WEAT measures the cosine similarity (a distance measure between two vectors in a dimensional space). A higher WEAT is assumed to have a stronger similarity, akin to a faster response time in the IAT. They used the WEAT to measure the similarity between vectors for gender stereotyped occupations or given names and vectors for men and women. While testing the accuracy of the WEAT, Caliskan et al. (2017) found that the strength of the WEAT correlated with demographic statistics for the percentages of female workers in the selected occupations and the percentages of people with the corresponding name who were women. They found evidence that within a corpus, the WEAT accurately predicted human biases both across morally neutral and gender biased items. Similarly, the WEAT, or cosine similarity, between vectors within our model's dimensional space will be used as the primary measure of vector similarity.

2.2 Experiment I: Semantic vector space modelling

2.2.1 Methods

Materials

Corpus materials were collected through the Contemporary Corpus of American English (COCA) (Davies, 2008). As a corpus of over 450 million words representing a period from 1990-2012, and composed of data collected from academic, spoken, news, fiction and magazine registers, the corpus was selected because of its representativeness of North American English. Verbs were selected from a subset of twenty-six verb classes. Verbs and verb classes were collected from Verbnet (Kipper et al., 2006), an online verb lexicon which classifies verbs as an extension of the Levin verb classes (Levin, 1993) and contains information regarding the thematic roles, selectional restrictions and frames for English verbs. Target verbs were cross-referenced with the norms of valence, arousal, and dominance database (Warriner et al., 2013) in order to control for emotional dominance and valence in the stimuli. The final set of four-hundred and twenty verbs were selected in order to include a balanced selection of stimuli by semantic class, emotional dominance and emotional valence, while sampling from a relatively wide breadth of VerbNet verb classes (see Appendix A.1 for a complete list of verbs by emotional affect).

Procedure

Semantic vector space modelling was completed using the *wordVectors* package version 1.3 (Goldberg & Levy, 2014) in R version 3.3.2 (R Core Team, 2016). This package wraps Google's word2vec code (Mikolov et al., 2013) for creating vector space models of texts while using convenient, R-capable functions. The wordVectors analysis began by training a model on the entirety of the lemmatized part-of-speech (POS) tagged COCA dataset. Models were tested using both POS and non-POS tagged data. The POS-tagged model was substantially better at reducing noise derived from homographs of other parts of speech (*e.g.*, *tire* (noun) and *tire* (verb)).

Using a continuous bag-of-words architecture, we used a model to calculate

co-occurrence frequencies for a window of twelve words (six right and six left). The dimensions of the vector space were reduced within a co-occurrence matrix, the frequencies of which were weighted by collocational strength using the cosine of their similarity, or WEAT (Caliskan et al., 2017). Table 2.1 visualizes a similarity matrix for a small number of target verbs to exemplify their use in lexical semantic research. We can see that verbs denoting violent events, *hit*, *strike*, *kick*, *slap* and *smack* bear fairly close similarity (based on their relatively high cosine similarity ratings). The verb *hit* shares the most similarity with *strike* (0.69), and *smack* with *slap* (0.79), while, for straightforward reasons, *worship* bears almost no similarity with any of the violent events.

Table 2.1: Cosine similarity (WEAT) matrix based on word vectors model

	hit	*strike*	*kick*	*slap*	*smack*	*worship*
hit	1.00	0.69	0.57	0.44	0.49	0.01
strike	0.69	1.00	0.48	0.44	0.42	0.07
kick	0.57	0.48	1.00	0.67	0.59	0.08
slap	0.44	0.44	0.67	1.00	0.79	0.11
smack	0.49	0.42	0.59	0.79	1.00	0.11
worship	0.01	0.07	0.08	0.11	0.11	1.00

Note: Higher values represent a closer semantic similarity

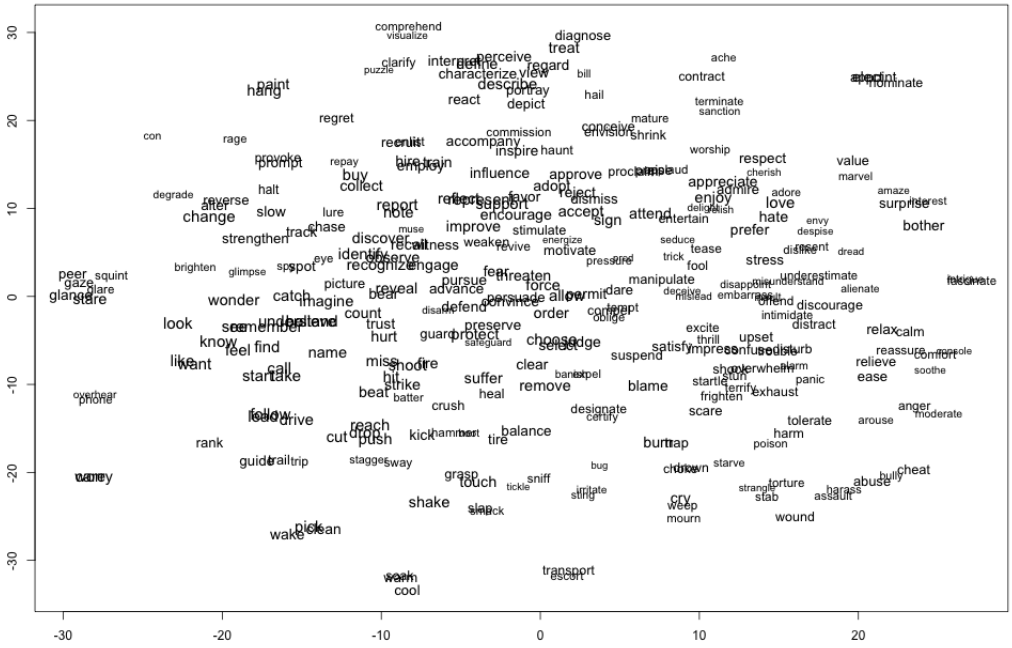
2.2.2 Analysis and Results

Two dimensional reduction

As suggested by Heylen et al. (2012), several visualization techniques were applied to the four hundred and twenty verb vector space in order to gain a better understanding of the semantic clustering of the target verbs. Figure 2.1 visualizes the basic two dimensional reduction of the target verbs within the vector space model (a larger version of this figure is available in Figure B.1 in the appendix). The x- and y-axes simply represent the two dimensional space of the vector model. Proximity of items within the space denote the similarity between words. Size of text represents the word frequency, where larger items have higher frequency within COCA. As can be seen, words with similar meaning and use form natural clusters within the vector space. For example, verbs denoting sight are clustered near (-30,

0) (*peer, gaze, glance, squint, glare, stare*) and verbs denoting actions of protection are clustered near (-5,-5) (*disarm, defend, guard, preserve, protect, safeguard*). Such a representation is useful in gauging the accuracy of a model and the patterns within it.

Figure 2.1: Two dimensional reduction of the verbal vector space model



Note: Proximity of words denotes degree of semantic similarity, size of text the word frequency

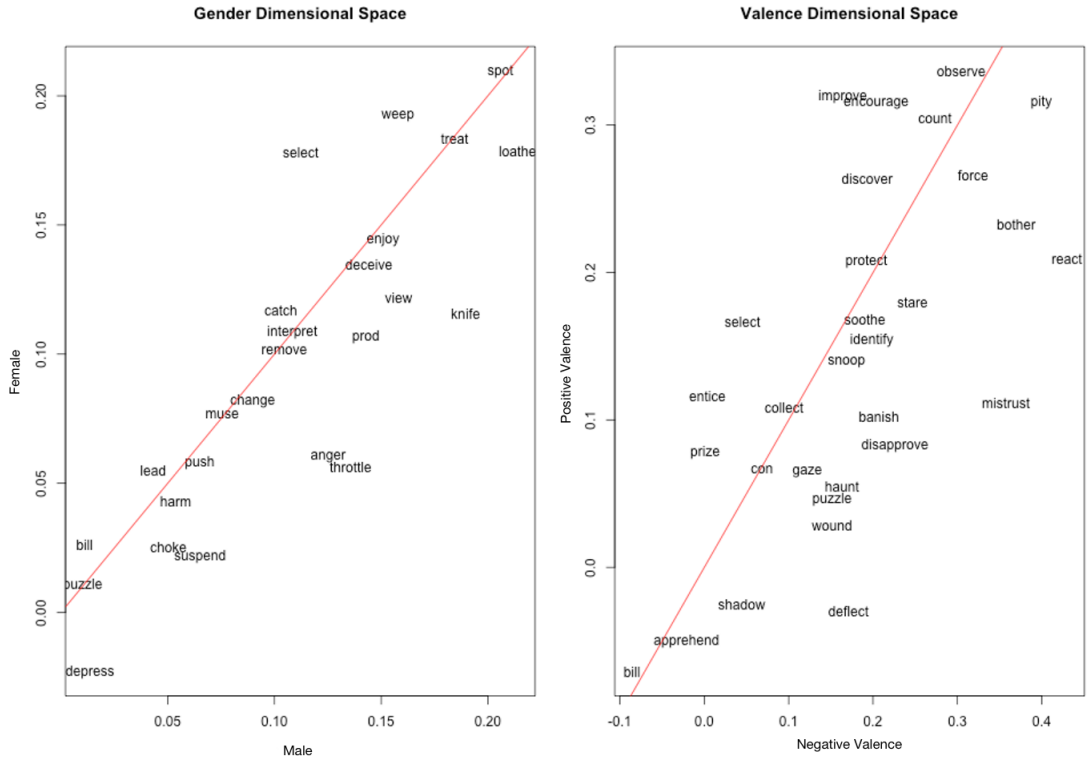
The SVM analysis continued by plotting the verbs into a discursive space where each axis represented a semantic dimension based on the target verbs' similarity to a set of keywords. We modelled two dimensional spaces that tracked the verbs' similarity between two sets of keywords. One two dimensional space plotted valence (Figure 2.2; right) based on positive valence keywords (y-axis: *good(adj), positive(adj), happy(adj)*) and negative valence keywords (x-axis: *bad(adj), negative (adj), sad(adj)*). A second discursive space (Figure 2.2; left) was built to differentiate the similarity between male keywords (x-axis: *man(n), male(n/adj), masculine (adj)*) and female keywords (y-axis: *woman(n), female(n/adj), feminine(adj)*. The plots in Figure 2.2 contain a sample of the verbs from each dimensional space.

Items closer to the red line indicate verbs that are used more neutrally between the two sets of keywords. Items further from the line therefore have a stronger

one way association to its particular set of keywords. For example, in the upper portion of the gender dimensional space, you see that *weep* is found to have a stronger female association, *loathe* a stronger male association and *treat* is used commonly with both male and female keywords. There is also a strong affinity for words of violence in the male keywords (*knife, throttle, choke, harm*). In the valence dimensional space, the distinction between positive and negative verbs is more clear, with words becoming more polarized as they get further away from the midsection (compare *improve* and *mistrust*).

The gender and valence dimensional spaces were then both compressed into a single two dimensional space and set to the x- and y-axis (Figure 2.3). This representation visualizes how verbs differ between male and female gender similarity (*e.g., taunt* is very male; *comfort* is very female) and the valence of the verb (ex. *treasure* is very positive; *frighten* is very negative). There appears to be a negative correlation between valence and gender, where male verbs carried a stronger

Figure 2.2: Verbal Dimensional Spaces by Gender and Valence



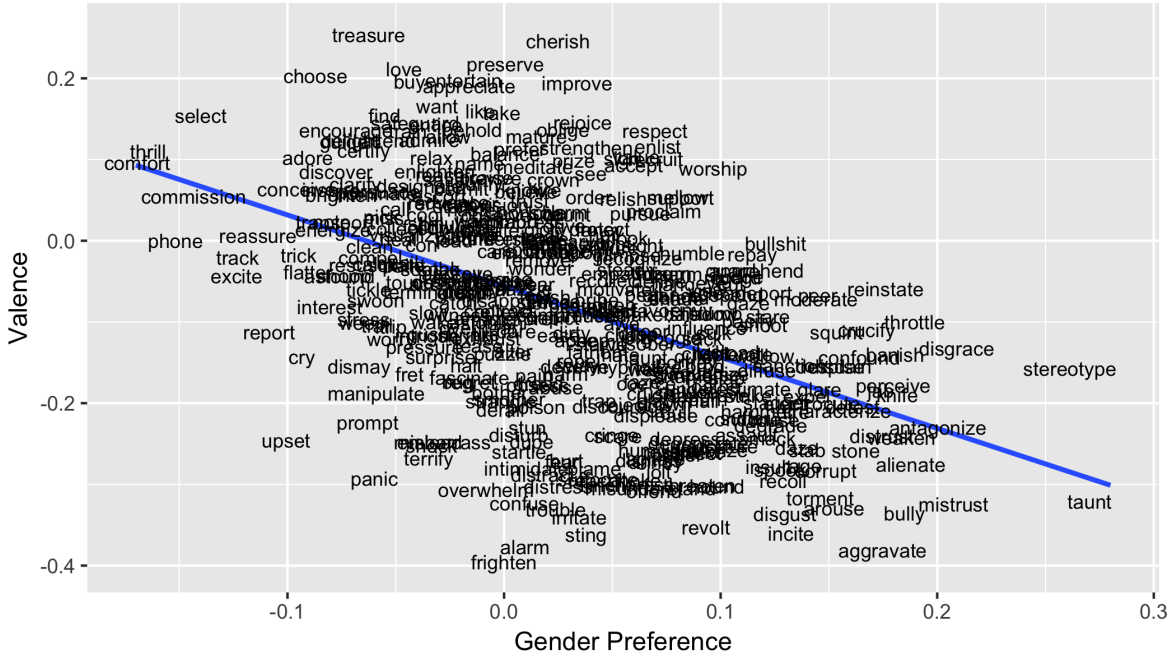
Left: dimensional space by gender; Right: dimensional space by valence

negative valence and female verbs a stronger positive valence.

Cluster analysis

In a final analysis of the SVM, the similarity matrix was used to produce a hierarchical agglomerative clustering of the verbs based on cosine distance and using Ward's minimum variance method. A summary of each cluster and the verbs contained within each can be found in Appendix B.1. Verbs were classified into forty-four clusters, named for the lemma most representative of the class by WEAT score (*e.g.*, SUFFOCATE had the highest similarity score and was the most representative lemma for the class containing *trap, drown, choke, stab, poison, starve, strangle, smother, gush, suffocate, electrocute*). Overall, the SVM clustering did fairly well at linking similar concepts (*e.g.*, GAZE: *stare, glance, peer, gaze, glare, squint, marvel, goggle* and WORSHIP: *proclaim, worship, crown, behold, rejoice, crucify*). We tested different agglomerative clusterings based on classification method (*i.e.*, between the SVM classification, the verbs' semantic class or VerbNet-based classification). Upon manual inspection, the SVM-based classification produced the most accu-

Figure 2.3: Two dimensional reduction of verb similarity by gender and valence



Note: proximity of words denotes degree of semantic similarity.

rate clustering. The meaningfulness of the SVM clustering will be addressed in Experiment II.

2.2.3 Discussion

SVM can be used to identify and visualize similarity between sets of words and can lend insight into trends in word usage and semantics within big datasets. In the case of the target verbs, the SVM indicated similarity is usage amongst particular verbs and that verbs carried semantic associations to gender and affective valence, as measured through cosine similarity for sets of associated keywords. The results of the SVM indicate that there is a stronger semantic association between negative valence verbs (*e.g., taunt, torment, aggravate*) and male keywords, and a stronger association between positive valence verbs (*e.g., love, treasure, comfort*) and female keywords. This is indicated through the negative correlation between gender and valence seen in Figure 2.3. Though the SVM visualizations are used here simply to get an understanding of verb semantics and how meaning is associated to concepts of gender and valence, the tools successfully identified some interesting trends. Simply looking at verb collocation within the corpus, it was possible to see an association between negative actions and male characters, positive actions and female characters and verbs of violence and male characters. Based on the findings proposed by Hare et al. (2009); Ryskin et al. (2016) and Roland & Jurafsky (2002), these measures of similarity based on co-occurrence can provide valuable insight towards the mental representation of verbs. The associations between male characters and negative actions and female characters and positive actions, as well as the stronger association between male characters and violence are based on distributional information about the verbs and their co-occurrence statistics. Because these associations are based on co-occurrence, they can be indicative of societal perspectives on gender and actions.

2.3 Experiment II: Collocational network analysis

The collocational network (Phillips, 1985; Williams, 1998) is a powerful tool for the quantitative analysis of corpus-based data used to interpret patterns in language use[1]. If two words within a corpus collocate (or co-occur within a certain window) more often than would be expected at random, they have a stronger association to one another. As Baker (2016) explained, words which collocate with one another help to imbue meaning to each other because words take on meaning from those around them.

Williams (1998) stated that collocational networks could form unique frames of reference for words within a given sub-language (or corpus) and could therefore be used to express gradual change in meaning and illustrate relational patterns amongst central concepts in the surface structures of corpus materials. The collocational network can be used to model word usage based on contexts within a corpus and is therefore a valuable tool in representing patterns of usage amongst a set of target words. In work by Williams (1998), collocational networks were used to identify patterns in language within the field of biology, and were ground breaking in introducing this method of analysis to the field of linguistics.

Following a similar design, Osborne, Stubbart & Ramaprasad (2001) evaluated company presidents' letters to stakeholders to predict the presidents' cognitive business strategies. Their theory was that the way each of the presidents wrote and spoke about their companies was shaped by the way they thought about their companies, and that the way presidents thought about their companies was affected by the context of the financial state of affairs of the companies. Osborne et al. (2001) used a quantitative analysis of the letters to accurately predict the companies' future performance.

Similarly, Magnusson, Arppe, Eklund, Back, Vanharanta & Visa (2005) used collocational networks to analyze quarterly reports from telecommunications companies to visualize the most frequent topics and changes in communication strategies within the telecommunications domain. They investigated individual sequential

[1]see Gablasova, Brezina & McEnery (2017) for a thorough review of collocation in corpus linguistics.

quarterly reports for three major telecommunications companies over the years 2000 to 2001. They reported that the text in annual reports accurately reflected the strategic thinking of the management of a company and strongly associated with its future financial performance. In essence, Magnusson et al. (2005) surveyed how language use within texts reflected cognition and values, and importantly, how these were realized in the real world (*i.e.*, the financial performance of the telecommunication companies).

In a broader context, these methods open the door to utilizing quantitative approaches on topics beyond financial assessment, and can be applied to research in human psychology. If a corpus of discourse surrounding a company can accurately predict its state of affairs, then from a corpus representative of a society we should be able to gain insight into the society's way of thinking. Corpora represent an abundant source of information regarding the regularity, frequency and distribution of formulaic patterns of language (Gablasova et al., 2017; Rebuschat, Meurers & McEnery, 2017). Innovative techniques are being designed to study a greater range of areas and find evidence of experimental findings in corpora (Baker, 2016; Heylen, Wielfaert, Speelman & Geeraerts, 2015; Rayson et al., 2017; Wielfaert, Heylen & Speelman, 2013). Gil-Vallejo, Coll-Florit, Castellón & Turmo (2017) used corpora to compare psycholinguistic data with corpus-based usage in the study of verb similarity. Similarity was measured through psycholinguistic means using word associations and through corpora using argument structure. They investigated the differences in results between the two approaches and found a correlation between similarity values in the assignment of the verb senses though both of the methods. Furthermore, they found that the finer grained the granularity of the semantic roles in corpora, the stronger the correlation with finer grained formalization of word associations in experimental data. They concluded that structural components of corpus data, through linear order or syntactic function, are necessary to achieve a higher correlation with experimental data. This means that psycholinguistic word associations and corpus-based argument structures derive from related sources when determining similarity in verb sense (Gil-Vallejo et al., 2017). This is evidence that corpus analyses can be used as an additional

resource in the investigation of experimentally observed phenomena.

It is possible to use corpora to find real-world evidence of experimental findings, or to test experimental hypotheses in language use prior to designing experiments (Aotani, Fraser, Aotani, Sugino, Fraser, Koga & Shojima, 2016; Gablasova et al., 2017; Gil-Vallejo et al., 2017; Rebuschat et al., 2017). In what follows we intend to investigate the effects of emotional dominance and its association with character gender. Adopting a corpus-based collocational approach to the associations between emotional dominance and character gender, we will investigate the presence of a gender bias in the set of four hundred and twenty target verbs.

2.3.1 Methodology

Materials

Experiment II uses the same COCA corpus materials (Davies, 2008) and set of verbs used in Experiment I. Table 2.2 contains a list of the VerbNet verb classes and their meaning sampled in this study along with their thematic role and examples of verbs within each category. A complete set of the VerbNet classes and verbs can be found in Appendix B.2.

Procedure

Analysis began by retrieving the lemmatized POS tagged collocates within a window of four lemmas left and right for each of the four hundred and twenty target verbs. Frequency of co-occurrence tables were created for collocates left or right of the target verbs. In our analysis, we chose to use frequency rather than MI score because we were interested in the relationship between a verb and all instances of gendered characters, not just the most significant associations. In our case, a frequency measure was more meaningful than an association measure.

The datasets were tagged for semantic information using Lancaster University's Semantic Analysis System (USAS; Rayson, 2009) in order to identify the collocates specifically referring to person identities. Person-marked collocates (USAS codes *Z1* (personal names), *Z8* (pronouns), *S2* (people) and *S4* (kin) were then semi-manually marked for gender as male (*father, he, man*) or female (*sister, she,*

Table 2.2: Sample of target verbs by VerbNet class and thematic role

VerbNet Class	VerbNet Meaning	Thematic Role	*C*	Example
10.1	Remove	AgEvo	6	*terminate, dismiss, suspend*
10.2	Banish	AgEvo	6	*deport, banish, expel*
29.1	Appoint	AgEvo	9	*appoint, nominate, elect*
29.2	Characterize	AgEvo	34	*diagnose, describe, represent*
33	Judgment	AgEvo	6	*judge, blame, condone*
40.7	Suffocate	AgEvo	4	*drown, choke, suffocate*
51.6	Chase	AgEvo	7	*follow, track, pursue*
51.7	Accompany	AgEvo	4	*escort, guide, accompany*
64	Allow	AgEvo	4	*allow, permit, sanction*
77	Accept	AgEvo	4	*discourage, reject, accept*
85	Defend	AgEvo	6	*guard, defend, protect*
13.5.1	Get	AgEvo	9	*call, phone, reach*
13.5.3	Hire	AgEvo	7	*employ, hire, recruit*
18.1	Hit	AgPat	9	*slap, kick, hit*
42.2	Poison	AgPat	11	*shoot, stab, poison*
45.4	Other cos	AgPat	46	*heal, weaken, wake*
59	Force	AgPat	39	*cheat, persuade, coerce*
30.2	Sight	ExpStim	15	*recognize, spot, overhear*
30.3	Peer	ExpStim	11	*gaze at, stare at, snoop on*
31.2	Admire	ExpStim	38	*fear, dislike, enjoy*
31.3	Marvel	ExpStim	28	*tire of, disapprove of, marvel at*
40.5	Flinch	ExpStim	5	*flinch at, recoil from, cringe from*
87.2	Comprehend	ExpStim	6	*understand, fathom, comprehend*
88.2	Empathize	ExpStim	2	*sympathize with, empathize with*
31.1	Amuse	StimExp	105	*scare, pacify, annoy*

woman). All non-person (*gum, was, inside*), gender ambiguous and gender neutral (*person, child, they, Smith*) collocates were omitted from analysis. The analysis continued working from the assumption that words semantically tagged as persons, were acting as the NP1 or NP2 of the target verbs when they were in a window of four words left or right of the verb, respectively. A more refined analysis was tested for a small sample of the corpus using the Functional Dependency Grammar Parser for English (Järvinen & Tapanainen, 1997) to more accurately account for argument structure between verbs and characters. Because of the similarity in results between the two analyses and the difficulty in processing such a large amount of data through the parser, we limited our analysis to collocate location relative to the target verbs and removed all passive voice sentences. Additionally, psycholinguistic research concerning gender stereotype and implicit causality bias (the modali-

ties through which associations between gender and dominance are measured in the following chapters) has focussed on active, transitive constructions[2]. In order to more directly contrast our corpus and psycholinguistic experiments, a focus on active constructions is therefore justified.

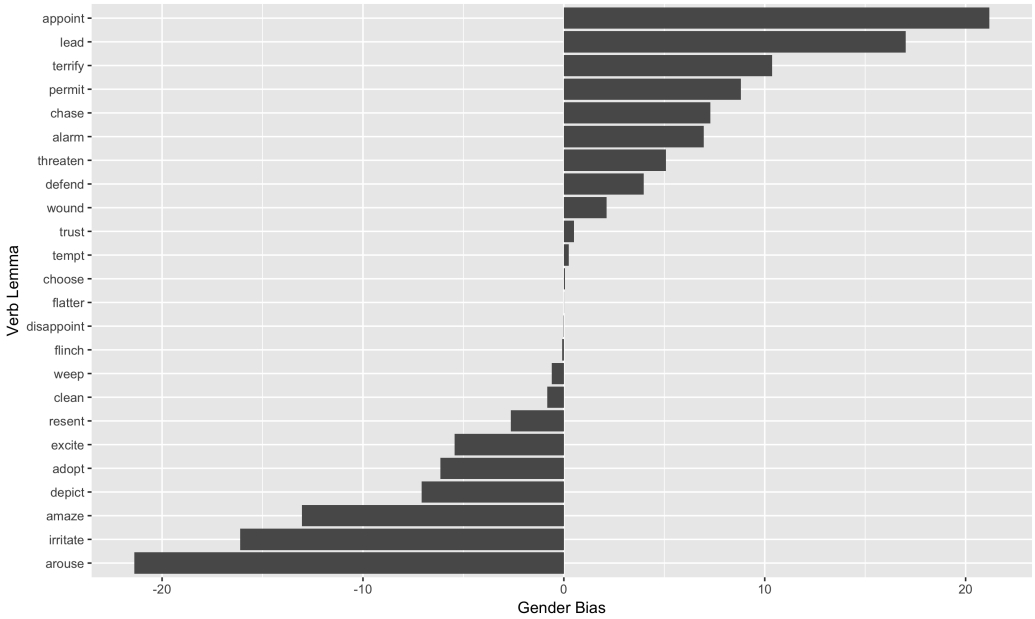
Based on the gender-marked *person* collocates, an NP1/NP2 gender-bias score was calculated for each of the collocates for each of the individual verbs. Following a methodology used by Ferstl et al. (2011) to calculate NP1 bias in an implicit causality experiment, this score was defined as the difference between the number of instances of NP1 and NP2 position *person*-tagged collocates for each verb in each of the five registers. This bias score, henceforth referred to as the NP bias, was used to calculate the relative bias a collocate had to be the NP1 or the NP2 in the context of a particular verb. As NP1, nouns in this position are assumed to play the role of subject and, the semantic agent or theme. The NP bias was calculated as the total frequency of an NP1 position collocate subtracted by the frequency of the NP2 position collocate divided by the summed frequency of the collocate, multiplied by one hundred. The higher the positive value a collocate had, the more strongly the collocate was associated with the NP1 position, whereas a higher negative value was associated with a stronger bias to the NP2 position. For example, within the news register, the collocate *mother* appeared in the NP2 position for the verb *hurt* in 71% of cases (*e.g.*, *He had so hurt your mother emotionally*), while in the spoken register, *mother* appeared in the NP1 position for the verb *clean* in 60% of cases (*e.g.*, *My mother would clean me from the top down*).

The NP bias was then used to calculate a by-verb gender bias score similar to the NP bias used by Ferstl et al. (2011), though the gender bias was calculated from the NP bias rather than raw frequency. Ultimately this lead to an NP1 bias score aggregated over collocate gender for each verb and each of the five COCA registers. As expected, the gender bias demonstrated that particular verbs carry a gender bias (see sample data in Figure 2.4 and a complete list of verbs and gender

[2]Although studies of gender stereotype and implicit causality bias have focussed on active, transitive constructions, Garvey & Caramazza (1974) state that in passive sentences, the implicit causality bias maintains the same deep structure; NP1-biased verbs in active constructions are NP2-biased in passive constructions, thereby preserving the bias on the same character.

biases in Appendix B.3). Overall, a male gender bias was observed across all verbs (mean=0.21, sd=0.98). The male bias maintained for all registers, though it was strongest for the academic register (mean=0.34, sd=0.94) and weakest for fiction (mean=0.07, sd=0.97).

Figure 2.4: Sample of verbs displaying the by-verb gender bias for NP1 position person-tagged collocates



Note: Positive values refer to a male bias, negative values a female bias.

2.3.2 Analysis and Results

Analysis

Data was analyzed using linear mixed-effects regression as implemented in the lme4 package, version 1.1-12 (Bates, Maechler, Bolker & Walker, 2015) and pairwise factor combinations within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) in R version 3.3.2 (R Core Team, 2016). In what follows, the gender bias - a calculation of the relative bias a verb had to have either a male or female character as its subject - was used the dependent variable. Variables included in analysis for the gender bias were the log transformed emotional dominance, arousal and valence for each verb, log transformed verb length and frequency in COCA. Random intercepts were included by verb and register.

Table 2.3: Analysis of Variance between the three linear regression models

	Df	AIC	BIC	logLik	deviance	Chisq Chi	Df	Pr	
SemClass	11	2838103	2838208	-1419042	2838083				
VerbNet	32	2838111	2838435	-1419025	2838049	34.216	21	0.0344	*
SVM Cluster	51	2838052	2838574	-1418976	2837952	96.990	19	<0.0001	***

Inclusion of random slopes by verb or register did not improve model fit. All non-significant fixed effects were removed from the model.

Three models were tested utilizing different methods of verb clustering. Each of the three models included one of the following as factors contributing to the gender bias: thematic role (*AgPat, AgEvo, StimExp, ExpStim*; see Section 1.6.3), VerbNet class or the usage-based verb clustering produced in the SVM cluster analysis in Experiment I (Appendix B.1). Analysis of variance between the three models found that the SVM based verb clustering provided the best model fit (p: <0.0001; Table 2.3). As the clustering was built from the verb usage and not canonical syntactic categorizations, the verb clustering appears to better pick up on patterns of language use and meaning and provide a more informed classification to account for how the verbs' gender biases appeared in the corpus (see Appendix B.4 for the results of the linear mixed model).

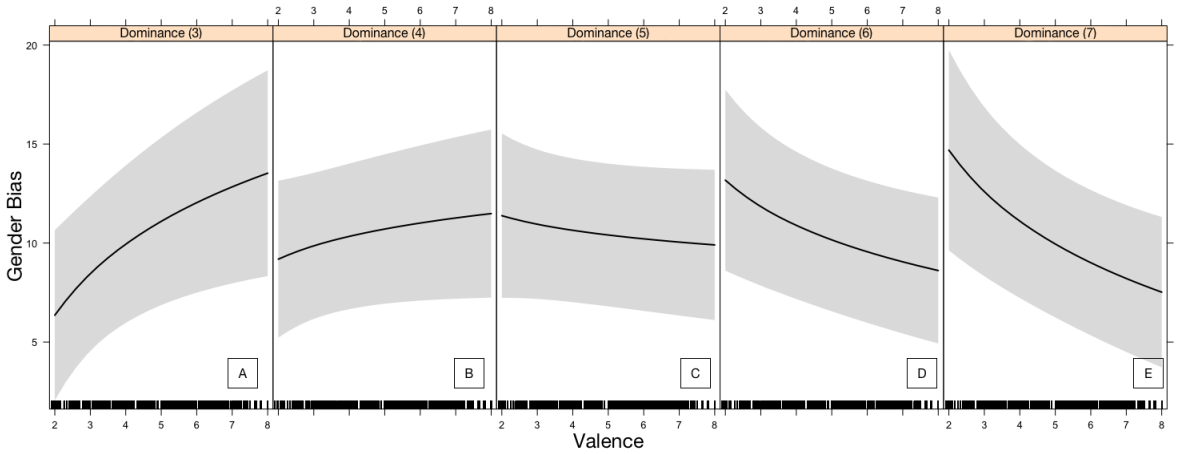
Results

Within the SVM clustering model (Appendix B.4), we observed an effect for the emotional valence of the verb (β = 18.59, SE = 5.11, t = 3.63) and emotional dominance of the verb (β = 18.30, SE = 4.80, t = 3.82). Emotional arousal, length and frequency of the verb did not have a significant effect of the gender bias and were removed from the model. In general, high valence verbs and high dominance verbs correlated with a stronger male bias, and low valence verbs and low dominance verbs with a stronger female bias.

Importantly, we found a significant interaction between the affective valence of the verb and its emotional dominance (β = -12.21, SE = 3.14, t = -3.89; Figure 2.5). Low valence, low dominance verbs had a stronger female bias (Panel A-B) and as the valence increased but dominance remained low (*i.e.*, high valence, low

dominance), the male gender bias became stronger. Low valence, high dominance verbs, too, had a stronger male bias, though as the valence increased and dominance remained high (*i.e.*, high valence, high dominance), the female gender bias strengthened (Panel D-E). The gender bias of mid-range dominance verbs were not significantly affected by emotional valence (Panel C).

Figure 2.5: Interaction between emotional dominance and valence on the gender bias



Note: Higher values refer to a stronger male NP1 gender bias

This indicates a bias in the corpus for male characters to be the subject (NP1) of verbs where the character's actions were either perceived as positive and outside of their control (*i.e.*, low dominance), or negative and within their control (*i.e.*, high dominance). There was a bias for the NP1 to be female where actions were perceived as negative and outside their control, or positive and within the character's control. Table 2.4 provides examples of verbs which share these features. Looking at these example verbs provides more clarity into the types of verbs characterized by these levels of valence and dominance.

Table 2.4: Verbs by gender bias, valence and dominance

Gender Bias	Valence	Dominance	Sample Verbs
Female	Low	Low	*suffer, frighten, panic, sulk*
Male	High	Low	*guard, safeguard, bear, spot*
Male	Low	High	*regret, anger, shame, provoke*
Female	High	High	*comfort, amuse, flatter, charm*

To further characterize these sets of verbs, the SVM from Experiment I was used to determine a common theme between the sets of verbs by finding the most similar concepts for each set of verbs. Low valence and low dominance verbs involved concepts of FRIGHT / HELPLESSNESS, high valence, low dominance verbs involved concepts of PROTECTION / SENTRY, low valence, high dominance verbs involved OFFENCE / RESENTMENT and high valence, high dominance verbs involved concepts of SEDUCTION / PLEASING. Based on the dominance and valence of the verbs, these gender biases appear to partly reflect the perceptions of language users. These categorizations appear to align with gender perceptions, where male biased verbs portray acts of protection or violence and female biased verbs portray acts of weakness or seduction. This idea that language user perception can affect gender biases will be explored further in Chapter 3.

2.3.3 Discussion

Experiment II began with the calculation of a by-verb gender bias score based on the distribution of NP1 position gender tagged collocates for a set of four hundred and twenty verbs. The gender bias was found to differ by verb, some having a strong male bias, others having a strong female bias with a majority having a relatively equal distribution between male and female collocates within the corpus. We were interested in why the verbs patterned as they did, and what effect, if any, the emotional dimensions of affect had on their gender bias. Properties of the verbs were investigated to determine which factors may affect the distribution of gender biases across the set of verbs. The results of the mixed effect regression model found a significant interaction between emotional dominance and valence, whereby a stronger male bias was correlated with both high dominance, low valence verbs and low dominance, high valence verbs. The bias became more female oriented when verbs were high dominance, high valence and low dominance, low valence.

The predictions made in this experiment were that high dominance verbs would have a stronger association to male collocates and low dominance verbs with female collocates. These expectations were originally based on intuitions from stereo-

typical gender-roles, where women are more strongly stereotyped towards low dominance roles and men to stereotypically high dominance roles. The results of Experiment II reveal the relationship between gender and dominance to be more complicated than originally hypothesized, but not altogether in an unexpected way. We found a male and female gender bias for both high and low dominance verbs that was further regulated by the verbs' valence. Dominance alone did not account for the gender bias, because, as can be seen through the examples in Table 2.4, high dominance and low dominance can be interpreted differently based on valence. It is by looking at the interaction between dominance and valence that we can better understand the role emotional affect plays in the distribution of verbs along the spectrum of gender bias.

The co-occurrence frequencies of a verb and its arguments can affect the probabilistic weighting of concepts in the mental representation (Ryskin et al., 2016). Through exposure and use, language users develop general knowledge about the emotional affect of verbs and the co-occurrence between verbs and the gender of the characters performing them. Such a system enables language users to use emotional dominance and valence information to make probabilistic inferences about a character's gender during language processing.

The corpus analyses executed through Experiments I and II provide evidence of a co-occurrence-based gender bias. This bias appears to be affected by a verb's emotional characteristics. We take the pattern between emotional dominance and valence found in our analysis to be representative of usage trends throughout North American English and as such, to provide quantitative evidence of a distributional association between emotional affect and gender. This association may play a role in the mental representation of gender that, through co-occurrence, becomes engrained within our social cognition. As argued by Osborne et al. (2001), by studying how a population speaks and writes, we can gain an understanding of their cognition, values and way of thinking that has a tangible effect on the actions of the people involved. A quantitative analysis of a population's language can therefore shed light on the context of individuals within the population, which, in our case, means North American society.

High dominance, high valence and low dominance, low valence verbs carried a significantly stronger bias towards female characters in the NP1 position (taken here to be the subject and the semantic agent or theme), and low dominance, high valence and high dominance, low valence verbs carried a significantly stronger bias towards male characters in the NP1 position. As seen in Table 2.4 and the results of the semantic vector space modelling, this can be summarized by saying that along the spectra of valence and dominance, male characters have a stronger association to concepts semantically closer to PROTECTION and OFFENCE and female characters with concepts of FRIGHT and SEDUCTION. This seems to reflect stereotypical notions of gender roles, which can portray men as protectors or perpetrators of violent actions, and women as victims or being overtly sexualized. We note that interestingly, these stereotypes are mirrored in our sample of language use and that corpus analysis was able to pick up on the semantic distinctions using these two dimensions of emotional affect.

2.4 Conclusion

Through the complexities of every day interaction and language use, users are trained on the patterns between gendered characters and their actions. Through exposure to this co-occurrence, the probabilistic qualities between the gender of a character and the affective valence and dominance of their actions can get engrained into the meaning of a verb. This can affect the mental representation of verbs as well as individual's conception of gender, and can therefore play a role in the development and strengthening of stereotypes related to gender and gender roles. To what extent language users access emotional dominance and valence information and its use in the probabilistic determination of gender will continue to be our primary topic of discussion in the following chapters. Regardless of whether men really do serve as protectors and women really are victims, in reality and probabilistically, the likelihood of a male in the NP1 position for a low dominance, high valence verb such as *guard* and a women for a low dominance, low valence verb such as *panic*, is statistically greater. We have proposed that the di-

mensions of emotional affect have the capacity to affect the mental representation of language. It appears that in tandem, both dominance and valence can be used to determine the more probabilistically likely gender of a character. If this is the case, we would expect to find evidence of this association in experimental data, to which we will turn in the following chapters.

Chapter 3

Effects of dominance in the perception of cause in an offline production task

3.1 Introduction

This experiment continues our line of research by examining the dimensions of emotional affect as associated semantic features of verbs and identifying how emotional affect may influence the perception of character gender. The experiment in this chapter is comprised of a large-scale offline sentence completion task specifically investigating the effects of all three dimensions of emotional affect (dominance, valence and arousal) on the implicit causality bias of verbs.

In Chapter 2, we used semantic vector space modelling and collocational network analysis and found evidence of a gender bias between verbs that was predicted by emotional dominance and valence. We found that the gender of a subject position noun phrase (NP1) was significantly more likely to be male for high dominance, low valence verbs (*guard*) and low dominance, high valence verbs (*shame*), while NP1 gender was significantly more likely to be female for high dominance, high valence (*comfort*) and low dominance, low valence verbs (*sulk*). Through semantic modelling of these subsets of verbs, we found that concepts of protection and offence were most strongly biased towards male characters and concepts of helplessness and sexuality carried the strongest female bias. This is significant to the present research, as it has been found that both lexical semantics and a word's

co-occurrence frequencies can affect the probabilistic weighting of concepts in the mental representation of verbs (Ryskin et al., 2016). If evidence of gender stereotypes is present in the relationship between the emotional dominance and valence of verbs and the gender of NP1 characters in corpus data, the question arises as to whether a similar pattern can be found in language production and language comprehension. If so, we may be able to observe an association between emotional affect and character gender through participant behaviour during language processing tasks.

For this reason, though we are primarily interested in the effects of emotional dominance, all three dimensions will be tested as variables in the assignment of cause in an implicit causality experiment. Implicit causality is often reliably investigated through sentence completion tasks, where participants are provided with a written sentence fragment and are asked to provide a logical continuation (*e.g.*, *Nicole intrigued James because ...*). Results of such studies have been used to characterize how various factors can influence the implicit causality bias across various criteria, including, for example, the semantic or thematic class of the verb, the participant or discourse character gender, or affective valence of the verb (Brown & Fish, 1983; Ferstl et al., 2011; Stewart et al., 2000). To illustrate this, Ferstl et al. (2011) found a general male bias: participants were more likely overall to name male characters as the inferred cause of events, rather than female characters. Furthermore, this bias was stronger for male participants than female participants. The intention of the present study is to use the well-established implicit causality bias as a tool to gain a clearer understanding of how emotional affect can impact the processing of verbal arguments, both in establishing causal relationships and inferring character gender.

Similarly to findings by Niemi et al. (2016), the current study also considers the role that socio-political ideology may have on the assignment of cause in an investigation of implicit causality bias. Niemi et al. (2016) found a link between ideology and the perceptions of victimhood, where moral values affected how participants perceived the responsibilities of victims. For example, through a battery of participant surveys, they found that participants who valued loyalty, obedience and

purity were more likely to attribute the cause of events to the character perceived as the victim (NP2).

Essentially, in our sentence completion task, participants are visually presented with sentence fragments involving two characters, one male and one female and an interpersonal verb in the structure of *NP1 [verbed] NP2 because ....* The characters are introduced through common North American given names. Participants are asked to complete the sentence however they choose. The purpose of the experiment is to gauge the effect of implicit causality, which we will measure by the preference participants have to refer back to either of the two characters as the cause of the interpersonal event (*i.e., NP1 [verbed] NP2 because* he/she). By modelling the preference across the set of verbs, the gender and position of characters and the affective properties of verbs, we intend to observe the interactions between gender, dominance and the implicit causality bias.

We hypothesize that for negative actions (*i.e.*, low affective valence), conservative-leaning participants are more likely to assign cause to NP2 and progressive-leaning participants to assign cause to NP1. Furthermore, if our findings from Chapter 2 generalize to language production, we expect to find additional effects of emotional dominance on the perception of character gender, where cause is attributed to male characters for high dominance actions and attributed to female characters for low dominance actions.

This Chapter addresses the following questions: 1. How do the three dimensions of emotional affect contribute to the implicit causality bias?; 2. Is the implicit causality bias of verbs affected by character gender?; and 3. Can participant demographics affect the implicit causality bias?

3.2 Implicit causality production task

3.2.1 Methods

Participants

Using the online crowd-sourcing website, Prolific Academic[1], one hundred and fifty-four participants (ages 18-61, M = 30, SD = 9.68; Male = 82, Female = 83) took part in the experiment. Using Prolific Academic, we had access to demographic information including participant age, gender, nationality, country of residence and country of birth. To more accurately ensure that participants understood the gender association for each of the names and had a similar frame of reference to each of the verbal stimuli, all participants were native-English speakers born, raised and currently residing in Canada or the United States. Only participants who completed the entire exercise were included in analysis.

Materials

Previous research has investigated relatively exhaustive sets of verbs from within a small number of VerbNet classes (Hartshorne, 2014; Hartshorne et al., 2015). In contrast, this experiment examines a smaller number of verbs from each VerbNet class, but draws from a greater number of the classes. This choice has two consequences. First, by using a sample of verbs that have not been studied in great depth in implicit causality research, the experiment can extend the set of verbs for which experimentally-validated implicit causality bias information has been collected. Second, by sampling a greater number of VerbNet classes, it allows for modelling of whether VerbNet classes are more suited to predict a verb's implicit causality bias than traditional thematic role-based classification (agent-patient, agent-evocator, stimulus-experiencer, and experiencer-stimulus). Table 3.1 contains a list of the VerbNet classes and thematic roles used in the study along with a sample of the verbs. A complete set of the verbs used in the experiment with their VerbNet classes and thematic roles can be found in Appendix C.2. Target verbs were cross-referenced with the norms of valence, arousal, and dominance database (Warriner

[1]https://www.prolific.ac/

et al., 2013) in order to control for emotional dominance and valence in the stimuli. The final set of four-hundred and twenty verbs was selected in order to include a balanced selection of stimuli by semantic class and emotional dominance and valence, while sampling from a relatively wide breadth of VerbNet classes.

Table 3.1: Each of the VerbNet classes and thematic roles for a sample of the target verbs

VerbNet Class	VerbNet Meaning	Thematic Role	*N*	Example
10.1	Remove	AgEvo	6	*terminate, dismiss, suspend*
10.2	Banish	AgEvo	6	*deport, banish, expel*
29.1	Appoint	AgEvo	9	*appoint, nominate, elect*
29.2	Characterize	AgEvo	34	*diagnose, describe, represent*
33	Judgment	AgEvo	6	*judge, blame, condone*
40.7	Suffocate	AgEvo	4	*drown, choke, suffocate*
51.6	Chase	AgEvo	7	*follow, track, pursue*
51.7	Accompany	AgEvo	4	*escort, guide, accompany*
64	Allow	AgEvo	4	*allow, permit, sanction*
77	Accept	AgEvo	4	*discourage, reject, accept*
85	Defend	AgEvo	6	*guard, defend, protect*
13.5.1	Get	AgEvo	9	*call, phone, reach*
13.5.3	Hire	AgEvo	7	*employ, hire, recruit*
18.1	Hit	AgPat	9	*slap, kick, hit*
42.2	Poison	AgPat	11	*shoot, stab, poison*
45.4	Other cos	AgPat	46	*heal, weaken, wake*
59	Force	AgPat	39	*cheat, persuade, coerce*
30.2	Sight	ExpStim	15	*recognize, spot, overhear*
30.3	Peer	ExpStim	11	*gaze at, stare at, snoop on*
31.2	Admire	ExpStim	38	*fear, dislike, enjoy*
31.3	Marvel	ExpStim	28	*tire of, disapprove of, marvel at*
40.5	Flinch	ExpStim	5	*flinch at, recoil from, cringe from*
87.2	Comprehend	ExpStim	6	*understand, fathom, comprehend*
88.2	Empathize	ExpStim	2	*sympathize with, empathize with*
31.1	Amuse	StimExp	105	*scare, pacify, annoy*

Stimuli were created as sentence fragments with pairs of mixed-gender characters such as in (7) and (8). That is, every sentence involved both a male and a female character. Using mixed-gender characters ensured that there would be no ambiguity if participants completed a sentence fragment using anaphoric reference to one of the two characters (*i.e.*, responding with either *he* or *she*). Additionally, using mixed-gender sentence fragments allowed for the investigation of the relationship between a character's gender, the dominance of the verb and the verb's resulting implicit causality bias.

(7) *Catherine agitated Jacob because ...*

(8) *Patrick praised Sarah because ...*

In designing the sentence fragments, the top one hundred male and female names were collected from the United States Social Security Administration database for the year of 1990[2]. Five native North American English speakers inspected the names, removing those they considered unusual or gender-ambiguous. Afterwards, the remaining 60 most frequent male and female names were selected to be used in the sentence fragments. Names were randomized within each list and counterbalanced so that each list contained an equal number of female NP1 and male NP1 fragments. Presentation of the fragments was randomized by trial. There were eight hundred and forty stimuli in total. Verbs were pseudo-randomly split into fourteen lists, sixty verbs per list, while ensuring that no verb was used twice in a single list. Each verb was sampled twice, once with a female NP1 and male NP2 as in (7) and once with a male NP1 and female NP2 as in (8).

Procedure

Prior to beginning the sentence completion task, participants completed a socio-political questionnaire to get a sense of their attitudes towards several social and political issues. The questionnaire was a modified version of the Political Ideology Questionnaire created by the Louisiana State University School of Social Work, and asked participants to provide their approval rating towards topics such as welfare programs, prayer in school, political correctness and same sex marriage. The main purpose of the questionnaire was to investigate whether a participant's socio-political leanings could predict participants' use of implicit causality bias during the sentence completion task. We hypothesized that the more conservative-leaning a participant's socio-political views, the more likely their responses would be NP2-biased for low valence stimuli. More specifically, conservative-leaning participants would be more likely to name the male character more often as the cause

[2]https://www.ssa.gov/oact/babynames/limits.html

of the verb, particularly when the dominance of the verb was high, and that such an effect would be less prevalent with less conservative-leaning participants. Our version of the socio-political questionnaire can be found in Appendix C.1.

Participants were asked to complete sentence fragments such as those in (7) and (8) by providing a coherent continuation for each sentence. Participants were not instructed explicitly to include reference to either of the two characters in their response and were free to conclude each sentence however they chose, though the instructions did encourage participants to provide unique responses for each fragment. Each participant was tested on sixty verbs, split into six blocks of ten sentence fragments. Participants could take a break between blocks, but were given a maximum of fifty minutes to complete the experiment. The average completion time was 19.5 minutes.

3.3 Results and discussion

3.3.1 Description of analysis

The majority of sentence completions (88.3%) started with a pronoun (*he* or *she*) or one of the two characters' names. The remaining responses (11.7%) were examined on a case-by-case basis in order to determine whether the continuation referenced either of the two characters as the sentence fragment's cause. This manual inspection accounted for an additional 5.4% of responses referring to either an NP1 or NP2 position character. All remaining continuations were categorized as *other*, and referred to neither the NP1 or NP2 position character. The most frequent *other* continuations were based on a mutual characteristic shared or mutual action undertaken by both characters (*e.g.*, *Richard supported Ashley because they were friends*) or referenced a third party cause beyond the consideration of the two characters (e.g., *Thomas scared Alicia because it was Halloween*). These responses were excluded from further analysis. In total, 93.7% of responses referenced the NP1 or NP2 position character as the causal character from the sentence fragment.

3.3.2 Socio-political Questionnaire

In the evaluation of participant data, responses in the socio-political questionnaire were scored in order to determine each participant's socio-political score. Each question was rated on a scale of negative three to positive three, where higher negative scores were associated with a stronger progressive-leaning ideology and more positive scores with a stronger conservative-leaning ideology. For example, in response to the statement, *The traditional family (married father and mother, children) must be preserved at all costs*, a response of *Strongly Agree* was scored as +3, while *Strongly Disagree* was scored as -3. Participant scores were categorized whereupon participants were identified as either progressive-leaning or conservative-leaning (*i.e.*, summed scores above zero were labelled as conservative (45% of participants) and those below zero as progressive).

3.3.3 Results

Excluding the *'other'* responses, the mean number of responses for each individual verb was twenty-one (range = 20-23, *SD* = 1). Because of our joint interest in the effects of emotional dominance on the implicit causality bias and its effects on character gender, we modelled the gender of the character selected as the causal continuation and the implicit causality bias separately in two different models. That is, in the first model the gender of the response was used as the dependent variable (*i.e.*, male/female), and in the second model the directionality of the response (*i.e.*, NP1/NP2). For example, take the response, *Rachel amused Ethan because he was starting to get bored*. In the first model, we analyzed the gender of the causal response (male), and in the second model, we analyzed the directionality of the response (NP2).

Data were fitted with mixed-effects logistic regression models for the categorical dependent measure of gender (male/female) and fitted with mixed-effects linear regression models for the continuous dependent measure of implicit causality bias (NP1/NP2 bias strength). We tested independent variables including participant age, nationality, gender, country of birth, and political leaning (*conservative*

vs progressive). Controlled variables included the gender of NP1, and the emotional dominance, valence and arousal, length, frequency of the lemma in the Corpus of Contemporary American English (COCA) and the implicit causality bias of the verb. Verb length, frequency, dominance, valence and arousal were log-transformed to reduce the non-normality of their distributions. Backwards stepwise model comparisons (Gries, 2013) and likelihood ratio tests were used to find the best model fit. Modelling used the lme4 (Bates et al., 2015) and pairwise factor combinations within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) package version 1.1-12 in R, version 3.3.1 (R Core Team, 2016). Note that due to the size and variance of mixed modelling, model summaries for continuous mixed-effects logistic regression report t-statistics rather than *p*-scores[3]. T-statistics greater than 2 and less than -2 are considered significant. In least-squares means comparisons, linear variables (*i.e.*, dominance, valence, arousal, verb length and frequency) were tested at two levels: the mean of all values above the standard mean, plus one standard deviation, and the mean of all values below the standard mean, minus one standard deviation.

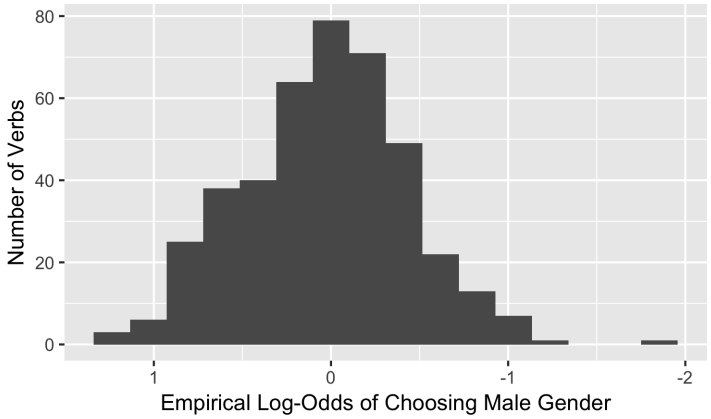
Gender of the causal continuation

The distribution of gender biases across individual verbs was relatively normal, with an overall bias towards male continuations (Figure 3.1). Two verbs exhibited a very strong female gender bias (*describe*, *deflect*). Anova analyses between a more simple model with random intercepts by item and by subject and more complex models with random intercepts by subject and item and random slopes for the gender of the first character introduced in each sentence fragment ($\chi^2(7) = 1459.30$, $p = >0.0001$), the implicit causality bias of the verb ($p = 1$), the dominance of the verb ($p = <0.89$). The complex model with random slopes by subject and item for the NP1 gender had the best model fit.

The gender of the NP1 character had a significant effect on the gender of the re-mentioned character (β = -0.09, SE = 0.03, t = -3.15). In least-squares means

[3]see Baayen, Davidson & Bates (2008) for a comprehensive discussion of the use of t-statistics in linear mixed effects modelling

Figure 3.1: Histogram of the gender bias by verb.



Note: Positive values refer to a male gender bias, and negative values a female bias.

comparison, we found that sentence fragments which began with a female character were significantly more likely to re-mention the male character.

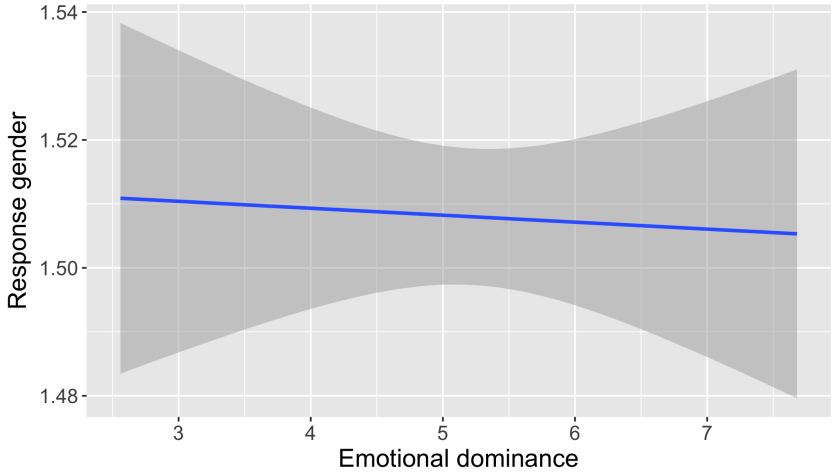
We also found an effect for the gender of the implicit causality biased character ($\beta = 0.29$, SE = 0.02, $t = 12.83$). For example, in the sentence fragment, *Rachel amused Ethan because ...*, the verb *amuse* has an NP2 bias. Therefore, the gender of the implicit causality biased character, given this fragment, would be male. Fragments where the implicit causality bias targeted female characters had significantly more responses that re-mentioned the female character as the cause. Responses regularly followed the implicit causality bias.

Emotional dominance also significantly affected the bias ($\beta = 0.29$, SE = 0.04, $t = 2.00$). Low dominance verbs had a significantly stronger female bias, and high dominance verbs had a significantly stronger male bias. Figure 3.2 visualizes the effect.

Affective valence affected the bias significantly ($\beta = -0.07$, SE = 0.02, $t = -2.99$). Low valence verbs had more responses to the male character, and high valence verbs had more responses to the female character. A visualization of the effect can be found in Figure 3.3.

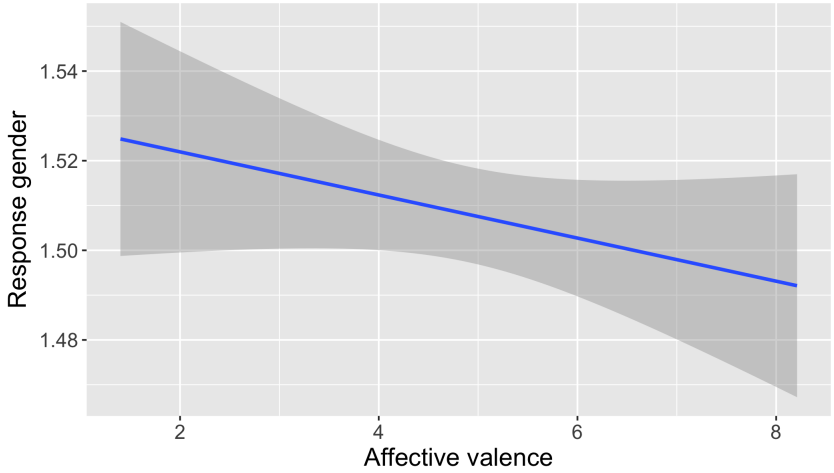
Finally, the length of the verb also affected the bias ($\beta = -0.04$, SE = 0.02, $t = -2.15$). Shorter verbs had a significantly greater number of male responses and

Figure 3.2: Effect of emotional dominance on gender of responses



Note: Greater values refer to a male gender bias, and lesser values a female bias.

Figure 3.3: Effect of affective valence on gender of responses



Note: Greater values refer to a male gender bias, and lesser values a female bias.

longer verbs had a significantly greater number of female responses.

Implicit causality bias

Modelling of the implicit causality data followed techniques used by (Hartshorne, 2014), who used bi-directional stepwise linear regression with each item coded as '1' if the participant's response referred to the NP1 character, '-1' if it referred to the NP2 character. Likelihood ratio tests were used to select between models in order to determine the best possible fit (Baayen, 2006; Baayen et al., 2008). Comparing the more simple model with random intercepts by item and by subject with a more

Table 3.2: Generalized linear mixed effects model of the gender of causal continuations

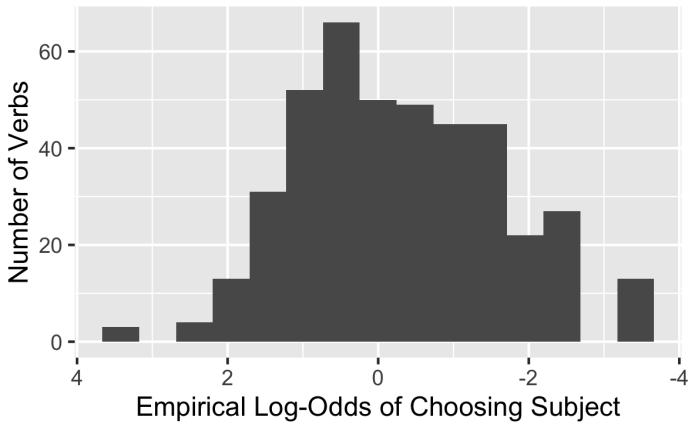
Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.552	−0.758	0.020	0.750	2.535
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Item	(Intercept)	0.05	0.22	
	NP1 Gender(Male)	0.18	0.42	-0.98
Subject	(Intercept)	0.01	0.11	
	NP1 Gender(Male)	0.05	0.23	-0.98
Residual		0.17	0.41	
Fixed effects:				
	Estimate	Std. Error	t value	
(Intercept)	1.47	0.05	28.83	
NP1 Gender(Male)	−0.09	0.03	−3.15	
IC-Bias Gender(Male)	0.29	0.02	12.83	
log(Dominance)	0.07	0.04	2.00	
log(Valence)	−0.07	0.02	−2.99	
log(Verb Length)	−0.04	0.02	−2.15	

specific model with random intercepts by item and subject and random slopes by item and subject for the dominance of the verb, the more specific model was found to better fit the data ($\chi^2(2) = 16.1$, $p < 0.002$). The best model fit was determined using backwards stepwise model comparisons. The final model included all significant predictors and non-significant variables that significantly improved the model fit: emotional arousal, dominance and valence of the verb, the political leaning of the participant and the gender of the NP1 character. Due to the complexity of the interaction between emotional dominance, valence and political leaning, where all three levels were continuous variables, political leaning was transformed into a categorical variable (politically progressive leaning, or conservative leaning).

The distribution of bias strengths across individual verbs was relatively normal, with an overall bias towards NP2 (Figure 3.4). Table 3.3 summarizes the results of the linear mixed-effects model.

As shown in Figure 3.5, emotional arousal affected the implicit causality bias ($\beta = 0.46$, SE = 0.11, $t = 3.93$). Lower levels of emotional arousal were associated with a stronger NP2 bias and higher levels emotional arousal with a stronger NP1 bias

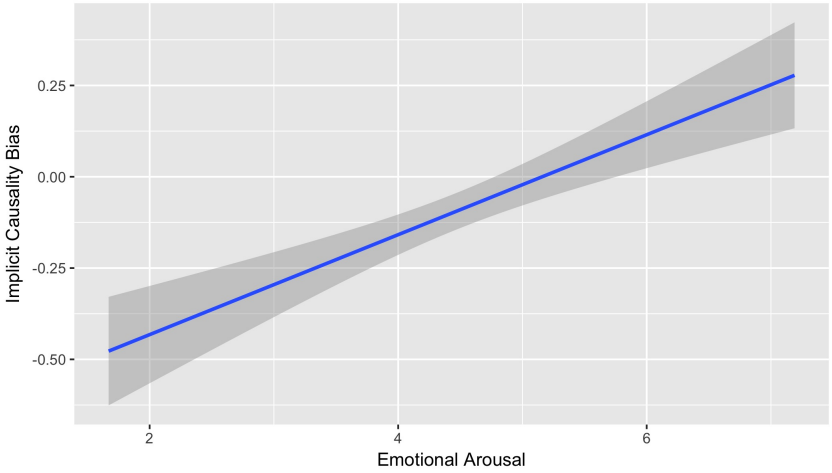
Figure 3.4: Histogram of implicit causality bias by verb.



Note: Positive values refer to an NP1 bias, and negative values, an NP2 bias.

(β = 0.08, SE = 0.08, *t* = -3.93). More exciting verbs appear to have a stronger focus on the characters performing the actions (*abuse, scare, seduce, fascinate*), while less exciting verbs have a focus on the recipient of the action (*calm, allow, quiet, worry about*).

Figure 3.5: Effect of verb-based emotional arousal on the implicit causality bias



Note: positive values correspond to an NP1 bias, negative values an NP2 bias.

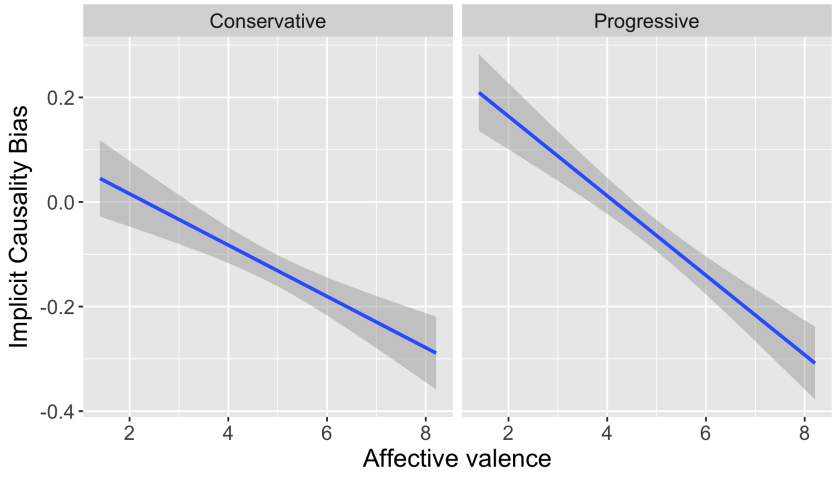
We also observed an effect for participant socio-political leaning (β = 1.30, SE = 0.53, *t* = 2.45). Though the difference was not significant in pairwise comparison (*t* = -0.81), conservative-leaning participants had a stronger overall NP2 bias during the sentence completion task, and while progressive-leaning participants also strongly maintained the bias towards NP2 sentence continuations, it

was weaker than the conservative-leaning participants. The tendency towards an NP2 bias was expected, as it has been observed in previous implicit causality research (Hartshorne, 2014; Niemi et al., 2016).

Additionally, NP1 gender approached significance as a factor affecting the implicit causality bias (t = 1.94), though was removed from the model. When the gender of the NP1 was male, we found a trend for participants to name NP1 as the causal character.

Participants' political leaning had a significant interaction with emotional valence (β = -0.89, SE = 0.38, t = -2.35); Figure 3.6). In pairwise comparison the difference between conservative and progressive participants was not significant for low valence (t = -1.44) or high valence (t = 0.06) stimuli. Although progressive-leaning participants' bias to assign cause to the NP1 character for negative valence verbs was stronger than their bias for positive valence verbs and nearly approached significance (t = 1.71).

Figure 3.6: Interaction between socio-political survey score and the valence of verbs



Finally, we observed a significant three-way interaction between participant political leaning, the emotional dominance and valence (β = 0.47, SE = 0.23, t = 2.02; Figure 3.7). There were several groups that were significantly different in least-squares means comparison. The political leaning of the participant had a significant effect on low dominance, low valence verbs (β = -0.16, SE = 0.05, t = -2.88), where conservative participants had a significantly stronger NP2 bias

and progressive-leaning participants had a significantly stronger NP1 bias. The difference between progressive participants with low dominance, high valence verbs and conservative participants with high dominance, high valence verbs was also significant. Among progressive participants, the NP1 bias was significantly stronger (β = 0.27, SE = 0.08, t = 3.05). Lastly, the difference amongst progressive participants for low dominance, low valence stimuli and high valence, high dominance stimuli was significant (β = 0.20, SE = 0.08, t = 2.50). Again, for low dominance, low valence stimuli, progressive-leaning participants had a significantly stronger NP1 bias and for high dominance, high valence stimuli, progressive-leaning participants had a stronger NP2 bias. Conservative responses to low dominance, high valence verbs appear to be more NP1 biased, as the first plot in Figure 3.7 appears to indicate. In pair-wise comparison, the difference in responses for conservative participants to low and high dominance, high valence verbs was not significant (t = 1.67).

Figure 3.7: Interaction between participant political leaning and emotional dominance by affective valence

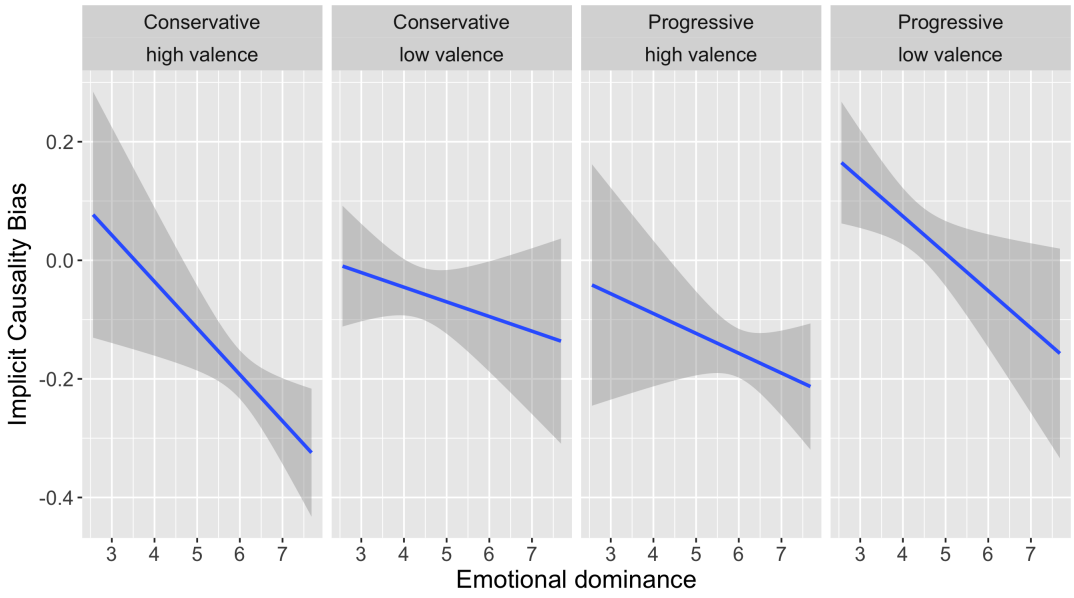


Table 3.3: Results of linear mixed effects model for the implicit causality bias production task

Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.487	−0.733	−0.135	0.786	2.632
Random Effects:				
Item	(Intercept)	0.36	0.60	
	Dominance	0.01	0.07	-0.60
Subject	(Intercept)	0.15	0.39	
	Dominance	0.00	0.06	-0.80
Residual		0.68	0.82	
Fixed Effects:				
Groups	Name	Variance	Std.Dev.	
(Intercept)	−1.62	0.84	−1.93	.
log(Arousal)	0.46	0.12	3.93	***
log(Valence)	0.66	0.57	1.16	
log(Dominance)	0.62	0.54	1.16	
SocioPol(Prog)	1.30	0.53	2.45	*
log(Valence) x log(Dominance)	−0.47	0.35	−1.35	
log(Valence) x SocioPol(Prog)	−0.89	0.38	−2.35	*
log(Dominance) x SocioPol(Prog)	−0.66	0.36	−1.83	.
log(Val) x log(Dom) x SocioPol(Prog)	0.47	0.23	2.02	*

3.3.4 Discussion

Emotional Affect

The observations in this study suggest that there may be utility in taking a verb's emotional affect into consideration when discussing implicit causality bias. To begin with, we found clear evidence of an effect of emotional arousal. Less stimulating verbs carry a stronger NP2 bias and more stimulating verbs carry a stronger NP1 bias (Figure 3.5). For example, take the verbs in (9) and (10), below. Both are *stimulus-experiencer* class verbs and are closely matched in emotional dominance and valence, though one is low arousal (*discourage*) and the other is high (*agitate*). Sentence completions for lower emotional arousal verbs had a significantly higher chance of having a causal continuation which referenced the NP2, as seen in (9). Sentence completions for high arousal verbs more commonly had causal relationships as seen in (10), where the causal continuation involved NP1. The results of our experiment suggest that the more emotionally arousing a verb is, the more likely that cause is attributed to the character performing the stimulating action.

(9) Melissa discouraged Sean because... *he was making poor choices*

(10) Catherine agitated Kevin because... *she wanted to see his reaction.*

Emotional dominance and valence both affected the implicit causality bias. How the bias was affected by these factors was influenced by participants' socio-political ideologies. Participants who had positive scores, and thus whose responses in the socio-political questionnaire trended towards a conservative-leaning, were differently affected by a verb's emotional dominance and valence than those with a progressive socio-political leaning.

Regardless of the implicit causality bias of the verb, when the valence of the verb was low, progressive-leaning participants more regularly assigned cause to the NP1 for low dominance verbs (*Zoe strangled Justin because he cheated on her*) and to NP2 for high valence verbs (*Dustin worshipped Kathleen because he thought Kathleen was amazing*). The same was not true among conservative-leaning participants, who had a significantly stronger NP2 bias for low dominance, low valence verbs than did the progressive-leaning participants. Though conservative and progressive participants appear to display a different bias for low dominance, low valence verbs, they appear to behave quite similarly for high dominance, high valence verbs, in which both groups displayed a NP2 bias (*Trevor motivated Sarah because she needed some encouragement*).

To summarize, when the cause of the action was perceivable by progressive-leaning participants to be outside their control (*i.e.,* low dominance) and had a positive effect (*i.e.,* high valence), they attributed the action to the recipient of the event (11d). Conversely, when the low dominance action had a negative effect (*i.e.,* low valence), they attributed cause to the character who was performing the action (11b). Conservative-leaning participants' responses were different to those of the progressive participants. In high valence conditions, conservative-leaning participants appeared to assign cause to NP2 for high dominance verbs (11c) and to NP1 for low valence verbs (11a). Conservative participants in low valence and progressive participants in high valence conditions appear to have behaved similarly.

(11) a. NP1 *worshipped* NP2 because **NP1**... [*loved NP2; wanted to be like NP2;*

thought NP2 was amazing]

b. NP1 *strangled* NP2 because **NP2**... [*cheated on NP1; made NP1 mad; annoyed NP1*]

c. NP1 *worshipped* NP2 because **NP2**... [*was NP1's best friend; was the best person NP1 knew; was so attractive*]

d. NP1 *strangled* NP2 because **NP1**... [*was a jerk; was insane; was abusive*]

Using participant scores in a socio-political ideology survey, we see a difference in responses to implicit causality-based sentence fragments. As political orientation is a contributor towards the content of a person's system of moral values (Graham et al., 2011), the socio-political scores can provide a lose measure of participants' moral views. Indeed, regardless of the level of emotional dominance, progressive-leaning participants attributed cause to the NP1 character for negative valence verbs and the NP2 character for positive valence verbs, an observation not found with conservative-leaning participants.

The interaction between dominance, valence and socio-political ideology may conform with theories of moral cognition. Niemi & Young (2016) reported that in NP1-harms-NP2 constructions, binding value dominant people (who are socio-politically more conservative-leaning) stigmatize the victim and individualizing value dominant people (who are more progressive-leaning) are sensitive to victim injury. Our observations provide a preliminary look into how such issues can be researched using affective properties. If we loosely associate verbs of harm with low valence verbs, then similar patterns arise; among conservative-leaning participants, low valence verbs had an NP2 bias, regardless of the dominance. Progressive-leaning participants, on the other hand, had an NP1 bias for low dominance actions. This suggests that for negative actions, where the perceived control over the event is low, progressive-leaning participants assigned cause to the character performing the action (as in 11b). This may be related to reports by Niemi & Young (2016) that individualizing value dominant people are more sensitive to victims.

Gender Effects

At the onset of the study, we hypothesized that emotional affect may act as a probabilistic quality which participants can access in the process of making inferences about the gender of characters. The expectation was that a greater number of participant responses for high dominance verbs would name the male character as the cause of the main clause verb, and name the female character for low dominance verbs.

Looking at the gender of the character that participants chose as the causal continuation of the sentence fragments, as the level of dominance increased, the gender selection for causal continuations became more male-biased (Table 3.2). Participants were more likely to select a male character as the continuation for target fragments when the dominance of the verb was high. At the same time, as valence increased, the likelihood of selecting a female character as the causal continuation increased. Overall, participants selected male characters as the sentence continuation most often for high dominance verbs and female characters for low dominance verbs. The strongest male bias was for high dominance, low valence verbs (*coerce, bait, intimidate*) and the strongest female bias was for low dominance, high valence verbs (*diagnose*, *witness*, *tempt*).

In the implicit causality mixed effects model (Table 3.3), we found no significant interactions between emotional affect and the gender of participant responses (*i.e.*, the gender of the character named as the cause of the main clause verb). That is, neither the gender of the two characters introduced in the sentence nor the gender of the causal character, affected the implicit causality bias. The current study of implicit causality bias provides a psychological basis for the hypothesis that the dominance of verbs affects the perception of character gender.

The results of this experiment suggest that lexical representations are experiential and access information regarding our general world knowledge, which includes the emotional dimensions of dominance, valence and arousal. During language processing, language users rapidly access different types of stored semantic information including semantic relatedness networks, general world knowledge

and selectional restrictions (Paczynski & Kuperberg, 2012). This information is used incrementally through language processing (Canal et al., 2015; Curiel & Radvansky, 2014; Gernsbacher, 1996) and therefore, as a word is processed, the components of its lexical representation are accessed to facilitate language processing and make active predictions about upcoming discourse (Altmann & Kamide, 1999; Caplan et al., 1994; Kamide et al., 2003; Troyer et al., 2016). Affective properties of verbs can influence the processing of their arguments. Importantly, how this influence is manifested is affected by a person's gender, experiences and beliefs.

Interpretation of dominance and valence in the assignment of cause was additionally affected by a person's socio-political beliefs. Niemi et al. (2016) reported evidence that for negative actions, participants with binding values were more disposed to assign cause to the NP2 character. This was interpreted to mean that participants with stronger binding values were more likely to participate in assigning the blame on the victim. We developed a similar proposal, looking at how a person's socio-political ideology could affect the interpretation of cause by using an implicit causality sentence completion task, while controlling for verbal dominance, valence and arousal. We found that in low dominance conditions, where NP1 was more likely to be perceived as having little control over his or her actions, conservative-leaning participants blamed the victim (*i.e.*, assigned cause to NP2) for low valence verbs, and assigned cause to NP1 for high valence verbs. The opposite behaviour was found amongst progressive-leaning participants, who assigned cause to NP1 for low valence actions and NP2 for high valence actions. The benefit of our methodology is that it provides a measurable scale for emotional dominance and valence. By utilizing measures of emotional affect, we have a clearer understanding of the conditions under which participants assigned cause to one or the other of the two characters. The insight gained on the factors which influence the implicit causality bias are considerable. The role that dominance and valence play in predicting differences in the assignment of cause between socio-politically progressive and conservative is rather innovative.

Furthermore, we found that emotional arousal, that is, the level of excitement provoked by a word, has an affect on the bias. Though the primary goal if this

dissertation is to investigate the perception of gender and the effect of emotional affect on the inference of character gender, it is certainly worth noting the role that arousal plays on the implicit causality bias. Our study finds evidence that verbs that elicit stronger excitement have a stronger NP1 bias. The more exciting an action is, the more likely that readers will interpret the character performing the action as the cause of the action.

3.3.5 Conclusion

In Chapter 2, we measured the gender bias of verbs based on the patterns of co-occurrence between verbs and gender marked NP1 characters. The corpus-based gender bias was taken as preliminary evidence that co-occurrence statistics can shed light on the foundations of socio-cognitive gender stereotypes, where we hypothesized a probabilistic association between the emotional dominance of verbs and the gender of NP1 position characters based on their mutual co-occurrence statistics. We reported an interaction between dominance whereby high dominance, low valence and low dominance, high valence verbs both had a stronger male bias. In the current study, we found a gender preference for causal continuations in which high dominance, low valence verbs had a stronger male preference, and low dominance, high valence verbs had a stronger female preference. The difference in gender bias for the portion of low dominance, high valence verbs found between the corpus analysis and the sentence completion task (*i.e.*, male/female bias) is not necessarily counter-evidential, as the two experiments were measuring different gender biases. In Chapter 2, we measured the proportion of NP1 position characters, while in Chapter 3, we measured the proportion of causal continuations. Because of the difference in measures, it is difficult to conclude that this is necessarily contradictory. Again, in the current study, we found that in high dominance, low valence conditions, participants were more likely to assign cause to male characters and in low dominance, high valence conditions, participants were more likely to assign cause to female characters. Impressionistically, this seems to be in line with gender stereotypes, where men are associated with high in-control, negative actions (*coerce, bait, intimidate*) and women are associated with less in-

control, positive actions (*diagnose, witness, tempt*). In the following chapters, further investigation will be conducted to elaborate on the findings in Chapter 2 to determine the relationships between gendered characters, specifically in the NP1 position and how the association between dominance and gender affects online language processing during reading.

Chapter 4

Influence of Emotional Affect on Gender Stereotypes during Reading Comprehension

4.1 Introduction

This chapter examines the dimensions of emotional affect as probabilistic properties of verbs used in the perception of character gender during discourse processing. The chapter is comprised of two reading tasks investigating the effects of emotional affect on the processing of social role and occupation-based gender stereotypes. Researchers have investigated the processing of gender-based stereotypes during language processing and found that language users actively make predictions about gender (Banaji & Hardin, 1996; Canal et al., 2015; Carreiras et al., 1996; Duffy & Keir, 2004; Esaulova & Von Stockhausen, 2015; Garnham et al., 2002; Gygax & Gabriel, 2008; Irmen & Schumann, 2011; Molinaro et al., 2016; Oakhill et al., 2005; Pyykkönen et al., 2009; Reynolds et al., 2006; Siyanova-Chanturia et al., 2012; Su et al., 2016; Zwaan et al., 1995; Zwaan & Radvansky, 1998).

For example, in self-paced reading studies in English and Spanish, Carreiras et al. (1996) used gender stereotyped role names (*e.g.*, *electrician* (male), *baby-sitter* (female)) to examine the effects of gender stereotypes during pronoun resolution. Participants read stimuli comprised of two sentences; a first sentence introduced a single character by way of a role name and a second sentence revealed the gender of the character through a gender-marked pronoun (*e.g.*, *The electrician exam-*

ined the light fitting. He/She needed a special attachment to fix it.). A congruence effect was found for reading times in the second sentence, which were significantly inhibited when the gender of the pronoun mismatched the gender stereotype of the role name in both English and Spanish sentences. Similar effects of gender stereotype-based inference have been found in self-paced reading (Carreiras et al., 1993; Gabriel et al., 2017), eye-tracking and reading (Doherty & Conklin, 2017; Duffy & Keir, 2004; Irmen & Schumann, 2011), visual world eye-tracking (Esaulova et al., 2014; Esaulova & Von Stockhausen, 2015; Pyykkönen et al., 2009) and ERP studies (Canal et al., 2015; Osterhout et al., 1997). Additionally, these and others have found rapid effects from gender stereotypes early in discourse processing (Carreiras et al., 1996; Irmen & Schumann, 2011; Pyykkönen et al., 2009). In a German eye-tracking study of stereotype-based gender processing, Irmen & Schumann (2011) had participants read stimuli consisting of one sentence, each including a gender unambiguous kinship term (*e.g., brother, mother*) followed by a gender stereotypical role name (*e.g., (Florist/in) florist (m/f), (Hausmeister/in) janitor (m/f)*) grammatically marked for gender. For example, *My brother is a singer (m) in a band*. They found a congruence effect early in role name processing for incongruent female role names (*i.e.,* male kinship terms paired with female role names), where the incongruent items had longer go past times (sum of fixations before passing to the right of the target interest area). A congruence effect was also found for incongruent male role names, though this was found later in sentential processing for total dwell time (sum of all fixations on an interest area). They concluded from their evidence of immediate resolution of female forms and late resolution of masculine forms that stereotype-based gender information is integrated into mental representation early in processing but that it can be used incrementally throughout sentential processing. In other words, gender information seems to be activated immediately after presentation of a gender stereotyped role name and used to update the mental representation incrementally throughout discourse processing.

Our research will continue to focus on the effects of emotional dominance on the perception and inference of character gender, with attention paid to the time

course of activation of such information. In this chapter we will expand on our investigation of the effects of emotional affect on gender inference during online discourse processing. We hypothesize that while processing verbs, language users may make inferences regarding a character's gender based on emotional characteristics of each verb. In Chapter 2, we found evidence that in active transitive sentences, emotional dominance played a role as a probabilistic feature of verbs based on co-occurrence between gendered NP1 characters (taken to be the syntactic subject and the semantic agent or theme) and affective emotional properties of verbs. We continue this line of research by inspecting whether emotional dominance can be used as a probabilistic property that language users access online during reading in order to infer the gender of characters in the depicted event. We will examine the use of emotional affect in the interpretation of character gender through self-paced reading and eye-tracking studies. To that end, we will investigate: (1) whether readers access emotional affect during reading comprehension; (2) if readers make probabilistic inferences based on the emotional affect of verbs; (3) whether emotional affect can impact the perception of character gender; and if so, (4) what is the effect of emotional dominance on the perception of gender; and (5) what is the time course through which readers access and utilize emotional affect during reading?

We approached these questions by following a similar approach to that which has been used previously to study the elaborative inference of character gender during reading. To explore whether gender-based inferences were made during reading, we measured reading time during pronoun resolution while varying the levels of emotional affect of verbs in the preceding context. We hypothesized that if readers attend to emotional dominance, where male characters are presumed to stereotypically be attributed with high dominance verbs and female characters with low dominance verbs, the level of dominance associated with a given verb may act as a cue for participants to infer the gender of a character. The degree to which readers anticipated a particular character gender can be measured through reading time during pronoun resolution. Slower reading times were expected when the inferred character gender was incongruent with the gender of the

pronoun.

Furthermore, we expected to find the well documented effect of role name based gender stereotypes. After processing a role or occupation name, some commitment is made in the readers' mental representation as to the gender of a character. When the gender stereotype of a role name mismatches the gender of a pronoun, we expected that processing time during pronoun resolution would be inhibited as readers updated their mental representation. Upon reading an incongruent pronoun, re-processing would be required to update the mental representation, leading to additional reading time.

In conditions where the gender stereotype of the role name mismatched the gender of the pronoun, we hypothesized that readers may be faster at updating their mental representation (*i.e.*, have shorter fixation durations during pronoun resolution) when the gender of the pronoun matched the dominance of the verb. The prediction here is that when readers process the verb, they activate the probabilistic gender association of the emotional dominance of the verb into their mental representation (*e.g.*, if the dominance of the verb is high, the character has a greater likelihood of being male). In mismatching conditions, where readers have to reinterpret the gender of the character based on the presentation of the gender marked pronoun, processing is facilitated when the gender of the pronoun matches in emotional dominance with the verb. In cases where the role name matches with the gender of the pronoun, we do not expect an effect of the dominance of the verb to be present. Because the gender inference based on the role name is processed first and is more salient, and the gender of the pronoun matches that of the role name, the probabilistic gender association from the verb would not be needed, as re-processing of the character's gender would not occur.

Based on work by Carreiras et al. (1993, 1996), who found that readers made elaborative gender inferences based on gender-stereotyped occupations and social roles, the stimuli for this chapter involves single characters introduced through role names that were either gender-stereotyped (male or female) or gender-neutral. Table 4.1 contains a list of each of the role and occupation names used in our stimuli. In the studies that follow, participants are presented with sentences that begin

with a gender stereotyped role or occupation name, followed by a dominance-controlled verb, and later followed by a gender-marked pronoun. We are interested in both the association between the dominance of the verb and the gender stereotype of the role name, and the dominance of the verb and the gender of the pronoun. In conditions where there is an association between dominance and gender, we expect to find inhibition when the dominance and gender are incongruent. Based on our current evidence, we expect to find an association between male characters and high dominance actions and female characters and low dominance actions. In Experiment I we used a self-paced reading task investigating the association between emotional dominance and character gender in discourse. In Experiment 2 we used eye tracking while reading to further inquire into the time course of these effects during comprehension.

4.2 Experiment I: Self-paced reading study

4.2.1 Methodology

Participants

Thirty undergraduate students at the University of Alberta (15 male, 15 female; mean age = 21; minimum = 18; maximum = 30) received course credit for participating in the experiment. All participants were native speakers of North American English and had normal or corrected to normal vision.

Materials

Role name and gender bias information was collected from the occupational stereotype norms created by Gygax & Gabriel (2008) and Carreiras et al. (1996) (see Table 4.1). Each sentence logically continued from the introduced role name with a verb controlled for emotional dominance and valence, and a pronoun that either matched or mismatched the stereotypical gender of the role (Table 4.2). Additionally, the causal continuation *because*, and an adverb were placed between the verb and the pronoun in order to increase the processing time participants had for each verb. Verbs were selected from the subset of four hundred and twenty target stim-

Table 4.1: Role and occupation names by gender stereotype

Male	**Female**	**Neutral**
boss	au pair	art historian
bricklayer	babysitter	artist
butcher	beautician	astrologer
carpenter	cashier	bank clerk
chauffeur	cheerleader	cinema goer
electrician	childcare worker	concert goer
engineer	cleaner	cook
farmer	dancer	interpreter
fire fighter	dental assistant	journalist
golfer	dietician	lawyer
grave digger	dressmaker	missionary
judge	embroiderer	musician
paratrooper	florist	neighbour
physics student	fortune teller	newscaster
pilot	hairdresser	novelist
plasterer	housekeeper	pedestrian
plumber	model	pediatrician
police officer	nanny	physiotherapist
porter	nurse	psychologist
president	prostitute	school child
soldier	psychology student	set designer
statistician	receptionist	singer
surgeon	sales assistant	skier
taxi driver	secretary	spectator
technician	servant	student
truck driver	social worker	tennis player
undertaker	typist	trapeze artist
worker	weaver	writer

uli, controlled for valence, arousal and dominance that were used as target words for the corpus analysis in Chapter 2. The complete set of verbs can be found in Appendix A.1. Target verbs in this chapter were selected based on their availability in VerbNet (Kipper et al., 2006), so as to include information based on the semantic class and thematic role of verbs in our analyses. To avoid unintentional ambiguity in the pronoun, each sentence contained only one character prior to pronoun resolution: namely, the character introduced through the role name. Each sentence occurred in two versions. In version one, the stereotype of the role name matched the gender of the pronoun. In the second version, the stereotype and the gender of the pronoun mismatched. For the purpose of the self-paced reading task, each sentence was divided into four segments, as seen in table 4.2.

Eighty-four target stimuli were counter-balanced in two lists, with an additional forty-two fillers. Thus, each experimental list contained forty-two experimental and the same forty-two filler stimuli. Filler items contained gender-unambiguous definitional role names (ex. *princess*, *father*) with gender-matched pronouns or a role name in the plural form matched with the plural pronoun (*they*). Each participant saw the same forty-two fillers. The role and occupation names were matched with the same verb across each trial. Appendix D.1 (target stimuli) and Appendix D.2 (fillers) contain a list of all items used in the self-paced reading experiment.

Table 4.2: Example of segmentation of constructions in Experiment I

1	2	3	4
The soldier detonated the explosive	because courageously	**she** fought	for the country's freedom.
The soldier detonated the explosive	because courageously	**he** fought	for the country's freedom.

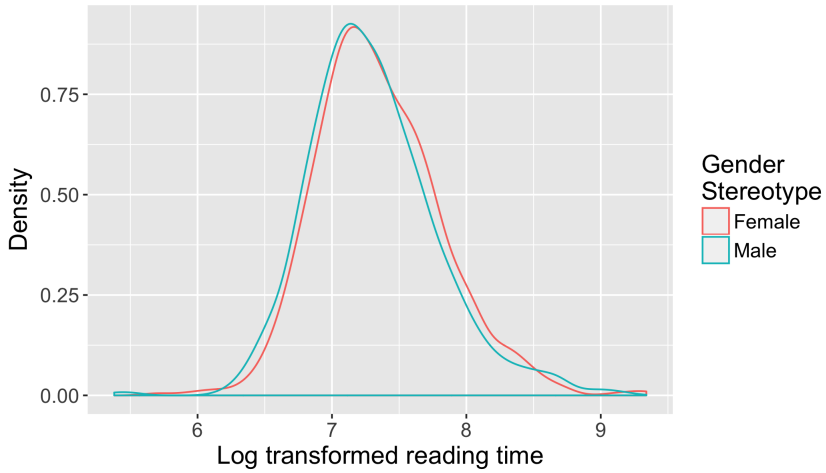
Procedure

Sentences were presented and data was collected using E-Prime version 1.0.0.223. Stimuli were presented on a 27″ LCD screen and responses were collected with desktop keyboards. The sentences were presented in a non-cumulative, stationary window self-paced reading paradigm, using a non-proportional Courier 14p font. That is to say, segments were presented one at a time, and once a segment was read (as indicated by pressing the button), it could not be read again. All sentence segments began at the same fixation point on the left side of the screen. Sentences were presented as segmented in the example shown in Table 4.2. Each session started with written instructions. Throughout the experiment, sentence comprehension questions were asked randomly for forty percent of the sentences. All questions were yes or no questions relating only to the current sentence. Participants progressed through the exercise by pressing the space key with their dominant hand thumb, while keeping both left and right index fingers on the <y> and <n> keys, respectively. Prior to beginning the experimental block, four practice sentences were presented to participants to familiarize the participants with the procedure.

4.2.2 Results

Data was analyzed using linear mixed-effects regression as implemented in the lme4 package, version 1.1-9 (Bates et al., 2015) and pairwise factor combinations within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) in R version 3.2.2 (R Core Team, 2016). Again, in least-squares means comparisons, linear variables (*i.e.*, dominance, valence, arousal, verb length and frequency) were tested at two levels: the mean of all values above the standard mean, plus one standard deviation, and the mean of all values below the standard mean, minus one standard deviation. Reading times are reported in log transformed milliseconds (*ms*). Trials for which comprehension questions were incorrectly answered as well as those with reading times two standard deviations above or below the by-subject or by-item segmental reading time were eliminated (6.97% of data points).

Figure 4.1: Effect of gender stereotype on reading time in segment one



Segment one

Segment one included the gender stereotyped role name, a dominance-controlled verb and the inanimate object of the verb (*e.g., The soldier detonated the explosive*). Inanimate objects were used so that the character to which the gendered pronoun referred was unambiguous. Compared to a more complex model including random intercepts and slopes by subject and item for gender stereotype ($p = 0.99$) and

pronoun gender (p = 0.89), a simple model including only random intercepts by subject and by item was found to have the best model fit. A summary of the model is located in Appendix D.3.

The significant factors to affect reading time in segment one were the gender stereotype of the role name and the length of the verb. Stimuli which contained a male pronoun had significantly faster reading times (β = -0.05, SE = 0.02, t = -2.35; Figure 4.1), and stimuli containing longer verbs had significantly longer reading times (β = 0.23, SE = 0.05, t = 4.81).

Segment two

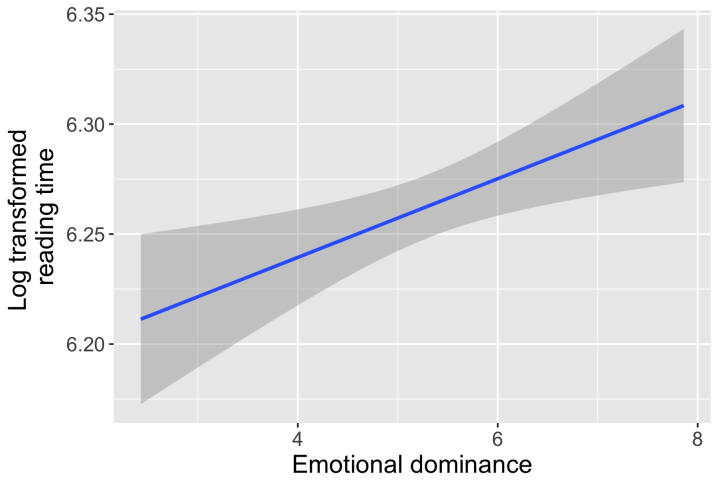
Segment two was composed of the causal continuation *because* and an adverb (*e.g., because courageously*). A less complex model including random intercepts by subject and item was found to be a better fit than one including random intercepts and random slopes by subject and item for gender stereotype (p = 0.39) and pronoun gender (p = 0.90). A summary of the model is located in Appendix D.4. The dominance of the verb was the only factor to affect reading time. Reading time increased with the dominance of the verb, where high dominance verbs had longer reading times than lower dominance verbs (β = 0.05, SE = 0.03, t = 2.00).

Segment three

Segment three contained the gender-marked pronoun and a following verb (*e.g., she fought*). The model included random intercepts by subject and by item. A more complex model also including random slopes by subject and item for the gender stereotype (p = 1.00) or the gender of the pronoun (p = 0.99) did not improve model fit. The model summary is located in Appendix D.5.

We expected to find an interaction between the gender of the pronoun and the dominance of the verb, specifically in mismatching conditions, where readers may rely more heavily on emotional dominance as a signal for the gender of the character than they may when the stereotypical role name accurately predicted the proper gender. Within the segment, we found no significant interactions between gender and dominance. As in segment two, the dominance of the verb was found

Figure 4.2: Effect of emotional dominance on reading time in segment three



to be the only factor affecting reading time. As dominance increased for the main clause verb, so did reading time for the third segment ($\beta = 0.07$, SE = 0.03, $t = 2.54$; Figure 4.2). Lastly, the effect of gender congruence between the gender stereotype of the role name and the gender of the pronoun was not significant. Reading time was not significantly affected by whether the gender stereotype matched (*e.g., soldier* (male) + *he*), or mismatched (*e.g., soldier* + *she*).

Segment four

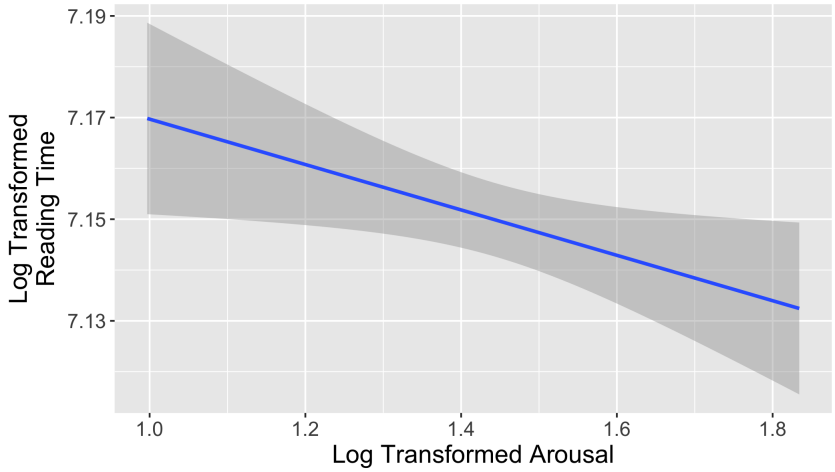
Segment four was the final segment and its content varied by item in order to bring the sentence to a plausible conclusion (*e.g., for the country's freedom*). A summary of the model is located in Appendix D.6. Research has shown that during processing of the end of a sentence, readers perform additional processing tasks (Just & Carpenter, 1980). These sentence final processes are known as sentence wrap-up. At this time, readers perform additional tasks including searching for referents that have not been assigned, using inference to construct interclause relations, and attempting to process any potential inconsistencies left unresolved in the sentence (Just & Carpenter, 1980). Therefore, we hypothesized that additional effects based on associations between the character's gender, the gender of the stereotypical role name and dominance of the verb may appear in segment four. This appeared to not have been the case. The only significant factor present in the fourth segment

was the emotional arousal of the verb (β = -0.13, SE = 0.06, t = -2.35). Stimuli involving more exciting stimuli had shorter reading times in the last sentence (compare the high dominance verbs *jeopardize, expose, detonate* with the low dominance verbs *summarize, consider, detach*.

Summed segments three and four

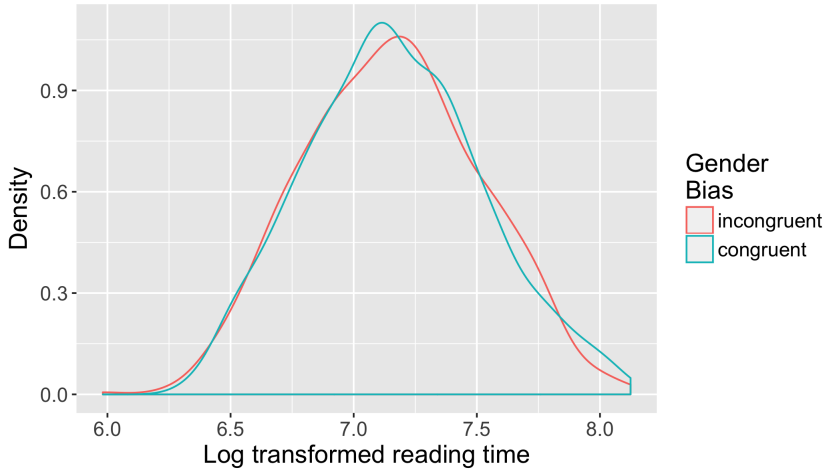
Past research has found that reading times for segments located both one and two words after the pronoun can show effects of pronoun resolution (Koornneef & Van Berkum, 2006). In our stimuli, segment four began on the second word after the pronoun. Because of the way our stimuli were segmented, we could expect to find effects of pronoun resolution both in segment three, which contained the pronoun and one additional word (*e.g., she fought*) and in segment four, which contained the second word after the pronoun and the conclusion of the sentence (*e.g., for the country's freedom*). Therefore, we summed the segmental reading times for the third and fourth segments together in order to attempt to capture the effect.

Figure 4.3: Effects of emotional arousal on reading time for the summed third and fourth segments during self-paced reading



A summary of the linear mixed effects model for the summed third and fourth reading times can be found in Appendix D.7. The dependent variable was the log-transformed reading time (*ms*) for the summed segmental reading time for the third and fourth segments. We tested independent variables including the emotional dominance, arousal and valence of the verb, as well as the gender of the

Figure 4.4: Effect of gender bias congruence for the summed third and fourth segments



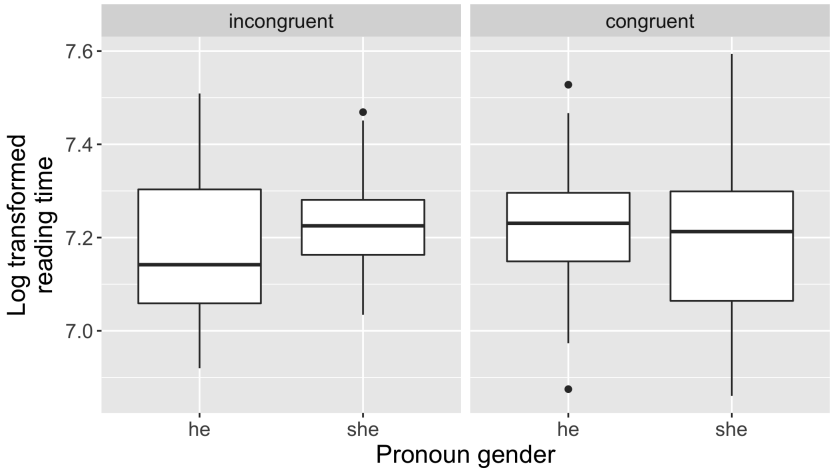
pronoun, the gender stereotype of the role name, verb length and verb frequency. Using backwards stepwise model comparisons and likelihood ratio tests, the final model included all significant predictors and non-significant variables that significantly improved the model fit. Independent variables included the pronoun gender, the congruence between the verb and the gender of the pronoun and the dominance, valence and arousal of the verb. Random intercepts were included for subject and item, as well as random slopes by subject and item for the gender stereotype. Compared to a simple model containing random intercepts for subject and item, the more complex model had a significantly better fit ($\chi^2(4) = 207.35$, $p = <0.001$).

We found main effects for the emotional arousal of the verb (β = -0.06, SE = 0.03, t = -2.92). Reading times were faster for stimuli which contained high emotional arousal verbs (Figure 4.3). Additionally we observed a congruence effect between the stereotypical role name and the gender of the pronoun (β = -0.15, SE = 0.06, t = -2.36; Figure 4.4). Reading times were faster when the stereotypical gender of the role name matched the gender of the pronoun (*e.g.*, *soldier* + *he*).

We observed a significant interaction between the gender of the pronoun and the congruence between the role name and the gender of the pronoun (β = 0.20, SE = 0.09, t = 2.29; Figure 4.5). In matching conditions where the gender stereotype and pronoun gender were congruent, male pronouns took longer to process

than female pronouns (β = 0.03, SE = 0.02, t = 2.00). The congruence effect was strongest with male pronouns, where male pronouns were processed faster when paired with male stereotyped role names than male pronouns paired with female stereotyped role names (β = -0.04, SE = 0.02, t = -2.20). The fact that this gender congruence effect was observed in the summed third and fourth segmental reading time suggests that perhaps some participants showed the congruence effect earlier during pronoun processing, while other showed the effect later in the last segment. The effect was not significant in separate segments, but combined it became significant.

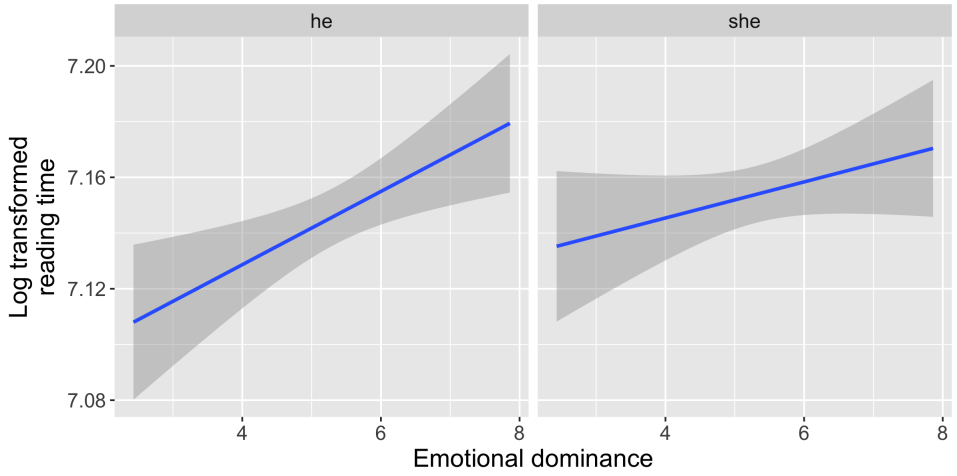
Figure 4.5: Interaction between pronoun gender and bias congruence for the summed third and fourth segments



We found an additional interaction between pronoun gender and the dominance of the verb (β = 0.10, SE = 0.04, t = 2.87; Figure 4.6). In high dominance conditions, segments containing male pronouns were processed faster than those with female pronouns, though the pairwise comparison was not significant (t = -0.14). The non-significance of the interaction in pairwise least-squares means comparison is presumed to likely be because the interactions is a component of a three-way interaction (to be discussed below).

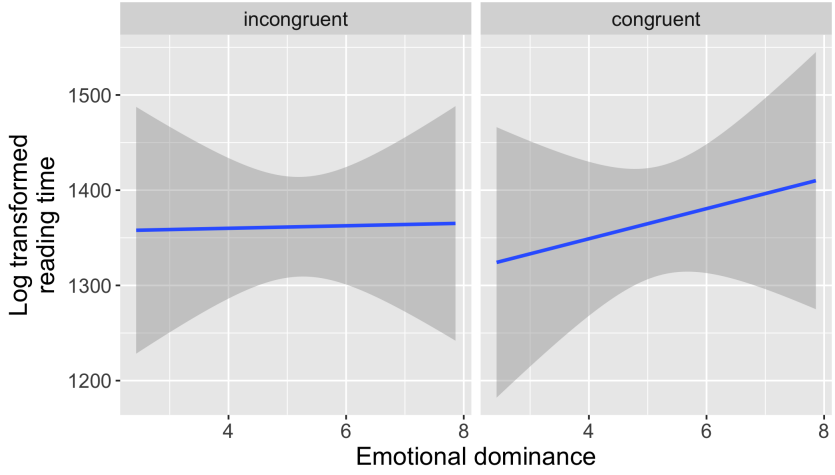
We also found interaction between the congruence of the gender stereotyped role name and the dominance of the verb (β = 0.11, SE = 0.04, t = 3.07; Figure 4.7). In stereotype matching conditions (*i.e.,* when the dominance of the verb matched the gender stereotype of the role name), segments which contained high dominance

Figure 4.6: Interaction between pronoun gender and emotional dominance for the summed third and fourth segments



verbs took longer to process in the third and fourth segments than low dominance verbs (β = 0.03, SE = 0.01, *t* = 2.70). In stereotype mismatching conditions, the summed reading time for third and fourth segments with high dominance verbs were processed faster than those with low dominance verbs (β = -0.03, SE = 0.01, *t* = -2.99). In segment one, we observed an interaction between stereotype and verb dominance. The fact that this additional interaction was found between pronoun gender and verb dominance suggests that the dominance effect in segment one may be over-ridden when the pronoun gender and gender stereotype mismatched.

Figure 4.7: Interaction between pronoun gender congruency and emotional dominance for the summed third and fourth segments



Finally, we observed a significant three-way interaction between the emotional dominance of the verb, the gender of the pronoun and the gender congruence (β = -0.16, SE = 0.05, t = -3.17). As can be observed in Figure 4.8, in incongruent conditions, stimuli with low dominance verbs and female pronouns had significantly shorter reading times than those with high dominance verbs and female pronouns (β = -0.04, SE = 0.02, t = -2.10). In incongruent conditions, stimuli with high dominance verbs and male pronouns had faster reading times than stimuli with high dominance verbs and female pronouns (β = -0.05, SE = 0.02, t = -2.71). Unexpectedly, in congruent conditions, stimuli with male pronouns and low dominance verbs had significantly shorter reading times than male pronouns with high dominance verbs (β = -0.05, SE = 0.02, t = -2.31).

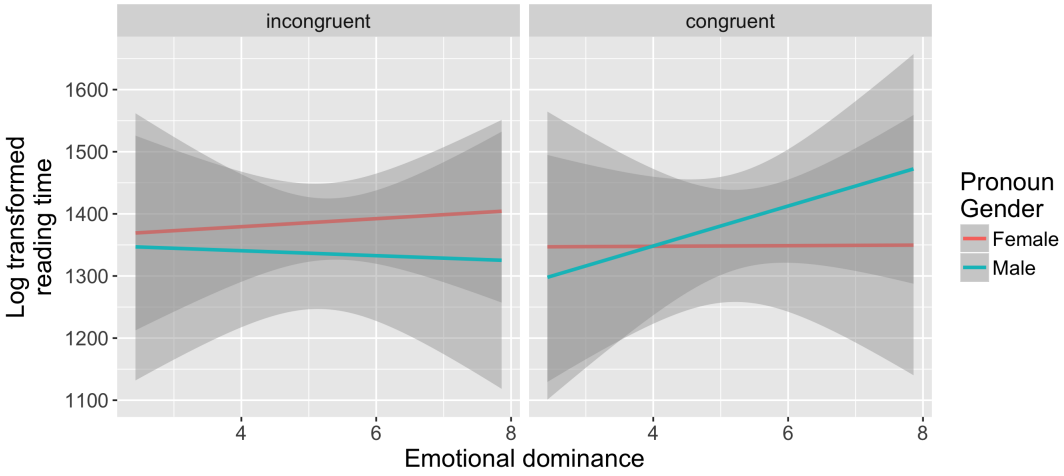
As hypothesized, emotional dominance appears to have provided a probabilistic cue for which, in incongruous gender stereotyped conditions, may have lead readers to infer the character gender congruent with the emotional dominance of the verb. This may account for the decreased processing time for segments where verbal dominance was congruent with pronoun gender and the increased processing time for segments where verbal dominance was incongruent with pronoun gender. In order to further investigate the patterns between stereotype congruent and incongruent stimuli, we examined two additional models looking at these two stimuli types independently.

Stereotype congruent

We first looked at stereotype congruent materials. These stimuli were gender matched between the stereotype of the role name and the pronoun. For example, the following sentence contains a male stereotyped role name (*porter*), matched with a male pronoun: *The porter unloaded the baggage because speedily he needed to return to the hotel lobby*. Our analysis investigated whether the low dominance of the verb *unload* affected processing during the process of pronoun resolution.

A complex model including random intercepts by subject and item and random slopes by subject and item for the stereotype of the role name was found to be a better fit than a simple model including only random intercepts by subject

Figure 4.8: Interaction between pronoun gender congruency, gender stereotype and emotional dominance for the summed third and fourth segments



and item ($\chi^2(4) = 255.66$, $p = <0.0001$). The model can be found in Appendix D.9. We found no significant interactions between dominance and gender on reading time. In fact, the only significant variable affecting the summed reading time for the third and fourth segments in gender congruent conditions was a main effect through the dominance of the verb ($\beta = 0.11$, SE = 0.02, $t = 5.96$). Regardless of the gender of the stereotype and pronoun, higher dominance verbs had longer reading times. This may suggest that in stereotype matching conditions, emotional dominance was not utilized to infer character gender. This may be because the initial inference based on the gender stereotypical role name alone lead readers to make the proper gender-based inference. When that inference was confirmed upon reading the pronoun, no additional processing was necessary to re-integrate character gender.

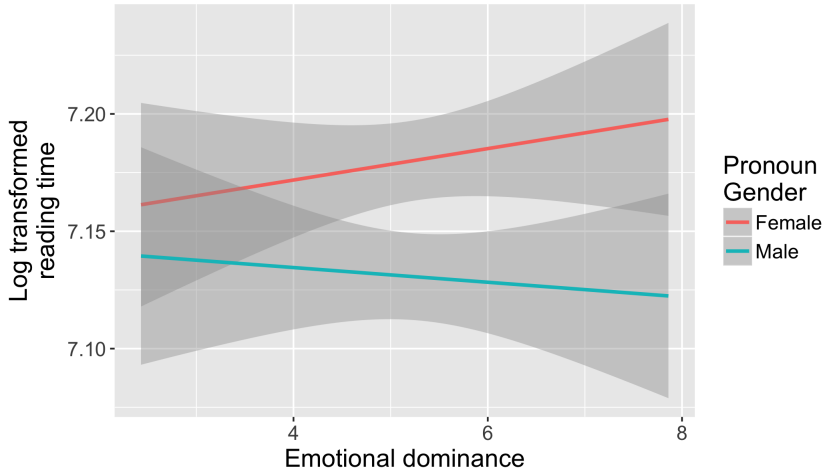
Stereotype incongruent

We then looked at stereotype incongruent materials. Incongruent materials mismatched in gender between the gender stereotypical role name and the pronoun (*The porter unloaded the baggage because speedily she needed to return to the hotel lobby*). We found a complex model including random intercepts by subject and item and random slopes by subject and item for the stereotype of the role name to be a better fit than a simple model including only random intercepts by subject

and item ($\chi^2(4) = 340.65$, $p = <0.0001$). The model can be found in Appendix D.8.

We found a main effect for the gender of the pronoun in mismatching conditions (β = -0.23, SE = 0.06, t = -3.75). Segments containing female pronouns had faster reading times than those with male pronouns. We also report finding an effect of dominance that was opposite to that found in matching stimuli; as dominance increased, reading times decreased (β = -0.05, SE = 0.02, t = -2.48).

Figure 4.9: Effects of dominance on the summed third and fourth segment reading time for stereotype-incongruent stimuli



Finally we found an interaction between the gender of the pronoun and the dominance of the verb (β = 0.15, SE = 0.03, t = 4.65). As visualized in Figure 4.9, the difference in reading time between pronoun genders for high dominance verbs was significant. Stimuli containing high dominance verbs and male pronouns had significantly faster reading times than stimuli with high dominance verbs and female pronouns (β = -0.07, SE = 0.02, t = -2.47). It appears that in mismatching conditions, where readers may have been required to re-evaluate the gender of a character based on a role name, dominance facilitated processing of the character's gender when it was congruent with the pronoun.

4.2.3 Discussion

Through this experiment, we found evidence of the expected effect of gender stereotype that has been reported by previous researchers (Carreiras et al., 1993, 1996;

Gygax & Gabriel, 2008), where a mismatch between stereotypical gender of the role name and the gender of the pronoun lead to slower reading times after presentation of the anaphoric pronoun. More pertinent to our research question is the fact that we also observed a significant interaction between emotional dominance and pronoun gender.

We predicted that high dominance verbs would have a stronger association to male characters and low dominance verbs with female characters. Our findings support this hypothesis. Throughout the study, regardless of the condition of congruency between the stereotype of the role name and the gender of the pronoun, participants were faster at processing the pronoun when the dominance-based gender association was congruent with the gender of the pronoun. That is, processing time during the summed third and fourth segments became faster for male pronouns as the dominance increased, and became slower for female pronouns.

For example, both the verbs *examine* and *divert* have high dominance. In stimuli that used the male pronoun *he*, reading times were faster than those with *she*. We expected to find the effect in conditions where the stereotypical gender of the role name mismatched the gender of the pronoun. Indeed, in independent analysis, the effect was present in the incongruent condition. For example, because of the dominance-based male gender preference of *examine*, reading times for the summed third and fourth interest area were most affected by dominance for stimuli such as *The social worker examined the house because importantly he reported on the family's living conditions*. *Social worker* carries a female gender stereotype, though the verb *examine* is high dominance. The high dominance of the verb lead to faster reading times during pronoun resolution for *he*.

The results of this analysis provide evidence that emotional dominance may have an association with gender that is actualized in language processing and the mental representation of characters. We have argued that, like affective valence, emotional dominance is a feature that can be accessed through its probabilistic association with male characters during language processing and online language comprehension. Emotional dominance can be considered a feature that has the

capacity to influence our perception.

Though we have evidence of an effect of dominance on the inference of character gender, it could be argued that readers adapt to the methodology of self-paced reading by using a more incremental processing strategy, whereby they may use probabilistic cues more quickly than during normal reading. Koornneef & Van Berkum (2006) have argued that readers may adapt to such a paradigm by more rapidly accessing lexically-based information because of the incremental nature of self-paced reading. Furthermore, even though self-paced reading is a good first-approximation method to tap into online language comprehension processes, its temporal resolution is rather low. Therefore, the time course of activation of dominance information in the processing of anaphoric pronoun resolution is yet unclear. Researchers have found that natural-reading eye tracking studies have found effects consistent to those found in self-paced reading paradigms (Koornneef & Van Berkum, 2006). Work on the use of gender stereotypes through eye-tracking experiments has provided thorough evidence of early effects in pronoun resolution (Pyykkönen et al., 2009). Therefore, we will conduct an experiment similar to Experiment I using an eye tracking paradigm. We expect that eye tracking will provide more fine-grained detail on the activation of dominance information during sentence reading.

4.3 Experiment II: Eye-tracking study

4.3.1 Methodology

Participants

Sixteen undergraduate students at the University of Alberta (8 male, 8 female; mean age = 20.4; minimum = 18; maximum = 27) received course credit for participating in the experiment. All participants were native speakers of North American English and had normal or corrected to normal vision.

Apparatus and materials

This experiment continues our investigation into the role of emotional dominance in the generation of gender-based inferences through an eye tracking version of Experiment I. Throughout the eye-tracking study, participants saw each sentence in its entirety (as opposed to the segmented stationary window in Experiment I) and each sentence was displayed on a single line. For the purpose of our analysis, stimuli in Experiment II were very similar to stimuli in Experiment I, though they were increased in length so as to segment the sentences into five interest areas rather than four. This segmentation refers only to our analysis and participants saw no visual cue as to how sentences were segmented during their participation. This was done to disambiguate pronoun resolution and sentence wrap-up effects (Just & Carpenter, 1980; Rayner, Kambe & Duffy, 2000), to provide a clearer view of the time course of pronoun processing. Table 4.3 provides a sample of how sentences were segmented. During sentence wrap-up, readers may search for referents that have not been assigned, use inference to construct interclause relations, and attempt to process any potential inconsistencies left unresolved in the sentence (Just & Carpenter, 1980). We wanted to try to ensure that this process was completed in a segment separate from that in which the pronoun was resolved.

As in Experiment I, each sentence occurred in one of two versions. In one, the gender stereotype of the role or occupation matched the gender of the pronoun, and in the other, the pronoun and gender mismatched (Appendix D.10). Filler items contained gender unambiguous definitional role names (*princess*, *sister*) with gender matched pronouns (*she*) or pluralized role names (*scientists*, *gardeners*) with the pronoun *they* (Appendix D.11). Each participant read a total of one hundred and twenty six sentences (eighty four targets and forty-two fillers). All items were

Table 4.3: Example of segmentation of gender stereotyped constructions in Experiment II

1	2	3	4	5
The soldier detonated the explosive	because courageously	**she** fought	for freedom	in the world.
The soldier detonated the explosive	because courageously	**he** fought	for freedom	in the world.

randomized by trial.

A desk top mounted Eyelink 1000 eyetracker (SR Research Ltd.) was used to monitor eye movements on a 27″ LCD screen in a sound attenuated booth. With the use of a stabilizing chin rest fixed to the table 86 cm from the top of the monitor and 58 cm from the top of the eye-tracker, the system was calibrated to participants' right eye using a nine-point grid. Eye movements were sampled at a rate of 1000 Hz.

Procedure

To begin each session, participants read written instructions which briefed them to read each sentence for comprehension. Before presentation of a sentence, a fixation mark appeared at the position of the first word of the sentence. While fixating on the mark, participants began a trial by pressing a button. The sentences were presented in their entirety, using 15 pt Times New Roman. Upon completion of a sentence, participants pressed the button on the game controller to progress. Throughout the experiment, sentence comprehension questions were asked randomly for forty percent of sentences. All questions required yes or no responses relating only to the current sentence. Respondents answered questions by pulling the right (yes) or left (no) trigger of the game controller. Prior to beginning the experimental block, four practice sentences were presented to participants to familiarize them with the procedure. The experiment lasted approximately forty-five minutes.

4.3.2 Analysis

Any fixation with a duration of less than 80 ms and within one character space of the next or previous interest area was moved to that interest area. All remaining fixations shorter than 80 ms were eliminated. Trials for which comprehension questions were incorrectly answered, as well as those with reading times two standard deviations above or below the mean by-subject or by-item segmental reading time were removed (2.71% of data points).

Data was analyzed using linear mixed-effects regression as implemented in the

lme4 package, version 1.1-9 (Bates et al., 2015) and pairwise factor combinations within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) in R version 3.2.2 (R Core Team, 2016). Reading times were measured in milliseconds (ms), and log-transformed for the analysis. Random intercepts by subject and item were included in the analyses. We tested independent variables of verb length, frequency, emotional dominance, valence and arousal, the gender stereotype of the role name, and the (in)congruence of the pronoun to the gender stereotype by segment for each of the reading time measures. For each model, we used backwards stepwise model comparisons and likelihood ratio tests to determine best model fit. Final models included all significant predictors and non-significant variables that significantly improved the model fit. Independent variables that differed by model will be discussed separately for each model below. The summary tables for each of the models can be found in Appendix D. Before providing results from individual models, we will discuss each of the interest areas and the reading time measures that were analyzed.

Interest areas

Each interest area refers to a segment of text as it was segmented in the experiment (see Table 4.3). The first interest area (*e.g.*, *The soldier detonated the explosive*) contained the gender stereotyped role name and the emotional affect-controlled verb. If emotional dominance and gender stereotype information arise early during processing (*i.e.*, before the pronoun), we expected to find and evidence of an interaction between the gender stereotype of the role names and the dominance of verb. Longer fixation durations were expected for sentences containing mismatched stereotypical gender roles and verb dominance pairs. The purpose of the second interest area (*e.g.*, *because courageously*) was to examine whether effects from the first interest area would spill over into the following interest area (*i.e.*, whether effects from the first interest area would appear later in processing, rather than earlier). The third interest area (*e.g.*, *he/she fought*) contained the pronoun and one word to the right. This interest area included not only the pronoun, but one additional word because often readers skip the pronoun entirely. The segment

resolves the gender of the character first introduced through the role name by providing gender information through the unambiguous gender marked pronoun (*he* or she). Reading time differences were expected when the gender of the pronoun mismatched the gender stereotype of the role name compared to when the pronoun matched the stereotype. Fixation durations were expected to be longer when the gender stereotype of the role name mismatched the gender of the pronoun, though results of the self-paced reading study in Experiment I show that it is possible for dominance to affect processing even in pronoun matched items. Finally, as proposed in clausal integration accounts, we looked at the reading time for the fifth interest area (*e.g.*, *in the world*) for differences in reading time in stereotype-pronoun gender incongruent sentences. Some researchers have argued that if semantic information is not activated until during clausal integration, effects on processing time would not appear until both implicit and explicit information from the main and subordinate clauses were integrated into a single representation (Garnham, 2001; Stewart et al., 2000). If this was the case for emotional dominance, processing effects would not appear until sentence wrap up in the fifth interest area. That is, we would not expect to find any early effects whatsoever. That being said, we expect that dominance information is available to readers early in processing, and though it is likely that given the incremental nature of language processing, it is likely there will be effects during sentence wrap-up, we do no expect to find evidence solely of clausal integration.

Reading time measures

We analyzed first fixation duration (the duration of the first fixation of the interest area on first pass), first gaze duration (the sum of all fixations on the interest area on the fist pass) and go past time (the sum of all fixations that occur before passing to the right of the interest area). Go past time is a measure of the summed first gaze duration that includes all regressive eye movements before moving on to a following segment. It differs from first gaze duration, as this measure includes regression into previously read interest areas. Regressive eye movements are taken as a sign of particular difficulty in sentence parsing, and so including regression

in a measure of first-pass reading time provides richer detail regarding text processing. In the current study, whole sentences were divided into five interest areas. Therefore, an interest area contained as many as five and as few as two words. As noted by Rayner (2009), when regions of interest areas are larger than a single word, additional measures are generally computed to take into account the more complex relationship between fixations, regressions and re-fixations. Therefore, we also analyzed second gaze duration (the sum of all fixations on the interest area on the second pass) and dwell time (the sum of all fixations on a given interest area). Dwell time can be more informative of reader text processing since a single fixation within a multi-word interest area is very likely. It differs from go past time in that it includes reading times when a segment is re-read after a reader has progressed onto a following segment. Below we report on each of the reading time measures for which significant effects were found. All significant effects are reported by interest area.

4.3.3 Results

First interest area

Neither measures of first fixation duration or first gaze duration showed significant effects. Go past time did show significant effects, while second gaze duration and dwell time did not.

For the measure of go past time (Appendix D.12), the effect from the gender stereotype of the role name was significant (β = 1.07, SE = 0.48, t = 2.26). Male stereotyped role names were fixated longer than female role names, though the effect was not significant in pairwise factor comparison (β = -.04, SE = 0.08, t = -0.57). We found early effects for the emotional dominance of the verb through an interaction between the stereotypical gender association of the role name and the dominance of the verb (β = -0.13, SE = 0.06, t = -2.15). Figure 4.10 visualizes the effect. In low dominance conditions, reading times for the first interest area were significantly faster when role name had a female stereotype and were significantly slower when the role name had a male stereotype (β = -0.22, SE = 0.11, t = -2.00). For example, take the low dominance verbs *submit* and *reject*. Reading times were

faster for segments containing female stereotyped role names (*The secretary submitted the request*) than those containing male stereotyped role names (*The engineer rejected the new plans*). This suggests an association between low dominance and female characters. Data for high dominance verbs followed the same pattern, where segments were processed slower when the gender stereotype of the role name was female and faster when the gender stereotype was male, though in least-squares means comparison the high dominance conditions did not reach significance (β = 0.07, SE = 0.10, t = 0.71).

Figure 4.10: Log transformed go past time for male and female stereotyped role and occupation names by emotional dominance of the main clause verb in the first interest area

Second interest area

We observed no significant effects for any of the measures in the second interest area. This was somewhat expected, since the purpose of the interest area was to look for spill-over of effects from the first interest area, before the gender of the character was revealed upon presentation of the pronoun in the third interest area. Therefore, no spill over effects were found to be present. This may suggest that any initial effects of emotional dominance influencing the mental representation of character gender upon reading the verb are concluded rapidly.

Third interest area

First fixation duration and first gaze duration showed significant effects. Measures of go past time did not show any significant effects, while second gaze duration and dwell time did.

Looking at measures of first fixation duration during pronoun resolution in the third segment (Appendix D.13), the congruence between the pronoun gender and the gender stereotype of the role name was the only significant factor in predicting fixation durations (β = -0.13, SE = 0.06, t = -2.09). When the pronoun was incongruent with the gender stereotype, segments were read significantly faster than when the pronoun was congruent with the gender stereotype. A similar effect was found for measures of first gaze duration on the pronoun resolution segment of sentences (Appendix D.14), where the congruence between pronoun gender and the gender stereotype was a significant contributor to fixation time (β = -0.13, SE = 0.06, t = -2.14). As visualized in Figure 4.11, when the pronoun was congruent, the pronoun resolution segment was read significantly slower than when the pronoun gender was incongruent with the gender stereotype (β = 0.13, SE = 0.06, t = 2.15). This may sound counter intuitive, since longer looking times are commonly associated with increased processing costs. In measures of first fixation duration, it is likely the case that when participants encountered the incongruent pronoun, they quickly regressed in order to try to disambiguate the potential processing error. This is consistent with other eye-tracking studies of gender inference, where gender incongruence has been found in decrease first fixation durations due to regressive eye movement (Irmen & Schumann, 2011).

Significant effects were found for measures of second gaze duration for the third segment (Appendix D.18). The congruence effect was significant (Figure 4.12), in which segments where the gender stereotype of the role name and the gender of the pronoun were congruent were read significantly faster (β = 0.24, SE = 0.12, t = 2.01). Processing time for segments containing pronouns incongruent to the gender stereotype of the role name were significantly slower. This seems to be consistent with our findings from first gaze duration in this segment. When

Figure 4.11: Log transformed first gaze duration by gender stereotype and pronoun gender congruence for the third interest area

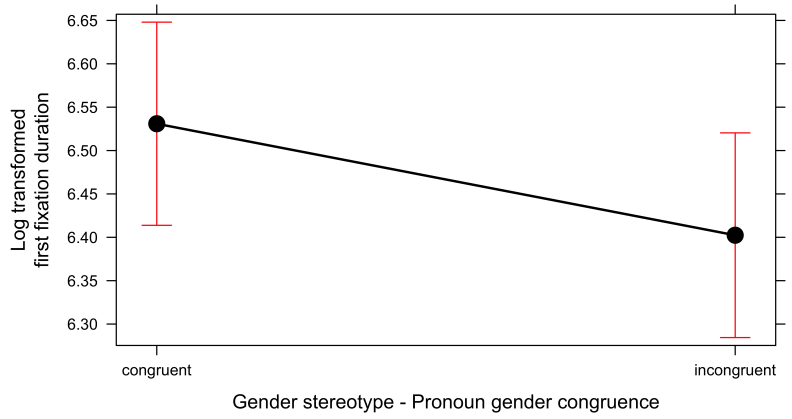
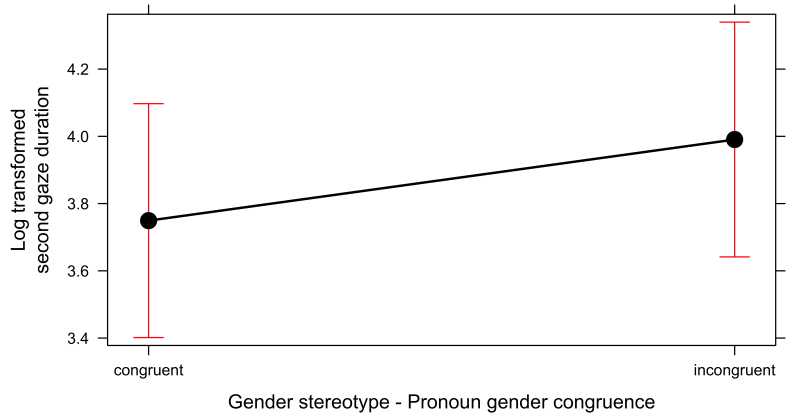


Figure 4.12: Log transformed second gaze duration by gender stereotype and pronoun gender congruence in the third interest area



readers enter the third interest area for the first time (*i.e.*, measures of first gaze duration), they recognize a possible incongruency and recheck the previous discourse. Afterwards, having confirmed the previous content, the longer processing time in incongruent conditions appears as expected (*i.e.*, in measures of second gaze duration).

Additionally in the third segment, the interaction in measures of second gaze duration between the gender of the pronoun and the dominance of the verb was significant (β = -1.17, SE = 0.46, t = -2.55). For sentences containing female pronouns, pronoun resolution was slower when the dominance of the verb was high

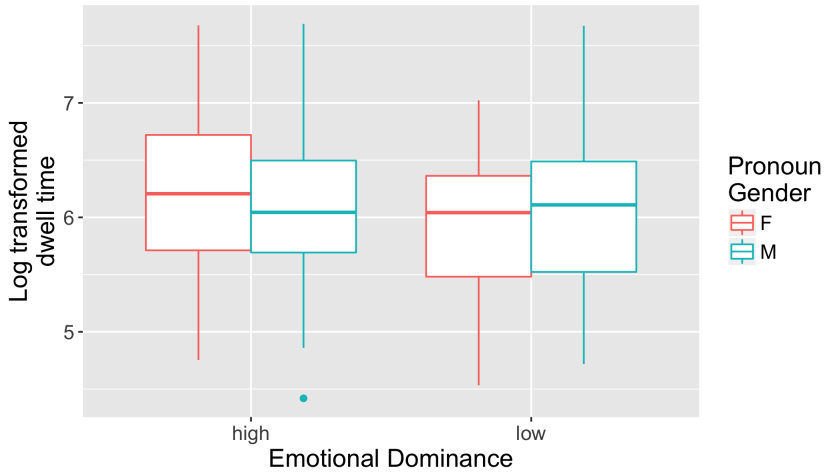
and faster when the dominance of the verb was low (β = 0.40, SE = 0.17, t = 2.32).

Looking at the dwell time on the third interest area (Appendix D.15), we found significant main effects for the gender of the pronoun (β = 0.69, SE = 0.18, t = 2.93), and the dominance of the verb (β = 0.46, SE = 0.10, t = 4.53). Segments containing male pronouns were read more slowly than segments containing female pronouns, though in pairwise factor comparison the difference was not significant (β = 0.03, SE = 0.04, t = 0.79). High dominance verbs had significantly longer dwell times than low dominance verbs (β = 0.13, SE = 0.04, t = 3.47; Figure 4.13). The interaction in measures of dwell time between pronoun gender and the dominance of the verb was also significant (β = -0.43, SE = 0.14, t = -3.04). Again, the higher the dominance of the main clause verb, the faster segments containing male pronouns, and the slower segments containing female pronouns were read (β = 0.23, SE = 0.05, t = 4.36). Female pronoun resolution in sentences with high dominance verbs was slower than female pronoun resolution in sentences with low dominance verbs (β = 0.23, SE = 0.05 , t = 4.36).

Fourth interest area

We found no significant effects for any of the reading time measures (Appendix D.16), though the congruence between the gender stereotype and the gender of the pronoun approached significance for first gaze durations (β = -0.13, SE = 0.7, t

Figure 4.13: Log transformed dwell time by dominance and pronoun gender for the third interest area

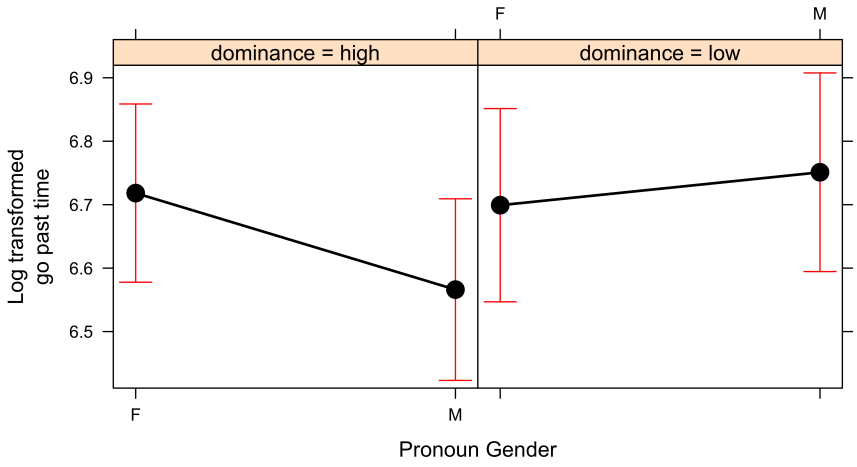


= -1.93). This marginal congruence effect was as expected; incongruent pronouns took longer to process than congruent pronouns. It is likely that this is spill over from the pronoun resolution in the third interest area.

Fifth interest area

We observed no significant effects for measures of first fixation duration, first gaze duration, or second gaze duration. Factors were found to significantly affect measures of go past time.

Figure 4.14: Log transformed go past time by pronoun gender and dominance congruence for the fifth interest area



In measures of go past time the interaction between the gender of the pronoun and the dominance of the verb was significant (Appendix D.17). During sentence wrap-up (Figure 4.14), sentences in which the dominance of the verb matched the gender of the pronoun (*i.e.*, high dominance, male pronouns; low dominance, female pronouns), go past times were more rapid (β = -0.51, SE = 0.25, t = -2.04). Specifically, for sentences containing male pronouns, sentences with high dominance main clause verbs were processed faster than sentences with low dominance main clause verbs (β = -0.18, SE = 0.09, t = -2.01). The same trend was found in sentences with female pronouns, where sentences containing high dominance verbs were processed slower than sentences containing low dominance verbs, though in pairwise factor comparison the effect did not reach significance (β = 0.02, SE =

0.009, $t = 0.21$).

4.3.4 Discussion

We found evidence of a congruence effect, whereby participants accessed role name-based gender stereotypes early in sentence processing for measures of both first fixation and first gaze duration in the third interest area. Table 4.4 summarizes mean reading times by gender stereotype and pronoun gender. Measures showed that participants quickly left the interest area when the gender marked pronouns were incongruent with stereotypical role names in the third interest area. Movement from the third interest area in segments where the stereotypical role name gender and pronoun were incongruent was likely because of reanalysis of previous discourse in order to overcome the processing difficulty. Measures of second gaze duration in the third interest area support this hypothesis, as measures were significantly longer for incongruent conditions. Likely, after readers entered the third interest area for the first time (*i.e.*, measures of first fixation and first gaze duration), they recognized the incongruence and regressed to re-read the previous discourse. Afterwards, having confirmed what had already been read, the longer processing time in incongruent conditions appeared as expected in measures of

Table 4.4: Mean fixation measures by interest area for congruency between the stereotypical gender of the role name and the gender of the pronoun

Interest Area	Gender Congruence	First Fixation Duration	First Gaze Duration	Second Gaze Duration
1	congruent	146.67	828.44	248.04
1	incongruent	147.19	811.10	228.78
2	congruent	155.18	877.72	229.30
2	incongruent	151.13	866.65	236.41
3	congruent	151.50	764.10	153.22
3	incongruent	144.57	745.73	173.90
4	congruent	145.36	824.71	186.53
4	incongruent	139.14	782.21	192.51
5	congruent	160.87	800.97	144.14
5	incongruent	156.19	797.89	146.50

Note: Dark shaded cells indicate significant differences and light shaded cells indicate near-significant differences in measures of fixation time.

second gaze duration. The near significant spill over congruence effect in measures of second gaze duration in the fourth interest area lends partial support to this interpretation, as the same congruence effect of dwell time in the third interest area was nearly significant in fourth interest area.

Regarding access to emotional dominance in the processing of character gender, we found evidence that participants utilized emotional dominance and role name-based gender stereotypes very early during sentence processing in measures of go past time in the first interest area. We found an interaction immediately in the segment containing the gender stereotyped role name and the main clause verb (Table 4.5). This interaction manifested prior to pronoun resolution, suggesting that right after presentation of a gender stereotyped role name, gender information has been activated. Measures of go past time decreased for sentences containing high dominance verbs and stereotypically male role names (*engineer, carpenter,*

Table 4.5: Mean go past time by interest area for the stereotypical gender of the role name and the dominance of the verb

Interest Area	Verb Dominance	Gender Stereotype	Go Past Time
1	high	F	996.22
1	low	F	889.70
1	high	M	965.78
1	low	M	971.58
2	high	F	1099.97
2	low	F	1034.40
2	high	M	1089.87
2	low	M	1096.76
3	high	F	981.64
3	low	F	933.61
3	high	M	988.74
3	low	M	977.45
4	high	F	1037.41
4	low	F	1045.61
4	high	M	1038.15
4	low	M	1014.20
5	high	F	998.61
5	low	F	1013.85
5	high	M	987.57
5	low	M	1018.87

Note: Dark shaded cells indicate significant differences in measures of fixation time.

judge). Similarly, go past times decreased for sentences containing low dominance verbs and female stereotyped role names (*nurse, florist, cashier*).

Finally, dwell time was significantly affected by the relationship between the gender of the pronoun and the dominance of the verb in the third interest area. As displayed in Table 4.6, dwell time was faster for female pronouns when the dominance of the verb was low and increased as the dominance increased. Again, the opposite effect was found between male pronouns and the dominance of verbs; dwell times for segments containing male pronouns were read increasingly faster as the dominance of verbs increased. The same effect was found during sentence wrap-up while measuring dwell time. Sentences containing male pronouns were processed faster when the dominance of the main clause verb was high, and dwell times were processed slower when the dominance of the main clause verb was low.

Because we find very early effects of emotional dominance from measures of go past time in the first interest area, to late measures of dwell time in the fifth interest area, the data indicate that the effect of dominance on the perception of character gender is fast and long lasting. That is, emotional dominance appears to activate rapidly and continue to be used throughout incremental discourse processing.

4.4 General Discussion

In general, it appears that participants made inferences about the gender of characters based on the dominance of verbs in the main clause of sentences. In Experiment I, this manifested as an interaction between the dominance of the verb and the gender of the pronoun. Female pronouns had longer reading time and male pronouns had shorter reading time when the dominance of the verb was high. When the gender stereotype of the role name was incongruous with the gender of the pronoun, readers were faster at reading the third and fourth segments of sentences when the pronoun gender matched the dominance of the verb than when it mismatched the dominance of the verb.

During eye-tracking in Experiment II, an effect of emotional dominance on gen-

Table 4.6: Mean fixation measures by interest area for the dominance of the verb and the pronoun gender

Interest Area	Verb Dominance	Pronoun Gender	Go Past Time	Second Gaze Duration	Dwell Time
1	high	he	1006.35	259.06	1146.72
1	low	he	968.79	221.70	1070.12
1	high	she	954.14	244.21	1150.89
1	low	she	894.81	222.04	1052.67
2	high	he	1077.85	227.95	796.52
2	low	he	1063.82	236.84	772.38
2	high	she	1111.56	239.70	744.91
2	low	she	1065.82	226.56	732.10
3	high	he	976.75	160.58	528.95
3	low	he	921.85	166.00	521.63
3	high	she	994.07	179.24	603.22
3	low	she	985.93	145.72	459.68
4	high	he	1031.30	188.12	620.34
4	low	he	1023.82	197.07	626.06
4	high	she	1044.27	197.20	618.49
4	low	she	1037.61	174.05	587.38
5	high	he	976.32	144.00	631.50
5	low	he	1034.95	148.32	583.72
5	high	she	1008.19	143.07	569.52
5	low	she	998.93	146.75	571.88

Note: Dark shaded cells indicate significant differences in measures of fixation time.

der perception was observed in measures of go past time for the first interest area. Upon reading the gender stereotyped role name and dominance-controlled verb, we found that high dominance and male role names and low dominance and female role names were fixated for significantly shorter durations. A similar effect was found in an interaction between emotional dominance and the gender of pronouns for measures of dwell time in the third interest area. Participants were able to process the pronoun resolution segments of sentences faster when the gender of the pronoun matched with the dominance of the main clause verb. High dominance lead to faster reading of male pronouns, while lower dominance lead to faster reading times for female pronouns. This effect continued into the fifth segment, where go past times were also significantly affected by the same interaction.

This evidence suggests that participants incorporated information regarding the emotional dimension of dominance associated with verbs into their mental representation of the depicted events. The eye-tracking data allowed us to obtain

more information on the time course than was possible from the summed third and fourth segments in the self-paced reading experiment, where it was not possible to disentangle pronoun resolution from sentence wrap-up effects. The eye-tracking data verified the presence of effects from dominance in both pronoun resolution and incremental integration. As well, effects during verb reading provide evidence that dominance is accessed early in processing, when the gender of characters is first inferred. Early effects such as these (*e.g.*, congruence effects in measures of go past time in the first interest area and measures of first fixation and first gaze durations during pronoun resolution in the third interest area) can be accounted for through the theoretical framework of immediate focus. Furthermore, the effect seems to be long lasting (*e.g.*, congruence effects in measures of dwell time during sentence wrap-up in the fifth interest area), providing evidence of incremental integration.

As we discussed in Section 1.6, within the field of implicit causality, researchers have adopted an account in which both immediate focussing and incremental integration theories are utilized to explain how language users access and unconsciously utilize implicit causality information throughout sentential processing (Bott & Solstad, 2014; Koornneef et al., 2016; Koornneef & Sanders, 2013; Pyykkönen & Järvikivi, 2010). The experimental evidence found throughout Experiments I and II in this chapter appear to support a similar account for the use of emotional dominance during sentential processing. Upon presentation of a verb, the inherent dominance associated with the verb lead readers to immediately make inferences about the gender of a character. When the dominance of the verb mismatched the gender bias of a gender stereotypical role name, processing difficulty occurred. Then, when the gender of the character was disambiguated during pronoun resolution, incremental processing difficulty occurred when the previously inferred gender of the character mismatched the gender of the pronoun.

4.4.1 Conclusion

Taken together, the results of these experiments provide relatively strong evidence that readers utilize emotional dominance during the inference of charac-

ter gender. Previous studies have provided evidence that readers make inferences about text based on the features of words, including the affective valence (Phelps, 2006; Schacht & Sommer, 2009), temporal information (Anderson, Garrod & Sanford, 1983), spatial information (Glenberg, Meyer & Lindem, 1987), emotional cues (Gernsbacher & Robertson, 1992) and gender-stereotypes (Doherty & Conklin, 2017; Gabriel et al., 2017; Garnham et al., 2002; Garnham & Yakovlev, 2015; Gygax & Gabriel, 2008; Molinaro et al., 2016; Nieuwland, 2014). Such cues can be used to edit and update the mental representation online, and incrementally. Readers are capable of making elaborative inferences based on the implicit content of words. Our research has built on this idea by providing evidence that dominance may be used by readers to make inferences about the gender of characters rapidly during discourse processing.

Expanding on these findings, Chapter 5 will continue our multi-modal and multi-methodological research into the ability of readers to make use of implicit cues from emotional dominance by conducting two additional reading experiments. In the following chapter, we will investigate the use of emotional dominance in the inference of character gender through the use of implicit causality.

Chapter 5

Influence of Emotional Affect on Implicit Causality Bias During Reading Comprehension

5.1 Introduction

In this chapter we continue our investigation of emotional dominance as a probabilistic feature accessible to readers during the processing of verbs and seek further evidence that emotional affect may play a role in the mental representation of character gender. The experiments featured in this chapter utilize implicit causality bias to investigate the role of emotional affect in the perception of character gender, similarly as to how it was used in Chapter 3. In our exploration of emotional affect, emotional dominance will be given the greatest consideration, as it was found to be the greatest contributor to the perception of character gender throughout the reading studies in Chapter 4. This chapter is comprised of two timed reading tasks that examine the effects of emotional affect during the processing of implicit causality.

As outlined in Section 1.6 of Chapter 1 and studied in Chapter 3, implicit causality bias refers to an unconscious bias to attribute the underlying cause of an event to one of two grammatical arguments of a verb. For example, in the sentence fragment *Amy intimidated Keith because shockingly ...*, the verb *intimidate* has an NP1 bias; the verb inherently attributes cause to the stimulus (*Amy*). Using an implicit causality framework, the more probable continuation for the phrase would consist of a causal explanation as to why *Amy* was intimidating *Keith* (Bott & Solstad,

2014). Researchers have confirmed the bias for a subset of interpersonal verbs through sentence completion and judgement tasks (for example, Ferstl et al., 2011; Garvey & Caramazza, 1974; Hartshorne et al., 2015, 2013). In a completion task, participants are provided with sentence fragments, such as in our experiment in Chapter 2 and asked to provide an explicit cause to each event. This method can provide information about the implicit causality bias by calculating the directionality of the bias based on participant responses.

We can also examine the bias by measuring reading time during pronoun resolution in reading studies. Returning to our example of *Keith* and *Amy*, based on the NP1 bias of *intimidate*, the reader is more likely to infer that the fragment will identify *Amy* as the cause of the intimidation. If, on the other hand, the phrase continued with *Keith* as the cause instead, (*e.g., ... because shockingly he threatened to tell the journalist about the scandal*), we would expect to find reading times to be longer. This additional processing time would likely be due to the time needed as readers bonded the identity of the causal character to *Keith* and updated their mental representation to reflect the changes in causal structure that were originally constructed based on the readers' probabilistic predictions introduced through the implicit causality bias of the verb.

Researchers have identified a wide range of factors that can influence how cause is assigned in implicit causality constructions (Bott & Solstad, 2014; Dery & Bittner, 2016; Featherstone & Sturt, 2010; Ferstl et al., 2011; Garnham et al., 1996; Garvey & Caramazza, 1974; Hartshorne, 2014; Hartshorne et al., 2015, 2013; Järvikivi et al., 2017; Koornneef et al., 2016; Koornneef & Van Berkum, 2006; Lafrance et al., 1997; Long & De Ley, 2000; McKoon et al., 1993; Niemi et al., 2016; Pyykkönen & Järvikivi, 2010). Lafrance et al. (1997) researched social interaction and the effects that gender had on the perception of implicit causality and control over action. In a judgement task, participants read simple S-V-O constructions, such as *Larry abhors Mary*. Participants were asked to rate the degree of causation they associated with the subject and object-position characters on a 9-point scale. They found that the causal bias was more strongly associated to male characters for action verbs (*e.g., help, deceive, criticize*) and more strongly associated to female characters for

psychological verbs (*e.g., love, trust, hate*). Furthermore, they found that regardless of the thematic role of the nominal argument, the causal bias was stronger for men when the valence of the verb was low (*i.e.,* constructions where male characters were acting negatively towards female characters). They concluded that in general, males are perceived to be the cause and initiators of negative actions, and therefore, negative actions performed by male characters are identity-confirming, while negative actions performed by female characters are identity-disconfirming.

Further influences from gender and affective valence were provided by Ferstl et al. (2011) through a web-based sentence completion task. Ferstl et al. (2011) calculated the implicit causality bias of verbs based on the number of participant responses that re-mentioned either the NP1 or NP2 character. The study assumed an active, transitive sentence structure in which the bias was towards NP1 for agent-patient and stimulus-experiencer verbs, and towards NP2 for agent-evocator and experiencer-stimulus verbs. They, too, found that gender affected the implicit causality bias, through which the overall preference was for continuations to attribute cause to male characters. They also reported an effect from valence, where cause was more commonly associated with the NP1 character for negative events and the NP2 character for positive events.

They also observed an interaction between valence and character gender. Negative actions were more likely to be attributed to male characters and positive events were more likely to be attributed to female characters, regardless of the gender of the NP1 character (*i.e.,* the character actually performing the event). Through their study of three hundred and five verbs, they found that positive events were more likely to be perceived as female-caused and negative events were more likely to be perceived as male-caused. Knowing that the dimension of affective valence and character gender are able to affect the implicit causality bias, it is possible that emotional dominance and character gender may also have an association with implicit causality.

The goal of this chapter is to provide clearer insight into the role of emotional dominance in the perception of implicit cause, and the role of emotional dominance in the perception of character gender. We are interested in the extent to

which gender and dominance can affect the implicit causality bias, and vice-versa, when participants comprehend sentences in real time. Using emotional dominance information and manipulating the gender of characters in the NP1 and NP2 position, we may be able to observe a difference in reading behaviour that informs us of the associations participants have between emotional dominance, implicit causality and gender. We hypothesize that readers may utilize emotional dominance probabilistically to infer character gender; that a high dominance verb may have a stronger probabilistic association to male characters, while a low dominance verb may have as stronger association to female characters. Additionally, we propose that readers may use dominance and gender information in order to predict causal association. Using our earlier example, *intimidate* is a high dominance verb. Are readers more likely to predict *Keith* to be the cause of the intimidation when it is *Keith* who has intimidated *Amy*, rather than *Amy* who has intimidated *Keith*? By controlling for the emotional dominance of the verb and manipulating the gender of characters, this is one of the key questions we intend to answer.

In what follows, we will examine the use of emotional affect in the interpretation of character gender and the assignment of cause through the use of implicit causality bias constructions in both self-paced reading and eye-tracking studies. The experiments are similar in design and structure, and therefore our research questions are similar to those in Chapter 4, though we investigate the associations between gender and dominance through a different modality, namely, implicit causality bias. We will investigate: (1) whether readers utilize emotional affect during reading comprehension; (2) whether readers utilize emotional affect in the assignment of implicit cause; (3) if readers make probabilistic inferences based on the emotional affect of verbs; (4) whether emotional affect can impact the perception of character gender; and if so, (5) the effect of emotional dominance on the perception of gender; and (5) the time course through which readers access and utilize emotional affect during reading.

5.2 Experiment I: Self-paced reading study

5.2.1 Methodology

Participants

Thirty undergraduate students at the University of Alberta (15 male, 15 female; mean age = 21; minimum = 18; maximum = 30) were given course credit for participating in the experiment. All participants were native speakers of North American English and had normal or corrected to normal vision.

Materials

This experiment investigates the role of emotional dominance in the generation of gender-based inferences through the framework of implicit causality. Sentences in Experiment I follow a self-paced reading design similar to Koornneef & Van Berkum (2006). Target sentences involved two characters, introduced by given name, and an interpersonal verb (*e.g., Mary advised Harold*). This was followed by the causative *because* and an adverb (*e.g., because genuinely*), a gender-marked pronoun and an additional verb (*she supported*), and a plausible conclusion to the sentence (*their partnership*). Sixty verbs were selected from the subset of four hundred and twenty target stimuli, controlled for valence, arousal and dominance (Warriner et al., 2013), implicit causality bias (Ferstl et al., 2011) and thematic role (Kipper et al., 2006). The set of four hundred and twenty verbs can be found in Appendix A.1, and a list of the verbs used in this experiment can be found in Appendix E.1. Verbs varied between Chapter 4 and the current chapter, though the same verbs were used within each chapters' experiments. Given names were selected from a list of the top one-hundred most popular boy and girl names in North America, and were verified to be common and gender-unambiguous by two native English speaking Canadians.

Using the data in Table 5.1 as an example, we designed four variants for each of the sixty target verbs. Each variant contained a male and a female character. This ensured that the pronoun unambiguously referenced a single character in each sentence. Two variants contained male NP1 characters and two contained female

NP1 characters. One of each of the two variants matched the implicit causality bias of the verb, while the other mismatched the bias. In the case of Table 5.1, *advise* is NP1-biased, and therefore sentences (b) and (c) are congruent with the implicit causality bias, while (a) and (d) are incongruent. Since the verb is NP1 biased, readers are more likely to expect the first mentioned character (NP1) to be re-mentioned as the cause of the event. The four variants were split into four lists, each containing only one of the four variants for each of the verbs. Each list was evenly sampled by NP1 gender, implicit causality bias and implicit causality bias congruence.

Table 5.1: Example of segmentation of implicit causality constructions in Experiment I

	1	2	3	4
(a)	Mary advised Harold	because genuinely	he supported	their partnership.
(b)	Mary advised Harold	because genuinely	she supported	their partnership.
(c)	Harold advised Mary	because genuinely	he supported	their partnership.
(d)	Harold advised Mary	because genuinely	she supported	their partnership.

In addition to the sixty target stimuli, we included another sixty filler items. Filler items contained gender-matched NP1 and NP2 characters (*e.g.*, *Anna [verbed] Vivian*; *Harold [verbed] Steve*). This was in part so that participant did not always assume a mixed-gender pairing. We used an equal number of filler continuations with either gender-ambiguous anaphoric pronouns or a cause that referred back to both members with the plural pronoun (*they*). Each participant saw the same sixty fillers. A list of stimuli and filler items can be found in Appendix E.2 and Appendix E.3, respectively.

Procedure

Sentences were presented on a 27″ LCD screen and responses were collected with desktop keyboards. The experiment was designed and responses were collected using E-Prime version 1.0.0.232. The sentences were presented in a non-cumulative, stationary window self-paced reading paradigm, using a non-proportional Courier 14p font. Each session started with written instructions. Throughout the experiment, comprehension questions were asked randomly for forty percent of the sentences. All questions required a yes or no response, relating only to the current

sentence (available in Appendix E.4). Participants progressed through the exercise by pressing the space key with their dominant hand thumb, while keeping both left and right index fingers on the <y> and <n> keys. Prior to beginning the experimental block, four practice sentences were presented to participants to familiarize them with the experimental procedure.

5.2.2 Results

We expected to find an effect of implicit causality during pronoun resolution. Sentences in which the gender of the causal character was incongruent with the predicted gender based on the implicit causality bias of the verb were expected to have longer reading times. Furthermore, we hypothesized that if participants attended to emotional dominance as they did during the sentence completion task in Chapter 3, the dominance of the verb may affect the perception of character gender with regard to the implicit causality bias. We have previously proposed that high dominance verbs are associated with male characters and low dominance verbs with female characters, as was also found to be the case with the gender stereotype-based reading task in Chapter 4. Similarly, we therefore expected that in incongruent conditions (*i.e.*, when the causal character is identified as the non-implicit causality biased character), readers would have faster reading times when the dominance of the verb was congruent with the gender of the pronoun (*i.e.*, high dominance verbs and male pronouns, low dominance verbs and female pronouns). For example, *advise* is a high dominance, NP1 biased verb. In the incongruent conditions of 5.1 (a) and (d), we expect reading times to be more facilitated in (a) than in (d). This is due to the cognitive association between male character and high dominance. Although both stimuli are incongruent with the implicit causality bias, the male pronoun *he* may have a processing advantage through which readers will be able to more quickly overcome the (in)congruence effect during pronoun resolution because of the association between male characters in discourse and high dominance.

Data was analyzed using linear mixed-effects regression as implemented in the lme4 package, version 1.1-9 (Bates et al., 2015) and pairwise factor combinations

within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) in R version 3.2.2 (R Core Team, 2016). Reading times were measured in milliseconds (ms), and log-transformed for the analysis.

In our analysis, trials for which comprehension questions were incorrectly answered and segments which had reading times two standard deviations above or below the by-subject or by-item segmental reading time were eliminated (5.9%). In previous research, pronoun resolution effects have been reported in self-paced reading experiments both one and two words after the pronoun (Koornneef & Van Berkum, 2006). As in Chapter 4 (Experiment I), the segments in this self-paced reading study corresponding to one and two words after the pronoun appeared in different segments. Therefore, following the analysis used in Chapter 4 we analyzed the reading time for the summed third and fourth segments of the sentences together to ensure we captured the effects of pronoun resolution in their entirety, as well as analyzing individual segments.

We tested independent variables of participant gender, verb length and verb frequency, emotional dominance, valence and arousal, and the congruence between the implicit causality bias and the bias of the sentence[1], while controlling for NP1 gender and the implicit causality bias of the verb. Note that in our analysis participant gender was not found to significantly affect measures of reading time for any segment, and was omitted from analysis. Backwards stepwise model comparisons and likelihood ratio tests were used to find the best model fit. Information regarding individual models is provided for each individual model.

Segment one

In the first segment (*e.g., Mary advised Harold*), only the significant predictors of reading time for segment one. The best model fit included random intercepts by subject and item and random slopes by subject for NP1 gender. Compared to a more simple model including only random intercepts by subject and item, the more complex model significantly improved model fit ($\chi^2(2) = 12.43$, $p = 0.004$).

[1] If the re-mentioned causal character was the same character biased by the implicit causality bias of the verb (*NP1* or *NP2*), the sentence was considered congruent (*e.g., Vincent greeted (NP1-biased) Victoria because always he seemed interested in meeting new people*).

The summary of the linear mixed effects model can be found in Appendix E.5.

Within the model, the length of the main clause verb also significantly affected reading time for segment one (β = 0.28, SE = 0.04, t = 7.32). Understandably, the shorter the verb's length, the shorter the reading time for the segment (β = -0.20, SE = 0.03, t = -7.32).

The emotional dominance of the verb was also found to significantly affect reading time, where segments which contained verbs perceived as being higher in dominance had longer reading times (β = 0.12, SE = 0.04, t = 2.82). The implicit causality bias of the verb also significantly affected reading times, where NP2 biased verbs were read significantly slower than NP1 biased verbs (β = 0.57, SE = 0.11, t = 5.18). In least-squares means comparison the difference between NP1 and NP2 biased verbs was not significant (t = 0.32).

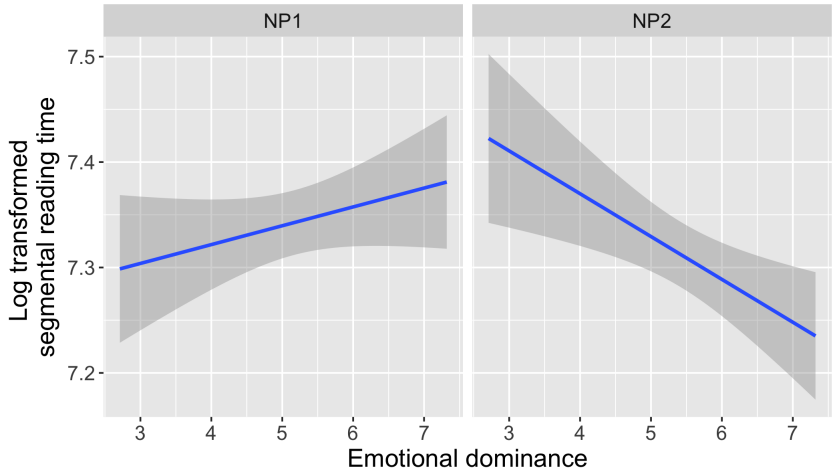
However, this was qualified by an interaction with emotional dominance (β = -0.35, SE = 0.07, t = -5.21). The effect is visualized in 5.1. In least-squares means comparison, the between group differences were significant. In low dominance conditions[2], segments containing NP1 biased verbs had significantly shorter reading times than segments containing NP2 biased verbs (β = -0.13, SE = 0.03, t = -4.45). Segments containing high dominance and NP1 biased verbs had significantly longer reading times than segments containing low dominance, NP2 biased verbs.

Segment two

In segment two (*e.g., because genuinely*), a more simple model including random intercepts by subject and item had the best model fit. More complex models, which included random intercepts by subject and item and random slopes by subject and item for did not significantly improve model fit for the NP1 gender of the sentence (p = 0.51), the implicit causality bias (p = 0.16), the emotional dominance (p = 0.91), or the congruity of the implicit causality bias (p = 0.96).

[2]In least-squares means comparison, dominance was tested at two levels: the mean of all values of dominance above the standard mean, plus one standard deviation (high dominance), and the mean of all values of dominance below the standard mean, minus one standard deviation (low dominance).

Figure 5.1: Reading time for segment one by emotional dominance and implicit causality bias



As summarized in Appendix E.6, the results reveal an effect for the implicit causality bias of the verb, where stimuli that contained NP1 biased verbs had faster reading times than stimuli with NP2 biased verbs (β = -0.04, SE = 0.02, t = -2.33). We also report an effect for the gender of the NP1 character (β = -0.03, SE = 0.02, t = -2.09). Stimuli which contained male NP1 characters had longer reading times than female NP1 stimuli (β = 0.03, SE = 0.02, t = 2.09). The interaction between NP1 gender and the implicit causality bias was not significant for segment two (t = 0.07), and was removed from the model.

Segment three

Segment three contained the gender-marked pronoun (*i.e., he supported*). A simple model including random intercepts by subject and item was found to have the best fit with the data. Complex models including random slopes by item failed to converge, and models that included random slopes by subject did not improve the model fit for NP1 gender (p = 0.72), the implicit causality bias (p = 0.31), the dominance of the verb (p = 0.06) or the congruence of the implicit causality bias (p = 0.66). A summary of the model can be found in Appendix E.7.

We hypothesized that if readers utilized the implicit causality bias, we would observe slower reading times in segment three for pronouns that were incongruent with the implicit causality bias of the verb. For example, earlier we used the

verb *advise* to illustrate the congruence effect. *Advise* is an NP1 biased verb, meaning that readers are more likely to expect the subject position character to be re-mentioned in the causal continuation as its cause. Therefore, in a sentence such as, *Mary advised Harold because genuinely he supported their partnership*, we expected slower reading times during the underlined portion of the sentence because of the mismatch in expected bias. Our expectation was not met, as no congruence effects were found in the third segment between the implicit causality bias of the verb and the gender of the pronoun.

We found a main effect for the dominance of the verb, in which stimuli that contained high dominance verbs had slower reading times for the third segment (β = 6.04, SE = 0.11, t = 2.54). Additionally the length of the verb affected reading time as well. Sentences that had shorter verbs in segment one had shorter reading times in segment three (β = -0.10, SE = 0.03, t = -4.08). Reading times were not significantly affected by the congruence between the implicit causality bias of the verb and the gender of the pronoun in the third segment. Implicit causality bias, even though accessed early, may not necessarily modulate pronoun resolution immediately (Koornneef & Van Berkum, 2006; Pyykkönen & Järvikivi, 2010) and could be masked by other factors (McDonald & MacWhinney, 1995), or occur only later during clausal integration (Garnham et al., 1996; Stewart et al., 2000).

Segment four

Segment four was the last segment of the sentence (*e.g., their partnership*). The best model fit included random intercepts by subject and item, and was not significantly improved by including random slopes by subject or item for the NP1 gender (p = 0.25), the implicit causality bias of the verb (p = 0.27), the emotional dominance (p = 0.13) or the congruence of the implicit causality bias (p = 0.56). The model summary is listed in Appendix E.8.

We found that the dominance of the verb significantly affected reading time in segment four (β = 0.62, SE = 0.15, t = 4.23). In pairwise comparison, stimuli which contained low dominance verbs had significantly shorter reading times than high dominance verbs (β = -0.13, SE = 0.04, t = -3.37). Additionally, a significant

interaction existed between the dominance and valence of the main clause verb (β = -0.26, SE = 0.10, t = -2.61). The interaction is visualized in Figure 5.2. In least-squares means comparison, the difference between high and low valence stimuli for the higher dominance verbs was significant (β = -0.26, SE = 0.04, t = -7.08). High dominance verbs that were also higher in valence (*e.g., applaud, cherish* had significantly shorter reading time than high dominance verbs that were low in valence (*e.g., intimidate, provoke*). The difference in dominance for high valence verbs was not significant (t = 0.77).

Figure 5.2: Interaction between dominance and valence in reading time for fourth segment

Summed segments three and four

Since past research has indicated that reading times for segments one and two words after the pronoun show effects from pronoun resolution (Koornneef & Van Berkum, 2006), we continued our analysis by summing segmental reading time of both the third and fourth segments together. Because the boundary for segment three in our stimuli was one word after the pronoun (*e.g., he supported*), we expected that perhaps we would find effects of dominance and gender only when the two segments were combined. Indeed significant effects were found in this model. Table 5.2 provides a summary of the linear mixed effects model. Compared to a simple model containing random intercepts for subject and item, the more complex model containing random intercepts for subject and item and random slopes by

subject for emotional dominance of the verb had a significantly better fit ($\chi^2(2)$ = 190.61, p = <0.001).

We found a main effect for the congruence of the implicit causality bias that was hypothesized in segment three (visualized in figure 5.3). In conditions where the gender of the pronoun mismatched the expected gender of the character based on the implicit causality bias of the verb, reading times were significantly slower (β = 0.02, SE = 0.006, t = 3.60).

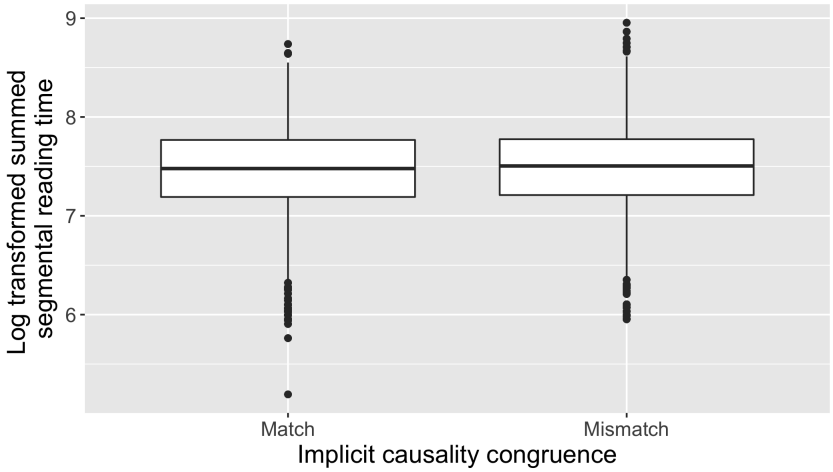
The results revealed an additional effect for the implicit causality bias of the verb (β = -0.02, SE = 0.006, t = -3.32). In least-squares means comparison, stimuli which contained an NP1 biased verb had significantly longer reading times than those with an NP2 biased verb (β = 0.02, SE = 0.006, t = 3.32).

Finally, we report an interaction between the gender of the pronoun and the dominance of the main clause verb (β = -0.05, SE = 0.02, t = -2.01). Pairwise comparison revealed that this effect appears to originate in sentences with high dominance main clause verbs. In high dominance conditions, segments containing

Table 5.2: Summary of linear mixed effects model of the summed third and fourth segments during implicit causality-based self-paced reading

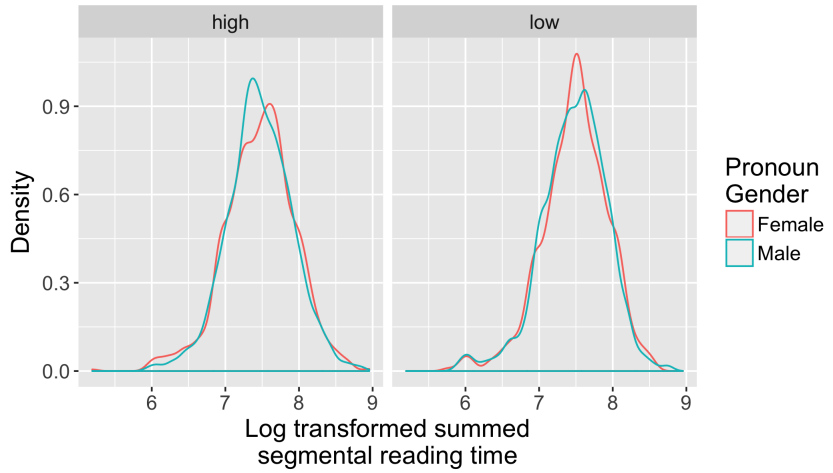
Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.732	−0.641	−0.043	0.579	7.541
Random effects:				
Groups	Name	Variance	Std.Dev.	
Block	(Intercept)	0.02	0.14	
Subject	(Intercept)	0.16	0.40	
	Dominance	0.002	0.05	-0.51
Residual	0.08	0.28		
Fixed effects:				
	Estimate	Std. Error	t value	
(Intercept)	7.46	0.07	102.48	***
IC-Bias(NP2)	−0.02	0.005	−3.32	***
log(Dominance)	0.07	0.04	0.53	
Pronoun(Male)	0.07	0.04	1.64	
IC-Bias(Mismatch)	0.02	0.005	3.60	***
log(Dominance) x Pronoun(Male)	−0.05	0.02	−2.01	*

Figure 5.3: Congruence of the implicit causality bias for reading times in the third and fourth summed segments



female pronouns were read significantly slower than segments containing male pronouns (β = 0.03, SE = 0.009, t = 2.93). This can be observed in the left panel of Figure 5.4, through the right-ward skew to the female pronouns. The difference between male and female conditions for sentences containing low dominance verbs was not significant (t = -0.48). It appears that regardless of the congruence of the implicit causality bias of the verb, in stimuli with high dominance verbs, segments with male pronouns were processed faster than those with female pronouns.

Figure 5.4: Density plot of male and female pronoun reading times for significant high (left) and non-significant low (right) emotional dominance during implicit causality-based self-paced reading



5.2.3 Discussion

It appears that participants made gender-based inferences about a character based partially on the dominance of the verb in the main clause of sentences. This manifested as an interaction between the dominance of the verb and the gender of the pronoun. These results are similar to those found in the self-paced reading study in Chapter 4. Previously, in the gender stereotype-based study, we found a significant interaction for the summed third and forth segmental reading time, between the gender of the pronoun and the emotional dominance of the main clause verb. Here, too, we observed that high emotional dominance in main clause verbs seemed to affect the manner in which readers inferred character gender during discourse processing.

In high dominance conditions, readers were faster at reading the summed third and fourth segments of sentences when the pronoun gender matched the stereotypical gender association as determined by the dominance of the verb. That is, high dominance verbs had faster summed third and fourth segmental reading times when the gender of the pronoun was male, and significantly slower reading time when the gender of the pronoun was female. For example, take the high dominance, NP1 biased verb, *provoke*. Reading times for *Richard provoked Mary because subtly he implied they were applying for the same position* were faster than reading times for *Mary provoked Richard because subtly she implied they were applying for the same position*. Participants were able to process the pronoun resolution segments of sentences faster when the gender of the pronoun matched with the associated emotional dominance of the main clause verb.

Though we hypothesized a three-way interaction between the emotional dominance, pronoun gender and the congruence of the implicit causality bias, influence of emotional dominance on gender was present regardless of the pronoun's congruence with the implicit causality bias of the verb. Although we found significant effects from emotional dominance in the inference of character gender, it appears that at least within self-paced reading parameters, emotional dominance may not have affected the implicit causality bias of verbs. We observed no significant inter-

actions between the implicit causality bias, dominance and character gender.

An additional consideration may be that due to differences in reading strategies based on the segmental nature of our self-paced reading experiment, readers did not access emotional dominance with regard to causal attribution. It has previously been argued that during self-paced reading, readers adopt strategies to process text in an incremental way that leads them to make greater use of probabilistic cues than that which is normally used during reading (Koornneef & Van Berkum, 2006). This kind of early access to lexically-based information made possible through self-paced reading may have lead readers to commit additional resources to inference production. If this is the case, it may explain why in Experiment I we found a more generalized effect of emotional dominance on gender inference. When the dominance of the main clause verb was high, readers showed a preference for naming the male pronoun as the cause of the event, regardless of whether the character was biased to be re-mentioned as the cause of the event or not.

The results of our self-paced reading experiment do suggest that emotional dominance affects perception of character gender, though the results do not provide much relevant insight into its effects on the implicit causality bias or the time course of access to dominance information in the processing of anaphoric pronoun resolution. The segment-by-segment analyses provide little information about the effects of dominance on gender inference and implicit causality bias. No interactions between dominance and gender were found on the individual segments of sentences. As discussed above, because it is possible to observe effects of pronoun resolution two words after the pronoun, we combined the segments which contained words one (segment three) and two (segment four) after the pronoun for an additional analysis. The summed reading time provided evidence of an effect of dominance on pronoun resolution, though told little of the time course of access to dominance-based information. By combining the segments we were able to observe the effect, but that further diminished the time course information.

Though self-paced reading paradigms in the study of implicit causality (Koornneef & Van Berkum, 2006) have found effects consistent with eye-tracking studies,

the sensitivity of time course information based on the incremental processing associated with self-paced reading means that information regarding the time course and the sensitivity of the reading procedure in general, are not as fine-grained. For example, our own eye-tracking study in Chapter 4 provided insight into the time course of emotional dominance to a greater degree than the self-paced reading study. During self-paced reading we found evidence of a male gender bias for high dominance verbs and a female gender bias for low dominance verbs. With eye-tracking, we found further evidence of the same interaction, with finer detail concerning the time course; within the first segment, where participants read the stereotyped role name and the dominance controlled verb, go past times were rapidly affected by the (in)congruence between the verb's dominance and the stereotypical gender. The same effect was found later in the sentence during pronoun resolution. Reading time decreased as the dominance increased for male pronouns and reading time decreased as the dominance decreased for female pronouns. The same interaction was found for dwell time during sentence wrap up. The eye-tracking measures provided clearer evidence that readers have rapid access to dominance-based gender probabilities and that once accessed, they may continue to be utilized throughout the reading process.

For these reasons, we follow our self-paced reading study on emotional dominance and gender perception through the processing of implicit causality sentences using an eye-tracking paradigm primarily in order to gain further insight into the time course of effects. As will be discussed in the following section, the eye-tracking study of implicit causality will incorporate the investigation of the effects of emotional dominance on the inference of character gender, while providing greater information regarding the time course of access to dominance-based information.

5.3 Experiment II: Eye-tracking study

5.3.1 Methodology

Participants

Thirty-two undergraduate students at the University of Alberta (15 male, 17 female; mean age = 20.6; minimum = 18; maximum = 31), all of whom did not participate in the previous experiments, were given course credit for participating in the experiment. Each participant was a native speaker of North American English and had normal or corrected to normal vision.

Apparatus and materials

Experiment I revealed that readers attend to emotional dominance to infer character gender in implicit causality constructions. A congruence effect between dominance and the gender of pronouns was present, where sentences containing high dominance verbs and male pronouns were processed faster than high dominance verbs paired with female pronouns. We continue our study of the effects of dominance on the perception of gender by utilizing an eye-tracked reading paradigm. To that end, sentences in Experiment II were lengthened in the segment following pronoun resolution and segmented into five interest areas rather than four (as seen in Table 5.3). The purpose of this change in stimuli was to enable us to disambiguate pronoun resolution and sentence wrap-up effects, which should provide more detail regarding the time course of pronoun processing.

Effectively this change allows us to better differentiate between effects of pronoun resolution and sentence wrap-up. In Experiment I, the segmentation of sentences was such that the last segment of sentences contained an area where we would expect effects of pronoun resolution (*i.e.,* two segments after the pronoun) and, being the final segment, sentence wrap-up. By extending the length of sentences, we now have a segment containing the pronoun (*e.g., he seemed*), a following segment where pronoun resolution effects may continue (*e.g., interested in meeting*) and a final segment (*new people.*) by which point we would expect pronoun resolution to have already completed. Such a design should provide more detail

regarding the time course of emotional dominance-based access and processing.

As in Experiment I, each sentence occurred in one of four versions. In the first two versions, the gender of NP1 was male (Table 5.3 a- b) and for the second two versions, the gender of NP1 was female (Table 5.3 c-d). A list of the experimental stimuli can be found in Appendix E.9. In one of each version of sentences, the gender of the pronoun matched either NP1 or NP2. Sixty target stimuli were created within each of the four structures, in addition to another sixty filler items. Filler items contained gender-matched NP1 and NP2 given names. A list of stimuli can be found in Appendix E.10. We used an equal number of filler continuations with either gender-ambiguous anaphoric pronouns or a cause that referred back to both members with the plural pronoun. Each participant saw the same sixty fillers.

In a sound attenuated booth, a desk mounted Eyelink 1000 eyetracker (SR Research Ltd.) was used to monitor eye movements on a 27" LCD screen. A stabilizing chin rest was fixed to the table 86 cm from the top of the monitor and 58 cm from the top of the eye-tracker. Participants' right eye was calibrated on a nine-point grid. Eye movements were sampled at a rate of 1000 Hz.

Table 5.3: Example of segmentation of implicit causality constructions in Experiment II

	1	2	3	4	5
(a)	Jack greeted Heather	because always	he seemed	interested in meeting	new people.
(b)	Jack greeted Heather	because always	she seemed	interested in meeting	new people.
(c)	Heather greeted Jack	because always	she seemed	interested in meeting	new people.
(d)	Heather greeted Jack	because always	he seemed	interested in meeting	new people.

Procedure

Sentences were displayed in their entirety on a single line. Participants were instructed read sentences in the experiment for comprehension. Each trial began with the appearance of a fixation mark at the position of the first word of the sentence. While fixating on the mark, participants began a trial by pressing a button on the game controller. The sentences were presented in their entirety on a single line, using 15 pt Times New Roman. Upon completion of a sentence, participants pressed the button on the game controller to progress. Throughout the experiment, sentence comprehension questions were asked randomly for forty percent of sentences. All questions were yes or no questions relating only to the current

sentence. Participants responded to questions by pulling the right or left trigger on the game controller. To familiarize participants with the experimental procedure, four practice sentences were presented prior to beginning the first experimental block. The experiment took participants approximately forty minutes.

5.3.2 Analysis

Short contiguous fixations were automatically merged, where interest areas with a fixation time shorter than 80 ms within one character space adjacent to another fixation were merged with that fixation. Any remaining fixation that was shorter than 80 ms was eliminated. Trials whose comprehension question was answered incorrectly (a list of the comprehension questions for Experiment II can be found in Appendix E.11), and those with reading times two standard deviations above or below the mean by-subject or by-item segmental reading time were removed (4.14% of data points).

Data was analyzed using linear mixed-effects regression as implemented in the lme4 package, version 1.1-9 (Bates et al., 2015) and pairwise factor combinations within fitted linear models were tested in the lsmeans package, version 2.26-3 (Lenth, 2016) in R version 3.2.2 (R Core Team, 2016). Reading times were measured in milliseconds (ms), and log-transformed for the analysis.

For each model, we used backwards stepwise model comparisons and likelihood ratio tests to determine best model fit. We tested participant gender, verb length, frequency, emotional dominance, valence and arousal, the implicit causality bias of the verb, and the (in)congruence between the gender of the pronoun and the implicit causality-based expected gender of the causal character[3]. Final models included all significant predictors and variables that significantly improved the model fit. Independent and random variables differed by model will be discussed separately for each model below, though participant gender was not found to significantly affect any measures of reading time and was omitted. The summary tables for each of the models can be found in Appendix E. Before providing results

[3]To exemplify the congruence between pronoun gender and implicit causality bias, take Table 5.3 as an example. *Greet* is NP1-biased and therefore, in sentence 5.3(a) pronoun gender and implicit causality bias are congruent and in sentence 5.3(b) are incongruent.

from individual models, we will discuss each of the interest areas and the reading time measures that were analyzed.

Interest areas

In our analysis we will consider each of the five interest areas separately. The first interest area contained the NP1 character, the dominance-controlled main clause verb and the NP2 character (*e.g., Ben instructed Alice*). We hypothesized that if early effects of gender and emotional dominance were present, they would be found through longer reading times in the first interest area if the gender of the NP1 character mismatched the stereotypical gender association of the dominance of the verb. For example, *instruct* is a high dominance verb (Warriner et al., 2013). Therefore, we would expect that in the first interest area *Ben instructed Alice* would have faster reading times than *Alice instructed Ben*. Because of the high dominance of the verb *instruct*, the incongruence between the gender of the character an the dominance of the verb may lead readers to take additional processing time.

In the second interest area (*e.g., because always*), if implicit causality affects processing early (Koornneef & Van Berkum, 2006; Pyykkönen & Järvikivi, 2010), we suspected that through parafoveal processing, we may find early congruence effects between the implicit causality bias of the verb and the gender of the pronoun in measures of early processing (*i.e.,* first fixation durations). Koornneef & Sanders (2012) found evidence of early implicit causality processing effects on *because*, since it cues readers to integrate causal relationships between the two characters and the verb. We expect that this would manifest as longer reading times when the implicit causality bias of the verb was incongruent with the bias of the sentence.

The third interest area contained the pronoun segment of the sentence (*e.g., he seemed*). We expected that when the gender of the pronoun mismatched the gender of the expected causal character, readers would require additional processing time, leading to longer fixations. Longer measures of first fixation durations in bias-incongruent conditions would support an early integration account of implicit causality bias.

During processing of the fourth interest area (*e.g., interested in meeting*), it is

possible we will find spillover effects of pronoun resolution. The interest area is segmented and begins at the second word after the critical pronoun. Effects have been found one and two words after the pronoun (Koornneef & Sanders, 2012), and therefore it is possible to find spillover effects of pronoun resolution in the fourth interest area. Because of the increased length of stimuli in the eye-tracking study (compared to the stimuli design of the self-paced reading study), we can better distinguish these spillover effects in the fourth interest area from sentence wrap up effects.

The additional length of sentences enabled us to segment the sentences into five interest areas. Since the fifth interest area (*e.g., new people*) is further away from the pronoun, it is likely we will find no effects of pronoun resolution in the fifth interest area. Rather, we hypothesize that any effects of gender incongruence between the gender of the pronoun or the dominance of the verb will be due to incremental integration and sentence wrap up in later measures (*i.e.* go past time and dwell time).

Reading time measures

As in the eye-tracking study in Chapter 4, we investigated effects on measures of first fixation duration (duration of the first fixation of the interest area on first pass), first gaze duration (sum of all fixations on the interest area on the first pass), second gaze duration (sum of all fixations on the interest area on the second pass), go past time (sum of all fixations that occur before passing to the right of the interest area) and dwell time (sum of all fixations on the interest area). Only and all significant effects are reported by interest area. We found no significant factors in predicting the first gaze duration or go past time in any of the interest areas, and therefore the measure has been omitted from our results.

First interest area

The first interest area consisted of the NP1 and NP2 characters and the main clause verb (*e.g., Jack greeted Heather*). We found factors that significantly affected measures of first fixation duration, second gaze duration and dwell time in the first

interest area. None of the variables significantly affected go past time.

First fixation duration

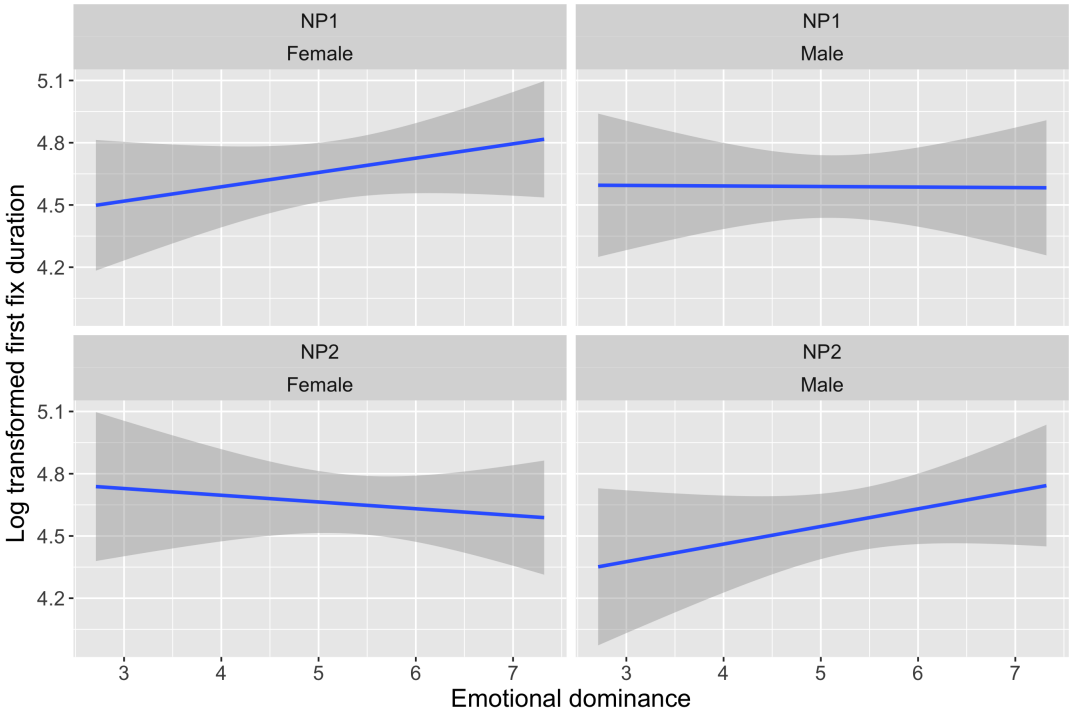
In the model of first fixation duration in the first interest area, random intercepts by subject and item and random slopes by subject and item for NP1 gender were included in the model. Compared to a more simple model including only random intercepts, the more complex model was a better fit ($\chi^2(4) = 22.12$, $p = <0.0002$). A summary of the model can be found in Appendix E.12. The dominance of the main clause verb significantly affected fixation durations, where verbs with higher perceived levels of dominance had longer first fixation durations ($\beta = 0.54$, SE = 0.24, $t = 2.27$). The interaction between the dominance of the verb and the gender of the NP1 character was significant ($\beta = -0.73$, SE = 0.36, $t = -2.06$), though in pairwise comparison the difference between low dominance verbs[4] with male and female NP1 characters ($t = 0.75$) and high dominance verbs with male and female NP1 characters ($t = 0.23$) was not significant.

We also report an interaction between the gender of the NP1 character and the implicit causality bias of the verb ($\beta = -1.86$, SE = 0.90, $t = -2.08$). In pairwise comparison the effect of implicit causality bias was not significant between NP1 male and female characters ($t = 1.26$) or NP2 male or female characters ($t = 0.58$). Neither were pairwise comparisons significant between female characters in NP1 or NP2 biased verbs ($t = 0.30$) or male characters in NP1 or NP2 biased verbs ($t = -0.53$).

We found a significant three-way interaction between dominance, the gender of the NP1 character and the implicit causality bias of the verb for first fixation durations ($\beta = 1.17$, SE = 0.54, $t = 2.15$). A visualization of this effect can be found in Figure 5.5. Both the interaction between dominance and NP1 gender and NP1 gender and the implicit causality bias appear to bear a relationship with a significant three-way interaction with the dominance of the verb. Using least-squares

[4]In least-squares means comparison, dominance was tested at two levels: the mean of all values of dominance above the standard mean, plus one standard deviation (high dominance), and the mean of all values of dominance below the standard mean, minus one standard deviation (low dominance).

Figure 5.5: Three-way interaction between implicit causality bias, NP1 gender and emotional dominance in measures of first fixation durations for the first interest area

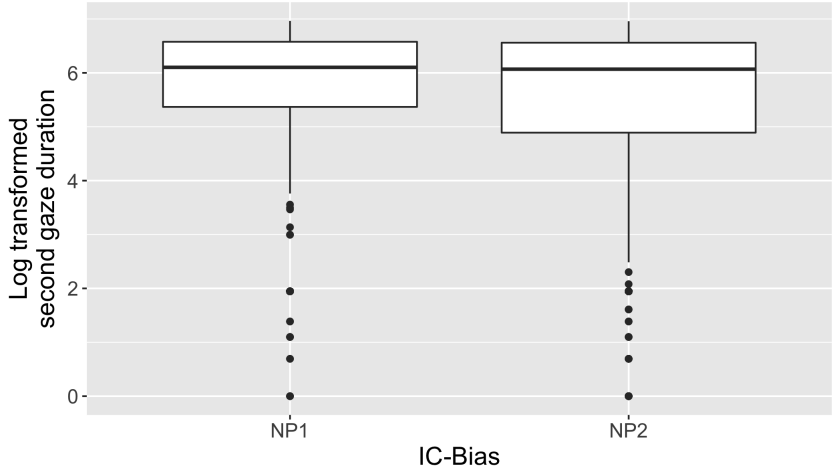


means for pairwise comparison, this interaction appears to arise from differences between NP1-biased verbs. Low dominance, NP1-biased verbs with NP1 female characters had significantly shorter first fixation durations than high dominance, NP1-biased verbs with NP1 female characters (β = -0.35, SE = 0.15, t = -2.27). Participants were faster when the NP1-biased character was female and the event was low dominance. For example, *abandon* is low dominance and *intimidate* is high dominance and both are NP1-biased. Therefore, because of the relationship between low dominance and female characters, *Donna abandoned Kenneth* had faster first fixation durations than *Donna intimated Kenneth*. Additionally, first fixation durations were significantly longer for NP1-biased, high dominance verbs when the NP1 gender was female, compared to sentences in which the NP1 gender was male (β = 0.33, SE = 0.16, t = 2.12). Continuing with our example above, this means that reading times were longer for *Donna intimidated Kenneth* than for *Kenneth intimidated Donna*.

second-pass gaze duration

In measures of second gaze duration, random intercepts by subject and item were included in the model. Through they did not improve model fit, we tested random intercepts and slopes by subject and item for NP1 gender (p = 0.99), the implicit causality bias (p = 0.37), emotional dominance (p = 0.96)) and the congruence with the implicit causality bias (p = 0.56)). The model summary for second gaze duration in the first interest area can be found Appendix E.13. NP1-biased verbs had significantly longer second gaze durations than NP2-biased verbs (β = -0.24, SE = 0.08, t = -2.86; Figure 5.6).

Figure 5.6: Effects of implicit causality bias on second gaze durations in the first interest area



Dwell time

In modelling dwell time for the first interest area, complex models including random intercepts by subject and item and random slopes by subject and item did not improve model fit for the NP1 gender (p=0.44), the implicit causality bias (p=0.17), the dominance of the verb (p = 0.27) or the congruence of the implicit causality bias (p = 0.81). We therefore used a more simple model including only random intercepts. A summary of the model can be found in Appendix E.14

The gender of the NP1 character significantly affected dwell time (β = -0.07, SE = 0.02, t = -3.25). NP1 female sentences had significantly longer measures of dwell time compared to NP1 male sentences in the first interest area (β = 0.07, SE = 0.02,

t = 3.25). Verb length also affected dwell time. As would be expected, sentences containing longer verbs had longer dwell times (β = 0.10, SE = 0.04, t = 2.32).

Second interest area

The second interest area consisted of the causal connective *because* and an adverb (*e.g., Jack greeted Heather because always*). No variables significantly affected measures of first fixation duration, second gaze duration or dwell time.

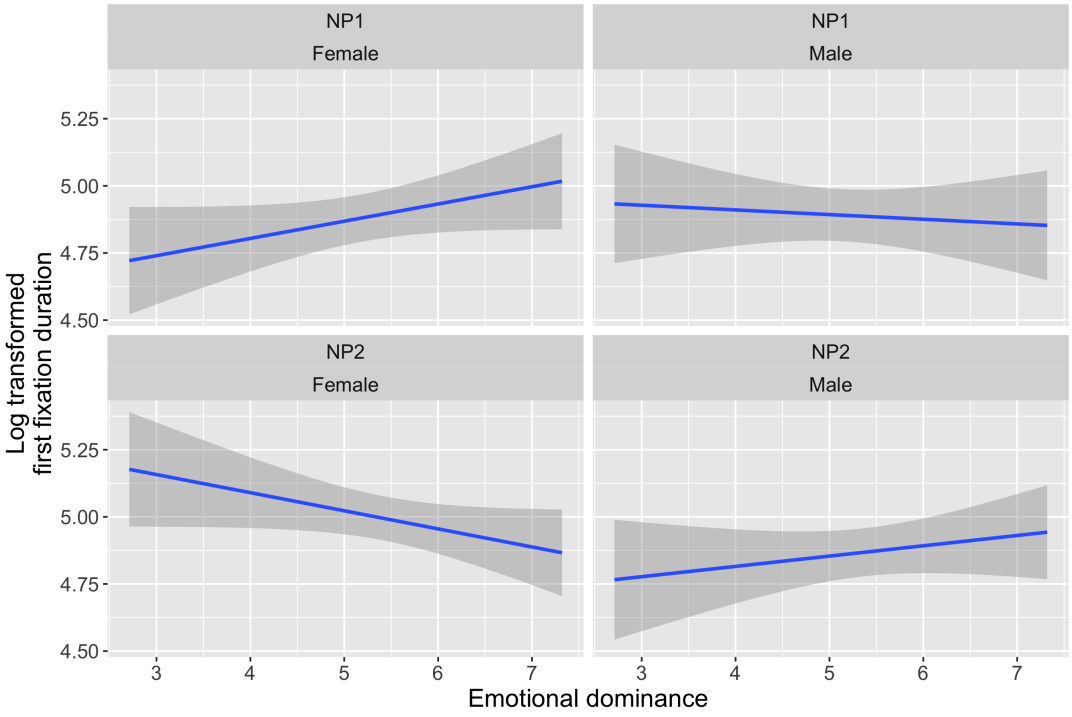
First fixation duration

Our model of first fixation duration included only random intercepts by subject and item. The model summary can be found in Appendix E.15. The model fit was not significantly improved by including random intercepts and slopes by item and subject for the NP1 gender (p =0.82), the implicit causality bias of the verb (p = 1), the emotional dominance (p = 0.60) or the congruence of the implicit causality bias (p = 0.16).

We found a significant interaction between the dominance of the verb and the implicit causality bias (β = -0.66, SE = 0.25, t = -2.61), though in pairwise comparison the difference between NP1 and NP2 biased verbs in high (t = -1.51) or low dominance conditions (t = 0.52) was not significant. An additional interaction was observed between the NP1 gender and the implicit causality bias of the verb (β = -1.54, SE = 0.59, t = -2.59). In pairwise comparison the difference between NP2 biased verbs with male or female NP1 characters was significant (β = 0.13, SE = 0.06, t = 2.12). First fixation durations were longer for NP2 biased verbs with female NP2 characters than male NP2 characters. We found no significant difference between NP1 biased verbs with male or female NP1 characters (t = 0.29). We also did not find a significant difference for female NP1 characters between NP1 and NP2 biased verbs (t = -1.37), or male NP1 characters between NP1 and NP2 biased verbs (t = 0.66).

Additionally we observed a significant three-way interaction between the NP1 character gender, the implicit causality bias of the verb and its emotional dominance (β = 0.86, SE = 0.36, t = 2.40; Figure 5.7). Among NP1 biased verbs with

Figure 5.7: Three-way interaction between implicit causality bias, NP1 gender and emotional dominance in measures of first fixation durations for the second interest area



female NP1 characters, high dominance stimuli had longer first fixation durations than low dominance stimuli (β = 0.21, SE = 0.10, t = 2.00). Let us continue using the NP1 biased, high dominance verb *intimidate* and the low dominance verb *abandon* to illustrate the effect. First fixation durations for the second interest area (*e.g., because shockingly*) were significantly longer for stimuli which began with an NP1 bias, female NP1 character and a high dominance verb (*Donna intimidated Kenneth because shockingly*). First fixation durations were shorter for matched stimuli with low dominance verbs (*Donna abandoned Kenneth because stupidly*). It appears that the implicit causality bias of the verb highlights the character associated with the bias. When the gender of the biased character mismatched the stereotypical dominance association of the verb (female characters and low dominance, male characters and high dominance), first fixation duration increased due to increased processing difficulty.

In NP2 biased conditions, low dominance stimuli with female NP1 characters (and hence, male NP2 characters) had longer fixations than those with male NP1

characters (β = 0.32, SE = 0.12, t = 2.66). Using an NP2 biased, low dominance verb (*criticize*) as an example, the interpretation of this difference would mean that *Donna criticized Kenneth because ethically* had longer durations than *Kenneth criticized Donna because officially*. Here too, it appears that the implicit causality biased character was affected by the dominance of the verb. Processing difficulty appears to have stemmed from the incongruence encountered when the low dominance of *criticize* was paired with a male character in *Donna criticized Kenneth*. In the second interest area, we observed increased processing difficulty through longer first fixation durations for such mismatches.

Finally, we observed the same three-way interaction through the significant difference between stimuli with a female NP1 character, where low dominance, NP1 biased verbs had shorter first fixation durations than low dominance, NP2 biased verbs with a female NP1 character (β = -0.33, SE = 0.11, t = -3.04). For example, *Donna abandoned Kenneth because stupidly* was faster than *Donna criticized Kenneth because officially*. The implicit causality bias highlights NP1 (*Donna*) in the former and NP2 (*Kenneth*) in the latter. Both verbs are low dominance, but because *criticize* is NP2 biased, (*i.e.*, biased towards *Kenneth*) the highlighted character and the dominance of the verb were incongruent. This lead to processing delays in measures of first fixation duration. The effect appears less to do with the syntactic subject and object of the sentence, and more with the semantic roles of NP1 and NP2 and the dominance of the verb.

Second-pass gaze duration

The model of second gaze duration included random intercepts by subject and item. The model fit was not significantly improved by including random intercepts and slopes by item and subject for the NP1 gender (p =0.53), the implicit causality bias of the verb (p = 0.97), the emotional dominance (p = 0.37) or the congruence of the implicit causality bias (p = 0.99). A summary of the model can be found in Appendix E.16.

The gender of the NP1 character significantly affected second gaze durations in the second interest area, where stimuli in which the NP1 gender was female

had significantly longer second gaze durations (β = -0.30, SE = 0.08, *t* = -3.60). The implicit causality bias of the verb also affected second gaze durations; stimuli in which the verb was NP2 biased had significantly shorter durations (β = -0.30, SE = 0.08, *t* = -3.65). Lastly the congruence between the implicit causality bias of the verb and of the pronoun was significant (β = 0.19, SE = 0.08, *t* = 2.31). Though the pronoun itself is one word outside of the second interest area, these are measures of second gaze duration, and so the gender identity of the re-mentioned character had already been viewed by participants. Sentences in which the implicit causality bias was congruent with the gender of the pronoun had significantly shorter second gaze durations (β = -0.19, SE = 0.08, *t* = -2.31). For example, *criticize* carries an NP1 implicit causality bias. Therefore, when reading *Donna criticized Kenneth*, participants were more likely to expect *Donna* to be re-mentioned as the causal continuation than to expect *Kenneth*. second-pass gaze durations were faster for stimuli such as *Donna criticized Kenneth because ethically she*.

Dwell time

In modelling dwell time for the second interest area, complex models including random intercepts by subject and item and random slopes by subject and item did not improve model fit for the NP1 gender (*p*=1.00), the implicit causality bias (*p*=0.80), the dominance of the verb (*p*=0.98) or the congruence of the implicit causality bias (*p*=0.79). We therefore used a simple model including only random intercepts by subject and item. A summary of the model of dwell time for the second interest area can be found in Appendix E.17.

Dwell time for the second interest area was affected by the congruence between the implicit causality bias of the verb and the gender of the pronoun (β = 0.08, SE = 0.02, *t* = 3.07). As seen in Figure 5.8, bias congruent sentences (*i.e.,* the implicit causality bias of the verb matched the gender of the pronoun in the third interest area) had significantly shorter dwell time than bias incongruent sentences (β = -0.07, SE = 0.02, *t* = -3.07).

We found that dwell time for the second interest area was further affected by an interaction between the gender of the NP1 character and the implicit causality

bias of the verb (β = -0.73, SE = 0.35, t = -2.06). In stimuli with an NP1 biased verb, second interest area dwell times were significantly longer when the NP1 character was female (β = 0.07, SE = 0.04, t = 2.01). The difference between male and female NP1 characters for stimuli with NP2 biased verbs was not significant (t = 1.94). Neither was there a significant difference between stimuli with male NP1 characters for NP1 or NP2 biased verbs (t = 1.93=) or stimuli with female NP1 characters for NP1 or NP2 biased verbs (t = 1.81).

Lastly the three-way interaction between the emotional dominance and the implicit causality bias of the verb and the gender of the NP1 character was significant (β = 0.44, SE = 0.21, t = 2.07). This three-way interaction is visualized in Figure 5.9. Least-squares means revealed several significant differences in dwell times in pairwise comparison. To exemplify the three-way interaction in dwell times, we use two NP2 biased verbs: one low dominance (*criticize*) and one high dominance (*applaud*). In stimuli containing NP2 biased verbs, low dominance verbs with NP1 female characters had longer dwell times that low dominance verbs with NP1 male characters (β = 0.19, SE = 0.07, t = 2.73). That is, stimuli such as *Donna criticized Kenneth because ethically* had longer dwell times than *Kenneth criticized Donna because ethically*. As we found with first fixation durations, it appears there is a relationship between the implicit causality bias-focussed character and emotional dominance. Incongruence between the focussed character's gender and the dominance of the

Figure 5.8: Influence of implicit causality bias congruence on second interest area dwell time

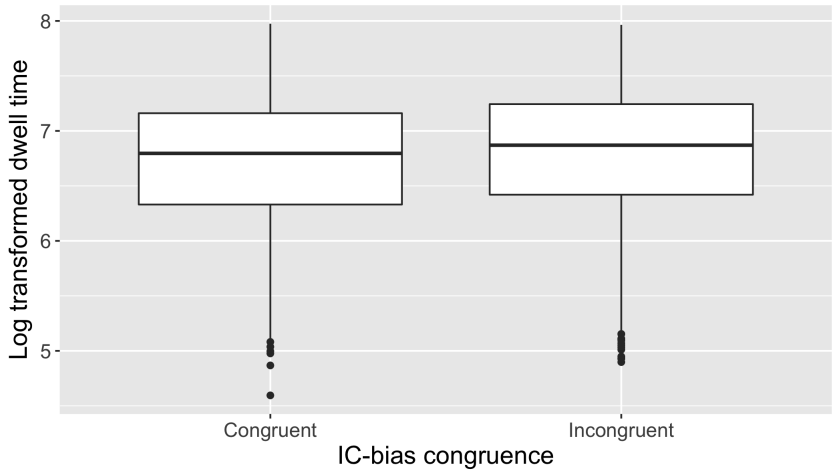
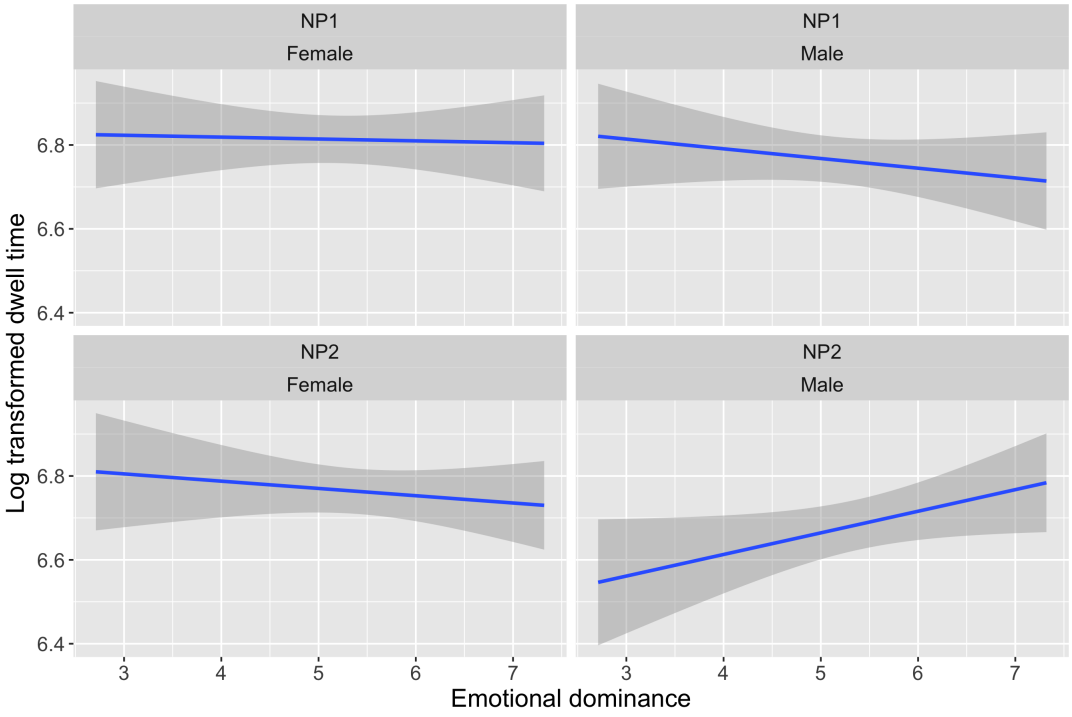


Figure 5.9: Three-way interaction between verb dominance, implicit causality bias and NP1 character gender for dwell time in the second interest area



verbs appears to lead to longer durations.

Further evidence comes from the significant difference in NP2 biased verbs between NP1 male stimuli with low dominance verbs and NP1 male stimuli with high dominance verbs. Low dominance stimuli had shorter dwell times than high dominance stimuli (β = -0.16, SE = 0.07, t = -2.27). Sentences with low dominance verbs such as, *Kenneth criticized Donna because ethically* had shorter dwell times than sentences with high dominance verbs such as, *Kenneth applauded Donna because officially*. The low dominance of *criticize* combined with the female character (*Donna*) being focussed by the implicit causality bias of the verb, meant that processing the interest area required less time, and lead to shorter dwell times.

The effect of dominance on character gender was also found for differences between NP1 and NP2 biased verbs, where low dominance NP1 biased verbs had longer dwell time than low dominance NP2 biased verbs (β = 0.19, SE = 0.06, t = 3.07). For example, *Kenneth criticized Donna because ethically* had longer dwell times than *Kenneth abandoned Donna because stupidly*. Since the dominance of both verbs

is low, we predict that there is a stronger probabilistic association between the verb and female characters. The implicit causality bias of *abandon* focusses *Kenneth* and has longer dwell times, while the implicit causality bias of *criticize* focusses *Donna* and has faster dwell times. This is in line with our expectations regarding emotional dominance and gender.

Similarly, within male NP1 stimuli, stimuli with low dominance NP2 biased verbs had shorter dwell times than NP2 biased high dominance verbs (β = -0.16, SE = 0.07, t = -2.27). *Kenneth criticized Donna because ethically* had faster dwell times during the second interest area than *Kenneth applauded Donna because officially*. The low dominance of *criticize* and the implicit causality biased female character in the NP2 position had faster processing time than the high dominance of *applaud* and the implicit causality biased male character in the NP2 position.

Finally, as can be seen in Figure 5.9 above, NP1 male, NP2 biased, low dominance verbs appear to have been most greatly affected by the interactions. In implicit causality bias and verbal dominance matching conditions, stimuli containing low dominance, NP2 biased, NP1 male characters had statistically shorter dwell times than stimuli containing high dominance, NP1 biased, NP1 male characters. *Kenneth criticized Donna because ethically* had shorter dwell times than *Kenneth intimidated Donna because shockingly*.

Third interest area

The third interest area contained the gender marked pronoun and a verb (*e.g., Jack greeted Heather because always he seemed*). No factors were found to affect reading measures for first fixation duration, though we did observe significant factors which affected second gaze duration and dwell time.

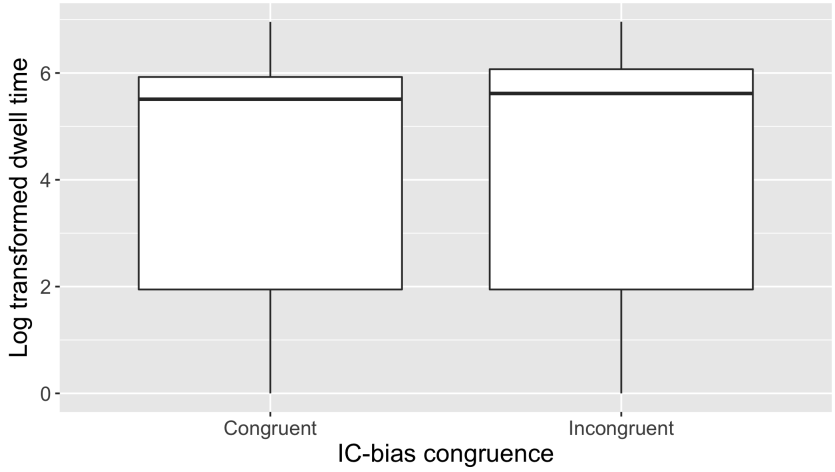
second-pass gaze duration

Models were fit with random intercepts by subject and item. A more complex model including random intercepts by subject and item and additional random slopes by subject and item were tested, but did not improve model fit for NP1 gender (t = 0.92), implicit causality bias of the verb (t = 0.61), its dominance (t =

0.82) or the congruence of the implicit causality bias (t = 0.98). The summary of the linear mixed effects model can be viewed in Appendix (E.19).

The only factor to affect second gaze durations in the third interest area was the congruence between the implicit causality bias of the verb and the gender of the pronoun, where congruent stimuli had faster measures of second gaze duration (β = 0.07, SE = 0.03, t = 2.38; Figure 5.10). This effect matches the congruence effect found for second gaze duration in the second interest area.

Figure 5.10: Congruence effect for measures of second gaze duration during pronoun resolution in the third interest area



Dwell time

In modelling the dwell time for the third interest area, we fit the model with random intercepts by subject and item. More complex models including random intercepts by subject and item and random slopes by subject and item were not found in improve model fit for NP1 gender (p = 0.56), implicit causality bias (p = 0.43), dominance (p = 0.75) or the congruence of the implicit causality bias (p = 0.25). A summary of the model of dwell time can be found in Appendix E.18.

We observed a congruence effect between the implicit causality bias of the verb and the gender of the pronoun (β = 0.07, SE = 0.03, t = 2.33). Sentences in which the implicit causality bias of the main clause verb and the gender of the pronoun matched had significantly shorter dwell times than bias incongruent sentences in the third interest area (β = -0.07, SE = 0.03, t = -2.33). The implicit causality bias

of the verb affected the dwell time in such a way that verbs which biased the NP2 character had significantly shorter dwell times than verbs which biased the NP1 character (β = -0.12, SE = 0.03, t = -4.30).

No effects were found with regard to the interaction between emotional dominance and the implicit causality bias of the verb and the gender of the NP1 character in the third interest area, though the hypothesized congruence between the implicit causality bias of the verb and the gender of the pronoun was found. Reading time was significantly slower when the gender of the pronoun mismatched the expected pronoun gender based on the implicit causality bias of the verb.

Fourth interest area

The fourth interest area contained a continuation of the sentence after pronoun resolution in the previous segment (*e.g., Jack greeted Heather because always he seemed interested in meeting*). No factors affected any of the measures of reading time within this interest area. Though no significant factors were found to affect reading time measures in this interest area, we expected that if there was an effect, it would be a spillover effect of the implicit causality bias incongruence upon reading the pronoun in the third interest area. The lack of significant factors suggests that the implicit causality information was processed prior to segment four, since we found congruence effects earlier in the sentence in interest areas two and three. It is possible that by the time readers were two or more words away from the pronoun, the gender of the pronoun had already been integrated into the updated representation.

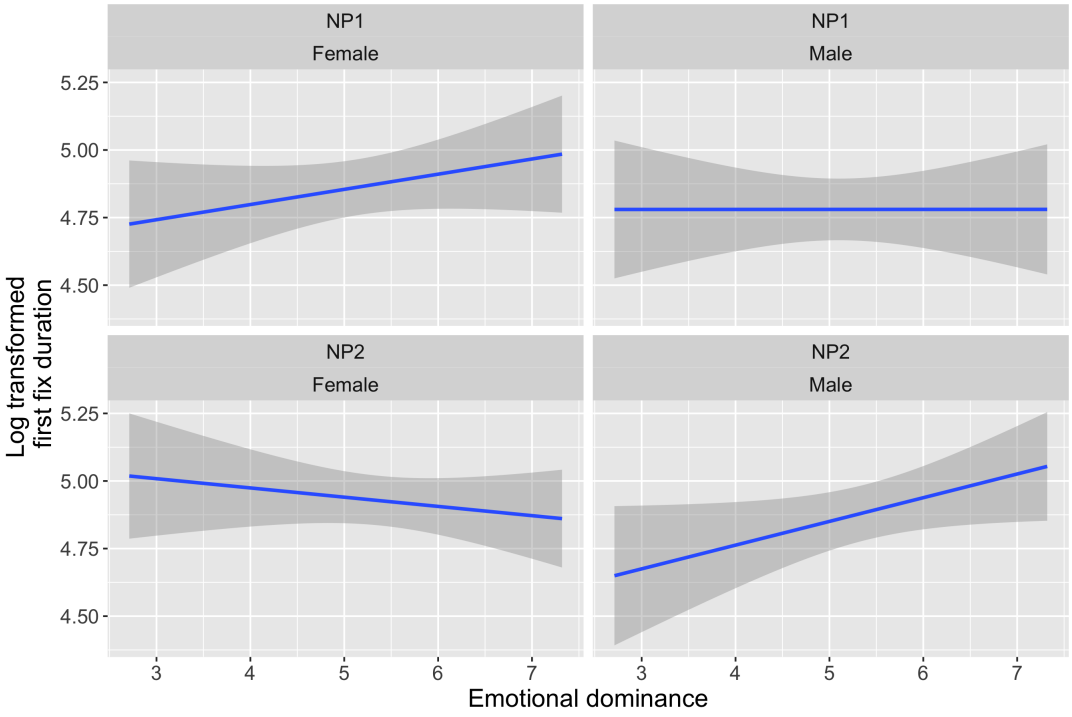
Fifth interest area

The fifth interest area was the last interest area and contained the wrap up segment of the stimuli (*e.g., Jack greeted Heather because always he seemed interested in meeting new people.*) Factors significantly affected measures of first fixation duration and dwell time. No factors were found to affect second gaze duration within the last interest area.

First fixation duration

Data was modelled using random intercepts and random slopes by subject and item for the gender of the NP1 character. Compared to simpler model including just random intercepts by subject and item, the more complex model was a significantly better fit ($\chi^2(4) = 15.33$, $p = 0.004$). A summary of the model can be found in Appendix E.21.

Figure 5.11: Three-way interaction between verb dominance, implicit causality bias and NP1 character gender for first fixation durations in the fifth interest area



The interaction between the gender of the NP1 character and the implicit causality bias of the verb was significant (β = -1.55, SE = 0.70, t = -2.20). In pairwise comparison the groups were not significantly different between NP1 biased verbs with male or female NP1 characters (t = 1.28) or between NP2 biased verbs with male or female NP1 characters (t = 0.88). Neither was the difference between NP1 or NP2 biased verbs significant between Male NP1 characters (t = 0.47) or female NP1 characters (t = 0.23).

We observed a significant three-way interaction between the emotional dominance and the implicit causality bias of the verb and the gender of the NP1 char-

acter (β = 0.96, SE = 0.43, t = 2.24). Figure 5.11 visualizes the effect. Note that the three-way interaction is present regardless of the gender of the pronoun, and hence whether the sentence is congruent with implicit causality bias, or not. In fact, first fixation durations did not show a congruence effect between the implicit causality bias and the gender of the pronoun. This may suggest that the implicit causality effect on pronoun resolution is processed prior sentence wrap-up.

In pairwise comparison, the difference between NP2 biased verbs was significant. NP2 biased verbs with NP1 female characters and low dominance verbs had significantly longer first fixation durations than NP2 biased verbs with NP1 male characters and low dominance verbs (β = 0.33, SE = 0.15, t = 2.28). To exemplify this, let us again use our low dominance, NP2 biased verb *criticize*. Segment five had significantly longer first fixation durations when stimuli had an NP1 female character (*Donna criticized Kenneth because he/she made no exceptions for a friend*) than stimuli with a male NP1 character (*Kenneth criticized Donna because he/she made no exceptions for a friend*).

In pairwise comparison between stimuli with NP2 biased verbs and male NP1 characters, those with low dominance verbs had significantly shorter first fixation durations than those with high dominance verbs (β = -0.31, SE = 0.15, t = -2.12). It appears that the implicit causality bias of the verb focussed one character above the other. When the dominance of the verb was congruent with the gender of the focussed character, readers had faster first fixation durations during sentence wrap-up. Stimuli with low dominance verbs, such as *Kenneth criticized Donna because he/she made no exceptions for a friend* had faster first fixation durations than those with high dominance verbs such as, *Kenneth applauded Donna because he/she made no exceptions for a friend*. We hypothesize that this is due to the association between the implicit causality biased character and the dominance of the verb. The congruence between the NP2 character (*Donna*) and the high dominance of *applaud* inhibited processing.

Dwell time

Linear mixed effects models of dwell time for the fifth interest area used a sim-

ple model including random intercepts by subject and item. This model was a better fit than a more complex model that also included random slopes by subject and item for NP1 gender (p = 0.80), the implicit causality bias of the verb (p = 0.84), the dominance of the verb (p = 0.47) or the sentential congruence of the implicit causality bias (p = 1). The model summary can be found in Appendix E.22.

The only factor found to significantly affect measures of dwell time in the fifth interest area was the dominance of the verb (-0.04, SE = 0.06, t = -6.64). Dwell times were longer for stimuli which had lower dominance verbs, and shorter for higher dominance verbs.

5.3.3 Discussion

First, regarding the implicit causality bias of the verbs, we found evidence of a congruence effect for the bias during pronoun resolution. Stimuli were considered incongruent when the gender of the pronoun did not match the implicit causality bias of the verb. In each sentence, two characters were introduced, one in the NP1 position, the other in the NP2 position (*e.g., Donna* (NP1) *verbed Kenneth* (NP2)). A sentence was incongruent when the re-mentioned character did not align with the implicit causality bias. For example, *criticize* carries an NP2 bias. Therefore, an incongruent sentence would be one in which the NP1 character is re-mentioned as the causal continuation (*e.g., Donna criticized Kenneth because she made no exceptions for a friend.*). We hypothesized that this effect would be present in the third interest area, and suspected that it may continue into the fourth. In fact, the incongruence of the implicit causality bias of the verb was processed before the fourth interest area and the effect was found earlier than expected. The congruence effect of the implicit causality bias was found to affect measures of reading time for the second and third interest areas. second-pass gaze durations and dwell times in the second and third interest area were significantly longer for bias incongruent stimuli. Table 5.4 has a summary of fixation measures for congruent and incongruent stimuli by interest area.

Implicit causality information appears to have been accessed later in processing gender marked pronouns, as we observed effects of incongruence between the

Table 5.4: Mean fixation measures by interest area for implicit causality congruent and incongruent stimuli

Interest Area	Congruence	Second Pass Gaze Duration	Dwell Time
1	Congruent	440.14	1587.83
	Incongruent	459.82	1635.37
2	Congruent	312.85	973.53
	Incongruent	332.03	1054.75
3	Congruent	244.59	698.59
	Incongruent	274.18	751.71
4	Congruent	276.23	828.73
	Incongruent	286.57	872.75
5	Congruent	192.76	738.31
	Incongruent	192.72	728.16

Note: Shaded cells indicate significant differences in measures of fixation time.

implicit causality bias and the gender of the pronoun in measures of second-pass gaze durations and dwell times. The congruence effect was observed as early as the second segment, in which the causal continuation *because* was fixated while the gendered pronoun was still in parafoveal preview. The congruence effect was maintained in the third segment, where incongruence between the bias and the gender of the pronoun continued to inhibit processing. No further congruence effects were found past the third interest area for the implicit causality bias and the gender of the pronoun. It appears that well before sentence wrap up in the fifth interest area, readers have accommodated the incongruence into their mental representation.

With regard to the interaction between emotional dominance and character gender, we hypothesized that because of the probability of co-occurrence between male characters and high dominance verbs, and female characters and low dominance verbs, emotional dominance may be accessed by language users to infer a character's gender during reading. We expected to find a correlation between NP1 gender and the dominance of the verb, where reading time would be inhibited when the NP1 gender and verbal dominance were incongruent (*e.g.*, female characters mismatched with high dominance verbs). Instead, we found the association to be between the implicit causality biased character (*i.e.*, NP1 or NP2), the gender

Table 5.5: Mean fixation measures by interest area for the implicit causality bias, NP1 gender and emotional dominance

Interest Area	IC-Bias	NP1 Gender	Emotional Dominance	First Fixation Duration	Second-pass Gaze Duration	Dwell Time
1	NP1	Female	high	176.39	475.94	1719.06
1	NP1	Female	low	178.35	447.90	1595.29
1	NP1	Male	high	175.86	478.07	1586.21
1	NP1	Male	low	161.02	446.43	1578.71
1	NP2	Female	high	173.13	449.02	1610.58
1	NP2	Female	low	177.83	458.59	1733.16
1	NP2	Male	high	183.76	398.28	1478.96
1	NP2	Male	low	163.43	442.62	1574.50
2	NP1	Female	high	176.96	350.19	1068.61
2	NP1	Female	low	162.57	380.23	1077.91
2	NP1	Male	high	171.44	310.69	984.35
2	NP1	Male	low	183.71	332.63	1045.77
2	NP2	Female	high	176.56	327.41	1005.40
2	NP2	Female	low	198.64	305.11	1003.33
2	NP2	Male	high	170.23	290.89	1037.73
2	NP2	Male	low	166.10	287.32	903.15
3	NP1	Female	high	157.17	260.48	763.79
3	NP1	Female	low	160.83	287.21	815.79
3	NP1	Male	high	160.29	275.63	751.71
3	NP1	Male	low	155.65	269.36	732.22
3	NP2	Female	high	157.91	243.96	660.89
3	NP2	Female	low	166.86	261.95	697.15
3	NP2	Male	high	169.39	214.99	663.66
3	NP2	Male	low	159.59	263.88	720.82
4	NP1	Female	high	159.21	281.27	884.67
4	NP1	Female	low	164.16	272.23	779.44
4	NP1	Male	high	151.59	285.34	851.03
4	NP1	Male	low	154.43	256.97	777.20
4	NP2	Female	high	160.48	276.15	906.15
4	NP2	Female	low	150.39	292.36	868.08
4	NP2	Male	high	168.75	261.90	882.42
4	NP2	Male	low	166.18	321.47	846.61
5	NP1	Female	high	183.50	170.44	701.15
5	NP1	Female	low	169.60	265.58	827.40
5	NP1	Male	high	177.98	148.86	656.45
5	NP1	Male	low	159.37	253.07	883.58
5	NP2	Female	high	176.22	168.86	684.01
5	NP2	Female	low	189.50	192.62	728.88
5	NP2	Male	high	185.66	161.40	707.36
5	NP2	Male	low	177.21	190.27	690.78

Note: Shaded cells indicate interest areas in which the three-way interaction between dominance, implicit causality bias and NP1 gender was a significant factor in measures of fixation time.

of the character and the dominance of the event. Rather than the association being between the NP1 character (*i.e.,* the character performing the event), and the perceived dominance of the event, it was instead found to be between the gender of the implicit causality biased character and the perceived dominance of the event (*i.e.,* the verb). Though the environment in which the effect was observed was different than expected, the association between high dominance and male characters and low dominance and female characters remained.

This suggests that the effect of emotional dominance is bound to lexical semantics, rather than syntax. Regardless of which character performed the event, the dominance of the verb affected processing with regard to the focussed character (*i.e.,* the implicit causality biased character). When the implicit causality biased character was incongruent with the perceived emotional dominance of the event, processing was inhibited. This inhibition occurred as early as first fixation durations in the first interest area, suggesting that it affects processing very early in reading. The three-way interaction was found to affect measures of first fixation durations in the first, second and fifth interest areas, as well as measures of dwell time in the second. In Table 5.5, we summarize mean measures of fixation time by interest area for the implicit causality bias of the verb, the gender of the NP1 character and the dominance of the verb. Verbs are classified as high or low dominance, depending on whether their dominance is above or below the mean emotional dominance of the stimuli.

5.4 General Discussion

The results from both the self-paced reading and eye-tracking studies of implicit causality further support our findings from Chapter 4. Through the experiments in Chapter 4 and Chapter 5, both gender stereotype studies and both implicit causality studies, reading times were found to be significantly affected by associations between the emotional dominance of the verb and the gender of the character. Participants appear to have accessed emotional dominance in the processing of character gender. Throughout all four reading studies, the dominance of the main

clause verb had significant interactions with character gender. In Chapter 4 (Experiment I), reading times for the summed third and fourth segments were significantly affected by the congruence between the level of perceived dominance for the verb and the gender of the pronoun. Segments containing male pronouns had faster reading times as the dominance of the main clause verb increased, and segments containing female pronouns slowed as the dominance of the main clause verb increased. In Chapter 4 (Experiment II), go past times were significantly affected by the dominance of the verb and the stereotypical gender association of the role name. For female stereotyped role names, go past times increased as the dominance of verbs increased, while go past times decreased for male stereotyped role names as dominance increased. Furthermore, pronoun resolution was significantly affected by the dominance of main clause verbs. Measures of go past time were significantly shorter for stimuli in which male pronouns were matched with higher dominance verbs, and significantly longer for stimuli in which male pronouns were matched with lower dominance verbs. This evidence builds a rather telling picture for the role of emotional dominance in the perception and inference of gender during discourse processing.

Observations from both the self-paced reading and eye-tracking experiments suggest a relationship between emotional dominance and character gender. Specifically, it appears that male characters have a stronger association with high dominance, and female characters have a stronger association with low dominance. Evidence suggests that when the dominance of a verb is incongruent with a character, processing time is inhibited.

In the self-paced reading in Chapter 5, we found a significant interaction between the dominance of the verb and the gender of the pronoun, where in high dominance stimuli, segments containing female pronouns had significantly longer reading times compared to male pronouns. In the eye-tracking experiment, the association between dominance and character gender was also observed, though the relationship between the character and dominance of the verb was more complex. The dominance of the main clause verb affected measures of reading time, in that processing was inhibited when the implicit causality focussed character

was incongruent with the dominance of the verb. Regardless of whether the re-mentioned character was congruent with the implicit causality bias or not, if the in-focus character's gender was incongruent with the perceived dominance of the event, reading was inhibited.

The difference between the observations in the self-paced reading and eye-tracking studies in Chapter 5 originates from the difference in character focus. In Experiment II, the fact that processing times for character gender were affected by dominance, regardless of whether the focussed character was actually the one performing the action, suggests that dominance information does not rely on syntactic information. If we presume that dominance information does not rely on syntactic structure, we could hypothesize that dominance affects gender perception for whichever character is more salient. In the eye-tracking data, the more salient character was the character that was biased through the implicit causality bias of the verb. In self-paced reading, it may be the case that the salient character was whichever character was re-mentioned during pronoun resolution in the third segment.

As discussed previously, due to the incremental nature of self-paced reading, readers may adapt their reading strategies from those used during normal reading (Koornneef & Van Berkum, 2006). It may be that because of the nature of Experiment I, participants learned to anticipate a gender marked pronoun in a certain position (*i.e.*, the beginning of the third segment during non-cumulative self-paced reading). This may have differently focussed their attention during the reading task in a way that made readers attend more closely to the pronominal character, hence, make the pronominal character the more salient. This could account for the difference in participant behaviour in self-paced reading and eye-tracking behaviour. If this were the case, then emotional dominance would affect the perception of salient characters, where high dominance events, expressed through verbal arguments, bear a stronger association to male characters and low dominance events, to female characters.

Regarding the time course of access to dominance and implicit causality-based information, we have found evidence for rapid access to both. Though the congru-

ence effect of implicit causality occurred rather late in Experiment II (in measures of second-pass gaze duration and dwell time in the second and third interest areas), there is additional evidence in favour of an early focussing account of the implicit causality bias. Recall that early focussing accounts imply that implicit causality information should be accessible as early as the presentation of a verb and focus one of the two characters involved in the interpersonal event (Pyykkönen & Järvikivi, 2010). Our eye-tracking experiment provides evidence of automatic activation of implicit causality information in measures as early as first fixation durations in the first interest area during reading. There, we observed congruence effects between the dominance of the verb and the gender of the focussed character. When the gender of the focussed character matched the dominance of the verb (*i.e.,* male, high dominance; female, low dominance), measures of reading time decreased, and when the gender of the focussed character mismatched the dominance of the verb, measures of reading time increased. This effect provides evidence that the implicit causality bias of the verb focussed one of the two characters prior to integration of the causal clause. Activation of implicit causality bias-based focussing occurring prior to the end of a clausal cause has been seen as strong evidence in support of an early focussing account (Järvikivi et al., 2017; Pyykkönen & Järvikivi, 2010).

While we find evidence in favour of early integration of implicit causality and emotional dominance information, the results of these studies also support and incremental integration account of discourse processing (Garnham et al., 1996; Kehler et al., 2008; Koornneef & Sanders, 2013; Stewart et al., 2000). As more information is processed, it and previous information are continually accessed to update the mental representation. Evidence in favour of such a framework comes from the continued effects of implicit causality and dominance throughout the sentences. We found that the gender of the implicit causality biased character and the dominance of the main clause verb continued to affect reading time past first fixation durations in the second interest area. Access and utilization of gender and dominance information was observed through measures of dwell time in the second interest area, and first fixation duration in the fifth interest area. Our ob-

servations suggest that the mental representation of events involved both gender and dominance-based information which may be evoked by verbs, as well as a bias-focussed character.

This suggests that readers accessed and maintained the associations throughout processing. The additional later congruence effects in second-pass gaze duration and dwell time between the implicit causality bias of the verb and the identity of the re-mentioned character (*i.e.,* through pronominal reference) also support a focusing account. Early and late effects both play a role in discourse processing (Kehler et al., 2008). As Greene & McKoon (1995); McKoon et al. (1993) hypothesize, early effects of implicit causality bias are immediate and automatic when implicit causality information first becomes available, while later effects emerge during sentence wrap-up, at which time implicit causality information is again taken into account and affects clausal integration. Therefore, the implicit causality bias affects processing early and persists into later integration and wrap-up effects (Pyykkönen & Järvikivi, 2010). Using this dual-process perspective, the implicit causality bias is activated upon presentation of the verb and throughout processing, additional factors determine how implicit causality information continues to be utilized (McDonald & MacWhinney, 1995; Pyykkönen & Järvikivi, 2010). As the present results indicate, these factors include affective properties of the verb and the gender of the verb's arguments.

Chapter 6

Discussion and conclusions

Throughout this dissertation we have investigated the role of emotional dominance and its use in the inference and mental representation of gender. Through corpus-based exploration, offline production and online processing experiments, we have found converging evidence that emotional dominance is cognitively associated with male and female genders in varying degrees. We began with a corpus analysis, investigating distributional co-occurrence patterns between NP1-position characters and affective properties of verbs for which those characters functioned as syntactic subjects. We continued our investigation of affective properties of verbs and their association with character gender by way of an offline sentence completion task, where participants provided causal continuations to interpersonal events involving two characters. The proportions of NP1 and NP2 position character re-mentions as the causal continuations, as well of the gender of those re-mentioned characters were analyzed at length with respect to the properties of emotional affect and individual differences based on socio-political ideology. This was followed by a series of four language processing experiments across two chapters that used both self-paced reading and eye-tracked reading paradigms to assess the association between emotional dominance and gender. Converging evidence across gender stereotype and implicit causality bias-based constructions provided additional support for our findings. High emotional dominance appears to have a stronger association with male characters, and low emotional dominance appears to have a stronger association with female characters in the mental representation of discourse.

In what follows, we will reiterate the findings of the seven studies undertaken in this dissertation with regard to each chapter's respective research questions. The implications of these results on the broader research questions outlined in Chapter 1 will also be addressed. We will then go on to a general discussion of the various implications of our findings based on the theoretical frameworks established throughout this dissertation. Following the discussion, we will acknowledge the limitations of the studies and formulate suggestions for future research.

6.1 Summary of results

6.1.1 Study 1: Corpus-based investigation of verbal dominance

In a corpus-based analysis we examined the distributions of verbs and their co-occurrence with gender-marked subject-position characters. Using Semantic Vector Space Modelling (SVM), we calculated Word-Embedding Association Test (WEAT) measures to determine the similarity between verbs in a two-dimensional semantic space. The results of the SVM indicated a stronger semantic association between negative valence verbs and male keywords, and a stronger association between positive valence verbs and female keywords. The associations between male characters and negative actions and female characters and positive actions, as well as the stronger association between male characters and violence provide initial evidence of differences in verb preferences between males and females. This indicated a difference in gender biases for subject-position verbal arguments. We then calculated a by-verb gender bias score based on the frequency of co-occurrence between female and male subject-position characters and the set of verbs. Linear regression mixed effects modelling of the by-verb gender bias revealed an interaction with both the emotional dominance and valence of verbs. Using a hierarchical agglomerative clustering of the SVM, it was revealed that a subset of verbs most strongly represented male and female gender biases within the corpus.

The male gender bias was strongest for high valence, low dominance verbs, involving concepts of protection and low valence, high dominance verbs involving concepts of offence. The female gender bias was strongest for low valence and

low dominance verbs involving concepts of helplessness, and high valence, high dominance verbs involving concepts of seduction. These results indeed suggest that individual verbs may carry a particular preference towards either male or female subject-position characters. The verbs most strongly biased to one gender or the other were those verbs that fell in the highest and lowest spectra of emotional dominance and affective valence.

The association between gender and emotional affect observed in the corpus analysis may bear a resemblance to the associations between gender and emotional affect in the mental representation of language. Corpus linguists have argued that corpora can act as an approximate source of information regarding experience and exposure to language. This information can play a role in the cognitive processing and mental representation of language (Ellis, 2014; Ellis et al., 2015; Gablasova et al., 2017; Rebuschat & Williams, 2012). Thus, the co-occurrence frequencies of a verb and its syntactic agents may affect their probabilistic weighting and mental representation. That is, the distributional information about a verb may affect both the structural preferences of a verb and its meaning (Ryskin et al., 2016). If a verb carries a distributionally motivated gender bias based in a corpus of natural (non-elicited) occurrence, that co-occurrence pattern may reflect a stronger cognitive association between a verb and its gender preference.

6.1.2 Study 2: Effects of dominance in the perception of cause in an offline production task

The second study in this dissertation expanded upon the findings of the first. The experiment was designed to determine whether associations between gender and emotional affect which were observed in the corpus data were present in data elicited in a sentence completion task. Additionally, this experiment was designed to determine whether the implicit causality bias of interpersonal verbs may be affected by emotional affect.

Participant responses were coded for the gender of the re-mentioned character and the relative proportion of responses for each verb by the syntactic position of the character in the initial sentence fragment (NP1/NP2). Results revealed that

the gender of character response was impacted by the implicit causality bias, the emotional dominance and affective valence of verbs. Evidence of an association between lower dominance verbs and female characters and higher dominance verbs and male characters was significant. As well, high valence verbs bore a stronger relationship with female characters and lower valence verbs with male characters.

In the implicit causality bias-based model, a relationship was revealed between emotional dominance, valence and a participant's socio-political ideology. Though the results of the socio-political survey did not affect response gender, it did have a significant impact on the directionality of response in regards to the syntactic position of the re-mentioned character. Progressive-leaning participants re-mentioned the NP1 position character significantly more often for low dominance, low valence verbs than they did for high dominance, high valence verbs. Progressive-leaning participants also assigned cause to the NP1 position character significantly more often than conservative-leaning participants in low dominance, low valence conditions.

The results of both models provided new insights: the gender-based analysis confirmed our hypothesis that emotional properties of verbs have a relationship with character gender, and the implicit causality bias-based analysis provided a novel account of the effect of emotional affect on the implicit causality bias.

6.1.3 Study 3: Influence of Emotional Affect on Gender Stereotypes during Reading Comprehension

Two experiments were presented to continue the investigation of the association between gender and emotional affect. These two studies utilized reading tasks to observe the effects of emotional affect on the processing of social role and occupation-based gender stereotypes during online language comprehension. We utilized reading studies in order to gain greater insight into the time course of access to affective information throughout discourse processing.

Linear mixed effects modelling of measures of the summed third and fourth segmental reading time during self-paced reading revealed a significant interaction between pronoun gender, stereotype-pronoun gender congruence and the

emotional dominance of verbs. In mismatching conditions, where the stereotypical gender of the role or occupation name was incongruent with the gender of the pronoun, the dominance of the main clause verb significantly affected reading times. Within the incongruent conditions, reading times for stimuli containing male pronouns decreased as the dominance of the verb increased. The opposite effect was observed in stimuli with female characters, where reading times increased as the dominance of the verb increased.

The results of the eye-tracked reading study provided additional support for these findings. In measures of go past time in the first interest area, the interaction between the gender stereotype and the dominance of the verb was significant. Go past times for sentences beginning with female stereotyped role names decreased as the dominance of the verb decreased. That is, go past times - the sum of all fixations within an interest area that occurred before passing to the interest area to the right - for female stereotyped role names were fastest for low dominance verbs and for male stereotyped role names were fastest for high dominance verbs.

Measures of second pass gaze duration and dwell time in the third interest area showed similar results. Both measures were significantly affected by the association between the dominance of the verb and the gender of the pronoun. Reading measures for stimuli were faster for low dominance, female pronouns and high dominance, male pronouns. The same results were reported in measures of go past time in the fifth interest area, where again, measures were faster for stimuli with high dominance verbs and male pronouns and slower for stimuli with low dominance verbs and female pronouns.

6.1.4 Study 4: Influence of Emotional Affect on Implicit Causality Bias During Reading Comprehension

These experiments continued to investigate the effects of emotional dominance on the perception of character gender using self-paced and eye-tracked reading, though they were designed to observe this association in the implicit causality bias-based constructions. Both experiments provided evidence of an effect of the implicit causality bias and support in favour of an association between emotional

dominance and character gender.

Measures of self-paced reading time for the summed third and fourth segments showed a significant congruence effect for the implicit causality bias of the verb: sentences in which the implicit causality bias of the verb mismatched the re-mentioned character in the causal continuation had longer reading times. The interaction between dominance and pronoun gender was also significant. Stimuli with high dominance verbs had faster reading times when the pronoun in the sentence was male, and slower when the pronoun in the sentence was female.

In the eye-tracked reading experiment, we found an implicit causality bias effect in measures of second pass gaze duration and dwell time in the second and third interest areas. Significant interactions between character gender, implicit causality bias and the emotional dominance of the verb were observed in multiple eye-tracked reading measures. First fixation durations in the first, second and fifth interest area, and dwell times in the second interest area all provided evidence of an association between the dominance of verbs and character gender. Throughout these measures, the implicit causality biased character was affected by the interaction between dominance and gender. When the gender of the focussed character was male, reading measures became shorter as the dominance of the verb increased and when the gender of the focussed character was female, reading measures became longer as the dominance of the verb increased.

The results of these models indicate that the association between the gender of a character and the perceived dominance of his or her actions result in differences in the time course of discourse processing. Processing times increased when the gender of the character and the dominance of his or her actions ran counter to a participant's expectations. Throughout the reading studies we observed a significant association between male characters and higher dominance and female characters and lower dominance.

6.2 General discussion

Broadly stated, the intent of this dissertation was to explore how the various components of emotional dominance are able to affect representations of gender. During discourse processing, language users have access to any number of sources of information to construct, edit and reconstruct their mental representation. We have discussed a wide range of sources of information that are automatically and incrementally accessed in order to achieve this, for example, syntactic structure, semantics, general world knowledge, gender, personal experience and beliefs, are just a few examples, (Altmann & Kamide, 1999; Caplan et al., 1994; Gernsbacher, 1996; Graesser et al., 1994; Kamide et al., 2003; Paczynski & Kuperberg, 2012; Singer et al., 1994; Troyer et al., 2016). How these sources of information are accessed, how they interact with one another and the time course through which they are accessed are a matter of on-going discussion. In the following sections, we will touch on how emotional dominance may fit into this discussion.

6.2.1 Inference production

Previously, we have discussed the fact that readers construct structured event representations during discourse processing, known as situation models (Gernsbacher, 1990; Zwaan et al., 1995). Part of the process involves the incremental and automatic production of inferences. Incremental inferences are produced based on the structure of the mental representation at any given moment, and can facilitate the processing of incoming information when they are semantically congruous. Inference-based facilitation is made possible as language users make active predictions about upcoming discourse. As this is done and users update their situation model accordingly, commitment is made to an expected outcome in advance to receiving the actual input (*e.g.,* Van Berkum et al., 2005).

Throughout this dissertation, we have discussed the possibility that upon encountering a verb, emotional dominance-based information may activate its semantic networks and provide information regarding the likely gender of characters. Semantic properties (including emotional affect) may activate stored co-

occurrence probabilities, which can lead to language users actively making inferences, including the likely gender of a character. The results of our reading studies provide evidence of such a process. We have proposed that upon reading a verb, participants in our studies made inferences regarding the gender of characters. When participants received further unambiguous gender information (*e.g.,* gender-marked pronoun), which was incongruent with dominance-based inference, reading times were significantly slower than when the inference and pronoun gender were congruent (*e.g.,* in measures of the summed third and fourth segments in self-paced reading implicit causality constructions). Our results provide evidence that readers made inferences about the gender of characters based on the dominance of verbs. Those inferences lead readers to make a commitment to the gender of the character, and in cases where the inference was later revealed to be incongruent with the gender of the character, they required more time to process the incongruence and thereby update their mental representation.

6.2.2 Prominence, agentivity and gender

Researchers have found that, among other sources, gender may act as a constraint on verbal arguments (Carreiras et al., 1993, 1996; Esaulova & Von Stockhausen, 2015; Ferstl et al., 2011; Garnham et al., 1996). For example, during eye-tracked reading, Esaulova & Von Stockhausen (2015) found that gender influenced the assignment of thematic roles to characters, where reading times were shorter when the gender of the agent-position character was revealed to be male. Gender information can be supplied by semantics through definitional gender (*father*), grammatical encoding (*actress*), or through stereotypes (*nurse*). In the case of stereotype-derived gender information, the gender information is derived from general world knowledge. In our own studies, we have seen evidence that gender stereotype-based information is active during incremental sentence processing. General world knowledge, along with syntax and semantics, are accessed simultaneously to make probabilistic predictions during discourse processing (Federmeier et al., 2002; Kintsch, 1972; Paczynski & Kuperberg, 2012; van Dijk & Kintsch, 1983).

Prominence theory (de Hoop & Lamers, 2006) has been used to identify and

hierarchically order the types of information that can interact with formal features of verbal arguments. The interaction between syntax, semantics and general world knowledge in a prominence theory-based interpretation of discourse processing allows for the incremental interpretation of verbal arguments (*i.e.,* NP1 and NP2 position characters) based on how features of verbal arguments are ranked in the prominence hierarchy (Esaulova & Von Stockhausen, 2015). The theory bears strongly on the selectional restrictions of verbal arguments. For example, in Section 1.3 we discussed how violation of the selectional restriction of animacy can lead to processing difficulty. Similarly, based on a prominence hierarchy, animacy is considered one of the hierarchically ordered information sources. Thus, because animate verbal arguments are higher in the hierarchy, they are more likely to be interpreted as agents and subjects than non-animate verbal arguments.

Evidence has shown that the semantic characteristics of male characters makes them more prominent (higher on the prominence hierarchy) than female characters, which therefore leads to a tendency for male characters to more easily fill the semantic agent and syntactic subject position in active, transitive constructions (Esaulova & Von Stockhausen, 2015). They claim that men's higher order is due to the socially perceived higher status and power of men, and that it leads readers to more quickly incorporate characters who are perceived as male into NP1 positions.

Similarly, Pyykkönen et al. (2010) have suggested that the semantics of verbs and their arguments have consequences on referential processing. Particularly relevant to the current discussion, Dowty (1991) defined a set of verbal properties which can affect the perception of a verb's arguments as more or less prototypically agent or patient-like. A verb which gives its agent volition, sentience and causes events or changes in state are considered more prototypically agent-like, than a verb that does not (*e.g.,* compare *hit* and *see*; Pyykkönen et al., 2010). In this transitivity hierarchy[1] (Hopper & Thompson, 1980), male characters may meet a greater number of prototypically agent properties than female characters; male characters can be perceived as more volitional, sentient and in control of their ac-

[1]similarly to (Pyykkönen et al., 2010), we are interested in high and low transitive verbs that are all grammatically transitive

tions than female characters. Therefore, male characters may be perceived as more prototypically agent-like.

Such perspectives on the mental representation of male characters provide a framework to explain why higher levels of dominance are associated to stronger male biases in our sentence completion and reading tasks. The affective property of dominance may have a cognitive association with agentivity. Characters who are more agent-like are perceived as having more control over their actions, and hence have a stronger association with higher degrees of emotional dominance.

6.2.3 Gender Stereotypes

Throughout discourse processing, general world knowledge can be accessed in order to make inferences about the gender of characters (Canal et al., 2015; Carreiras et al., 1996; Molinaro et al., 2016; Su et al., 2016). Research on gender-based inference production has been partially based on the use of role and occupation names (Banaji & Hardin, 1996; Carreiras et al., 1996; Garnham et al., 2002; Oakhill et al., 2005; Pyykkönen et al., 2009), and reading studies have investigated the effect that stereotyped role names have on pronoun resolution.

One point of contention in the field is in regards to the point at which readers necessarily make an inference about the gender of a character. Some have argued that readers only necessarily make an inference about the gender when they reach the pronoun and gender must be incorporated into the mental representation (Duffy & Keir, 2004). Others have responded saying that it is not possible to say whether an inference is made upon presentation of a gender stereotyped role name because prior to presentation of the pronoun, readers do not have access to any unambiguous gender cues (Canal et al., 2015; Garnham et al., 2002; Gygax & Gabriel, 2008; Oakhill et al., 2005).

In our eye-tracked reading study, go past times were significantly affected by the interaction between the gender stereotype of role names and the dominance of main clause verbs. Not only did this interaction support the hypothesis that emotional dominance provides readers with a general world knowledge-based cue regarding character gender, but the eye-tracked reading study also provided ad-

ditional evidence that readers automatically made gender-based inferences upon presentation of a gender stereotyped role name. This additional finding is in line with a growing body of literature that reports readers to have access to, and automatically activate, various sources of real world knowledge in the construction of mental representations during discourse processing (Canal et al., 2015; Esaulova & Von Stockhausen, 2015; Garnham et al., 2002; Gygax & Gabriel, 2008).

During eye-tracked reading, we found a significant interaction between the gender stereotype of role names and the dominance of verbs for measures of go past time. When the dominance of the verb matched the gender stereotype of the role name (*e.g.,* male stereotypes and high dominance, female stereotypes and low dominance), reading times in the first interest area were significantly faster. If one takes the position that the relationship between high dominance and male characters and low dominance and female characters has been established over the series of experiments presented within this dissertation, then the effect of verbal dominance on the gender stereotype of the role names in the first interest area of stimuli provides strong evidence that readers established a gender stereotype-based inference early during processing, immediately after the presentation of the role name. If readers had not already activated gender information in their mental representation of the discourse, we would not have expected to find the dominance of the verb to show a significant interaction with the gender stereotype. Furthermore, the observed interaction between dominance and gender for the stereotypical gender of role names reflects the same interaction as that between the dominance of verbs and the gender of pronouns in the self-paced and eye-tracked reading gender stereotype studies. The fact that the interaction reflects the same bias provides additional support to the hypothesis that readers activate gender stereotype-based gender information immediately and automatically, regardless of the presence of a disambiguating pronoun.

6.2.4 Implicit causality

Our results provide insight into several aspects of implicit causality. First, we reported evidence that the gender of causal re-mentions was significantly affected

by the affective valence of verbs. We found evidence that re-mention biases were more male biased for low valence actions and more female biased for high valence actions. These findings are in line with previous work in the field (Ferstl et al., 2011; Hartshorne, 2014). In a sentence completion task, Ferstl et al. (2011) found that sentence completions were significantly more male biased when the valence of verbs was negative. They concluded that positive events were more likely to be viewed as female-caused and negative events more likely to be viewed as male-caused. We extended previous work by accounting for a second dimension of emotional affect, namely emotional dominance. In the sentence completion task, biases were more female for low dominance actions and more male for high dominance actions. Events that were perceived as higher in emotional dominance were viewed as more male-caused, while events perceived as lower in emotional dominance were viewed as more female-caused.

Further evidence of the association between dominance and gender in implicit causality re-mention was provided through the two reading tasks. An interaction was found between the implicit causality bias of the verb, the gender of the character and the dominance of the verb. Reading times were faster when the gender of the implicit causality biased character was male and the dominance of the verb was high, and slower when the biased character was female and the dominance of the verb was high.

Socio-political ideology

We have gathered evidence that the implicit causality bias of verbs can be affected by features of emotional dominance. We found a significant interaction between the dominance of verbs, their affective valence and the socio-political ideology of participants.

Niemi et al. (2016) reported that a participant's psychological attitudes towards moral values can predict re-mention biases in implicit causality bias research. When participants' morals valued the perseverance of loyalty, respect for authority and the pursuit of purity (binding values), participants would attribute cause to the NP2 position character significantly more frequently, especially for events involv-

ing harm or force. Though the current sentence completion task did not directly measure participant attitudes towards morality, the socio-political ideology survey did provide a rough approximation of participants' political leaning - a factor that contributes to a person's moral values (Graham et al., 2011). The results of the sentence completion task provide complimentary evidence to previous work (Niemi et al., 2016; Niemi & Young, 2016).

The interaction between emotional dominance, effective valence and participants' socio-political leaning provide evidence that progressive-leaning participants had a significantly greater chance of providing NP1 character re-mentions, while conservative-leaning participants displayed an overall NP2 bias. These findings are similar to those of (Niemi et al., 2016) if one approximates events of harm and force to low dominance, low valence verbs (*e.g., abuse, blame, slap, hurt*).

Time course of implicit causality and emotional dominance

Evidence of early effects of implicit causality have been provided by Pyykkönen & Järvikivi (2010), who observed its effect in a Finnish visual word eye-tracking experiment. Their early effect was found after presentation of the verb, and before listeners heard the causal connective *because*. Our study also presents an account of implicit causality bias that supports an early focussing framework. We found evidence of the bias as early as the presentation of the verb in measures of first fixation duration in the first interest area. We found an interaction between the gender of the NP1 character, the implicit causality bias of the verb and the dominance of the verb. The interaction worked in such a way that first fixation durations in the segment of sentences containing the verb and its arguments (NP1/NP2) were affected by emotional dominance. Readers took less time when the gender of the more salient character, that is, the character biased to be the re-mentioned causal continuation, was female and the dominance of the verb was low and when the gender of the more salient character was male and the dominance of the verb was high. Because the interaction was present only for the re-mention biased character, these findings are evidence that readers were attending to the implicit causality bias shortly after reading the verb. Thus, the implicit causality bias affects pronoun

processing at the moment that selection of the causal referent begins.

The clausal integration account (Garnham et al., 1996; Stewart et al., 2000) is in opposition to the early focussing account. Through this frame work, implicit causality only occurs late in clausal and sentential processing. Throughout our studies of implicit causality we found additional interactions between the focussed character, emotional dominance and perceived gender in measures of first fixation and second pass gaze durations in the second interest area, and first fixations in the fifth interest area. Finding both early and late effects provides support for a focusing account, but not the strong version of the integration account that states that semantic implicit causality information is checked only during late clausal integration. What these results provide evidence of is that implicit causality affects processing early and persists through out processing (Pyykkönen & Järvikivi, 2010). Though the early and late processes are likely different (McKoon et al., 1993; McKoon & Ratcliff, 1992): the early effect may be an automatic process that occurs immediately when the implicit causality information becomes available (*i.e., after reading the verb*), while the latter concerns later integration and sentence wrap-up processes. At this later stage, readers again take implicit causality information in addition to gender and emotional dominance-based information and utilize it during clausal integration.

An incremental integration account assumes early and late effects of implicit causality, and therefore our results also support an incremental integration framework (Koornneef et al., 2016). The implicit causality bias, the gender of the focussed character and the dominance of the verb affected measures of reading time at more than one point during reading. In the first segment, the verb and its associated emotional dominance lead readers to immediately make inferences about the gender of the focussed character. Participants had longer reading times when the inferred gender mismatched the dominance of the verb. Later, when the actual gender of the character was disambiguated during pronoun resolution, incremental processing difficulty was observed when the previously inferred gender of the character mismatched the gender of the pronoun. The implicit causality bias was activated upon presentation of the verb and throughout the course of sentential

processing, additional factors determined how implicit causality information continued to be utilized. Our reading studies support a similar account for the use of emotional dominance and implicit causality bias during sentential processing.

6.2.5 Wider implications and future directions

Though the studies contained in this dissertation provide an initial, multi-modal and multi-methodological investigation into the association between emotional dominance and perceived character gender, it also serves as a starting point from which many new avenues of research can proceed.

To begin with, let us discuss how the results revealed throughout this dissertation can be interpreted with regard to our language processing system. We took the perspective that language users automatically and incrementally utilize language input to create a mental representation of discourse. That is, language users do not wait until the end of an utterance before beginning to interpret its meaning. Instead, as soon as information is received, analysis immediately begins. Part of the process includes the production of inferences. We explored to what extent the level of the emotional dominance of verbs affects how language users make predictions about the gender of characters. Throughout our experiments we found convergent evidence that high dominance is associated to male characters and low dominance is associated to female characters. It is doubtful that anyone would say they were aware of this interaction. Indeed, the interactions between dominance and gender very likely occur without users' awareness. Regardless, the way language is processed and the way language is used is reflected in our beliefs, attitudes, and our conceptions of social and societal relations. These beliefs, attitudes, and conceptions appear to rapidly impact our online language comprehension.

In our research, we have focussed on the perceived power imbalance between male and female characters, and how emotional dominance affects perception of characters based on the parameter of gender. It appears that within the experiments undertaken in this dissertation, participants perceived a power imbalance between men and women. This imbalance was reflected in participants' language production and processing times. Participants showed a significant preference to

select male characters as the re-mentioned cause of high dominance actions and female characters for low dominance actions. When female characters were associated with high dominance actions, participants' processing times during reading were significantly slower. This indicates a knowledge of, whether participants are aware of it or not, an association between men and power.

Of course there are many more societal power imbalances that can just as easily be investigated in association with emotional dominance - age, race, and social hierarchy are just a few. It may be, and, likely is the case, that the association between dominance and gender is just one facet of a larger pattern of associations amongst difference dynamics of perceived power and control. Further attention should be placed on how dominance associates with additional constructs of perceived power and control.

Additionally, our research has only investigated dominance and gender associations from the stand point of North American societal norms. The corpus analysis was undertaken on the Corpus of Contemporary American English (Davies, 2008), all participants who took part in the crowd sourced sentence completion task had been born, raised and currently lived in North America, and participants in the reading studies were native English speakers residing in Edmonton, AB, Canada. Extending this research to investigate additional populations, speaking additional languages would add a depth to our findings that may show differences based on different cultural norms.

6.2.6 Conclusion

The experiments undertaken throughout this dissertation aimed at providing evidence of a cognitive association between the gender of characters and the perceived dominance of their actions. The corpus-based analysis provided initial evidence that, proportionally speaking, verbs may show a gender bias, where certain actions are more likely to be undertaken by one gender rather than the other. The gender preference for certain verbs could be partially explained by the emotional dominance and valence of verbs and appeared to reflect strong societal gender stereotypes. The sentence completion task provided evidence that participants

were more likely to assign cause to male characters for actions perceived as being high dominance, and to female characters for actions perceived as being low dominance. Through a series of reading tasks, the association between gender and dominance significantly affected measures of reading time. Effects were observed based on the gender of stereotypical role names, pronouns and implicit causality bias focussed characters, all of which showed significant interactions with the dominance of verbs. Throughout all four reading studies, this association appeared through faster processing between low dominance and female characters and high dominance and male characters. The evidence suggests that the activation of this association may occur early in processing and that it can be used incrementally throughout discourse processing to update the mental representation. These data suggest that the emotional dominance of verbs may play a role in how we perceive of gender, at least in English-speaking communities in North America. Thus, an understanding of the association between gender and dominance can provide a greater understanding of the cognitive processes involved in language processing. Language is a reflection of our society, attitudes and beliefs, and therefore, understanding the patterns and associations through cognitive processing can help inform us of our own nature.

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Appendix A

Chapter 1: Supplementary information

Table A.1: Complete list of target verbs and their mean dominance, valence and arousal

Verb	Dom	Val	Aro	Verb	Dom	Val	Aro
abuse	2.90	1.53	6.21	interpret	5.24	5.20	4.43
accept	5.94	6.39	2.80	intimidate	5.75	2.84	5.27
accompany	5.63	5.47	3.85	intrigue	6.21	6.05	5.18
ache for	4.00	3.27	4.30	irritate	4.39	3.19	5.85
admire	7.33	7.35	5.00	jab	5.42	3.81	4.85
adopt	5.45	6.90	4.71	jolt	4.76	4.43	6.63
adore	6.26	7.37	5.96	judge	3.78	3.89	4.50
advance	6.12	6.11	4.62	kick	5.10	4.55	5.10
aggravate	4.85	2.55	5.90	knife	5.29	4.33	4.86
agitate	4.55	3.36	5.82	know	5.78	6.82	3.24
alarm	6.58	3.86	6.85	lead	5.22	5.56	3.95
alienate	3.71	2.79	4.27	levitate	5.04	5.40	6.10
allow	6.11	6.39	2.95	like	6.28	7.44	4.40
allure	5.77	6.90	4.25	loathe	4.77	2.68	5.18
alter	5.57	4.57	4.17	look at	5.88	5.95	3.76
amaze	5.83	7.24	5.00	love	5.92	8.00	5.36
amuse	6.80	7.10	5.17	lure	5.44	4.65	4.48
anger	5.14	2.50	5.93	manipulate	5.74	3.21	4.76
annoy	4.64	2.49	5.04	marvel at	5.21	5.84	4.77
antagonize	4.00	3.15	4.95	mature	7.05	5.95	3.48
applaud	5.91	6.70	5.05	meditate on	7.15	6.47	2.85
appoint	5.65	5.95	4.25	mellow	7.00	6.68	2.81
appreciate	7.00	7.33	3.10	mislead	4.20	3.20	5.10
apprehend	4.48	4.14	5.13	miss	5.12	4.10	3.90
approve of	7.26	7.00	4.09	mistrust	4.45	2.00	5.09
arouse	6.10	6.67	6.21	misunderstand	3.50	4.05	5.09
assault	3.49	2.05	6.80	moderate	5.53	5.52	4.00
astonish	6.00	5.55	5.38	moon on	6.11	7.00	3.43
astound	5.56	6.30	5.05	motivate	7.22	6.05	5.09
attend to	6.70	5.40	3.50	mourn	4.08	2.40	4.95
awe	5.85	6.85	3.83	muse on	6.12	6.30	4.75

Verb	Dom	Val	Aro	Verb	Dom	Val	Aro
bait	5.95	4.00	3.50	name	5.14	5.62	3.04
balance	5.47	6.84	4.13	nominate	6.05	5.86	3.48
banish	4.64	3.85	4.71	note	5.28	5.78	3.33
batter	6.00	5.24	3.85	oblige	5.11	5.19	3.74
bear	3.59	5.33	4.50	observe	5.92	5.30	4.25
beat	5.59	4.38	5.52	obsess over	4.10	3.23	4.95
behold	6.59	6.48	3.88	offend	4.17	3.29	4.81
believe	6.56	7.05	3.33	order	6.56	5.82	3.19
bill	4.00	3.11	4.00	overhear	5.21	3.89	4.27
blackmail	3.98	2.59	5.44	overwhelm	4.24	3.30	4.36
blame	3.33	2.94	4.81	pacify	5.32	5.67	2.55
boot	6.24	5.30	3.95	pain	3.47	2.00	6.27
bother	4.22	4.44	4.20	paint	6.56	5.74	4.50
bribe	4.59	3.32	4.44	panic	2.65	2.56	6.40
brighten	6.77	7.37	5.32	peep at	4.96	4.42	4.30
bug	4.08	3.45	6.06	peer at	6.05	5.64	4.05
bullshit	3.00	2.33	7.00	perceive	6.00	5.81	4.43
bully	3.18	2.67	5.86	permit	4.68	5.26	3.76
burn	3.90	3.73	5.40	persuade	6.00	5.67	3.65
buy	6.78	6.82	4.29	pester	4.04	3.26	5.18
call	5.61	6.18	3.29	phone	4.44	6.09	3.43
calm	7.44	6.89	1.67	pick	5.94	5.91	3.62
care about	6.56	7.64	2.67	picture	6.12	6.73	3.29
catch	5.47	5.64	4.00	pity	4.52	3.18	4.07
certify	5.93	5.89	3.62	poison	3.38	2.16	6.01
change	5.81	5.09	4.05	portray	6.11	5.35	3.09
characterize	6.32	5.50	3.24	praise	6.57	7.65	5.45
charm	6.43	7.34	4.51	prefer	6.89	5.62	4.65
chase	4.68	3.77	6.60	preserve	6.00	4.90	3.00
cheat	4.37	3.05	4.91	pressure	4.40	3.56	4.48
cherish	7.32	6.75	4.14	prize	6.16	8.00	5.50
choke	3.74	2.42	5.30	proclaim	6.10	5.38	4.84
choose	6.83	6.00	3.60	prod	5.30	4.65	4.23
clarify	6.04	6.00	2.85	prompt	5.92	6.33	2.90
clean	6.11	7.09	3.57	protect	5.83	6.83	3.70
clear	6.17	6.14	2.71	provoke	5.23	3.30	6.72
coerce	5.87	3.32	5.45	purify	6.77	6.95	4.88
collect	5.48	5.90	3.14	pursue	6.12	5.39	4.45
comfort	7.18	7.24	2.76	push	4.06	5.39	4.40
commission	5.38	5.81	4.59	puzzle	5.86	6.53	4.42
compel	5.59	4.89	4.33	quail at	5.20	5.43	2.67
comprehend	6.73	6.57	3.94	quiet	5.80	6.47	1.95
con	3.95	3.21	4.52	rage at	4.17	2.50	6.62
conceive	5.92	5.63	4.95	railroad	5.29	5.68	3.95
condone	5.48	5.10	3.57	rank	5.57	5.26	3.67
confound	3.85	4.88	3.75	reach	5.72	5.78	3.35
confuse	4.39	4.50	3.95	react over	6.12	5.15	5.48
console	5.79	6.53	4.09	reassure	6.07	6.55	3.70
contract	6.84	5.10	3.95	recall	5.78	4.77	4.48
convince	6.44	5.45	4.39	recognize	7.11	6.14	4.20
cool	6.44	6.82	3.43	recoil from	4.31	4.80	4.63

Verb	Dom	Val	Aro	Verb	Dom	Val	Aro
corrupt	3.70	3.00	5.98	recollect	5.75	5.05	3.05
count	5.17	5.89	2.30	recruit	6.00	4.53	4.77
cringe at	3.57	3.24	5.85	reflect on	6.72	6.10	3.35
crown	5.62	6.00	4.52	regard	6.38	5.70	3.39
crucify	3.11	2.26	5.60	regret	5.63	3.41	4.90
crush	3.96	4.72	5.60	reinstate	5.25	5.11	3.33
cry for	2.56	3.22	5.45	reject	3.46	2.95	4.78
cut	4.55	3.90	5.07	rejoice about	7.68	7.14	5.56
dare	4.17	4.67	5.60	relax	6.94	7.82	2.38
daze	4.58	4.14	4.50	relieve	6.62	7.25	3.90
dazzle	5.88	6.46	4.96	relish	5.56	4.55	4.45
deceive	4.58	2.95	5.90	remember	6.31	6.50	3.14
defend	6.64	6.30	4.55	remove	4.56	4.21	3.11
define	5.31	5.57	3.95	repay	5.94	5.18	3.65
deflect	5.37	5.10	3.68	repel	4.75	3.67	4.43
degenerate	2.95	2.70	4.68	report	4.94	4.77	3.52
degrade	4.40	2.62	4.95	represent	6.12	5.43	3.86
delight	7.29	8.21	5.02	resent	4.21	3.28	4.05
delude	4.35	3.62	3.95	respect	7.26	6.79	4.79
depict	5.71	4.74	3.88	resuscitate	5.91	5.65	4.62
deport	3.73	3.14	3.84	reveal	6.50	5.86	4.14
depress	3.67	2.47	3.14	reverse	6.08	5.20	3.73
derail	4.22	3.86	4.85	revive	6.11	6.53	3.92
describe	5.55	5.90	2.95	revolt	4.97	4.00	4.36
designate	5.61	5.62	4.60	rouse	4.95	5.24	4.79
despise	4.38	3.08	4.77	sack	5.00	5.11	4.24
detest	4.65	3.05	5.09	safeguard	4.94	5.50	3.17
diagnose	4.71	5.00	3.72	sanction	5.14	4.43	4.40
diffuse	4.75	5.04	3.86	satisfy	6.33	7.09	5.53
dirty	5.05	3.17	5.05	scare	4.58	3.55	7.10
disappoint	4.07	3.38	3.91	seduce	6.18	6.74	6.23
disapprove of	5.21	3.55	3.81	see	6.00	6.27	3.90
disarm	5.94	4.38	3.70	select	5.46	6.10	4.05
discourage	3.71	3.05	3.73	shade	6.25	5.91	2.91
discover	6.79	7.18	5.70	shadow	4.41	5.07	3.10
disdain	4.21	3.71	3.21	shake	6.37	4.59	5.20
disgrace	3.32	2.45	4.28	shame	5.21	2.62	5.40
disgust	4.84	3.32	5.00	shock	5.79	3.90	5.95
dislike	5.81	3.25	4.27	shoot	4.67	3.50	6.00
dismay	3.95	3.10	2.85	shrink from	3.70	4.00	3.42
dismiss	5.08	4.58	3.70	sight	5.94	7.11	3.20
displease	4.45	2.63	5.71	sign	5.38	5.27	3.19
distract	4.35	3.68	3.55	slap	4.78	2.95	4.59
distress	3.90	3.25	4.00	slow	5.39	4.00	2.89
distrust	3.32	2.95	4.05	smack	5.11	3.95	5.39
disturb	4.29	3.45	4.98	smother	4.20	2.68	4.75
dread	3.62	3.00	4.50	sniff	5.92	5.10	4.95
drive	5.67	6.50	4.19	snoop on	4.24	3.45	6.05
drop	4.82	4.23	4.67	soak	5.60	6.05	3.00
drown	2.65	2.33	5.35	sober	6.86	5.95	4.32
dull	4.71	3.40	1.67	soothe	6.40	6.63	3.91

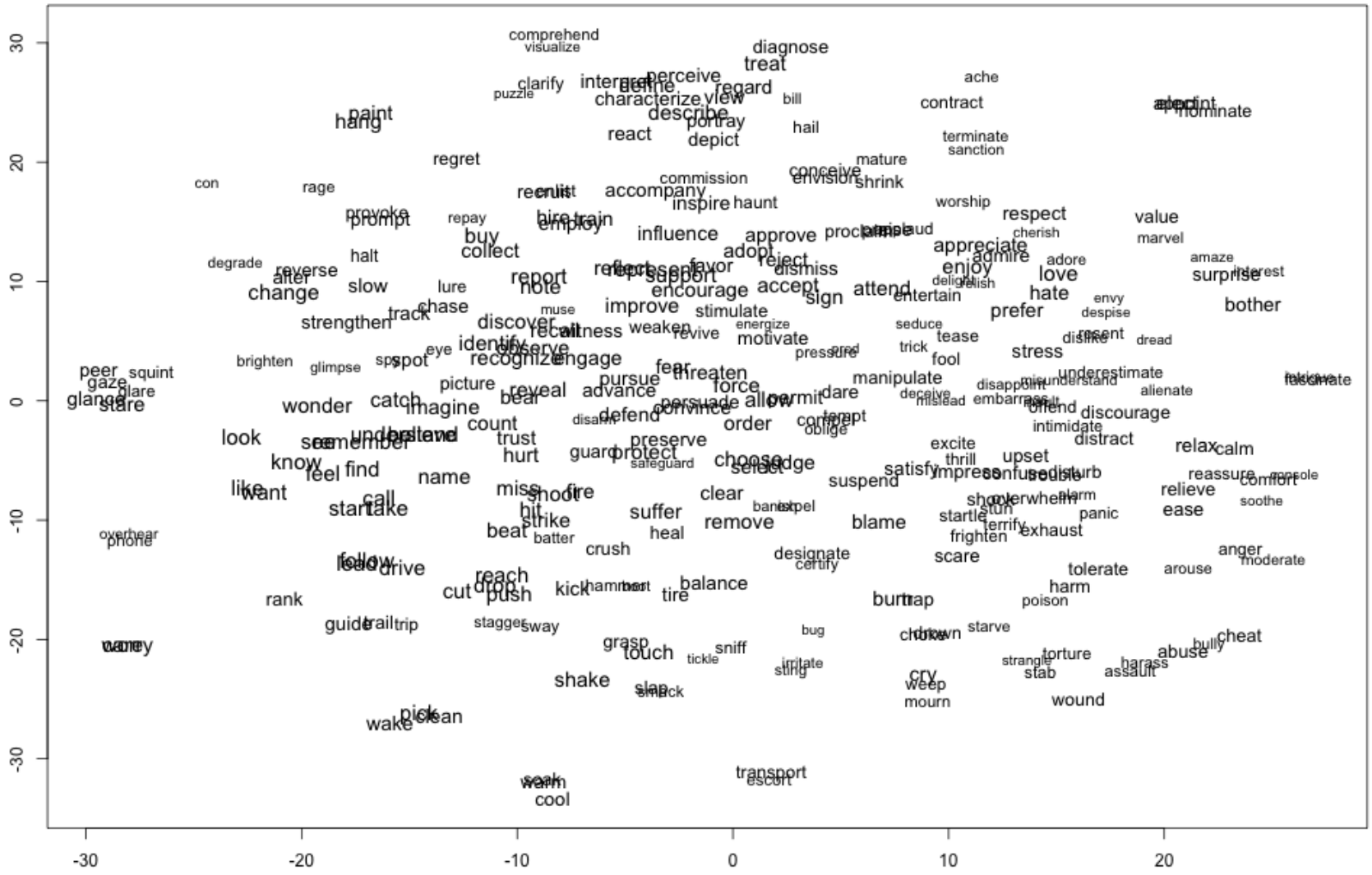
Verb	Dom	Val	Aro	Verb	Dom	Val	Aro
dupe	3.86	4.00	3.73	spook	5.00	3.70	5.14
ease	6.42	6.15	2.45	spot	4.83	5.12	2.95
elect	5.43	5.52	4.00	spy	3.84	4.68	4.74
electrocute	4.42	3.27	6.00	squint at	4.62	4.40	3.71
embarrass	4.22	3.38	5.47	stab	4.12	3.05	5.17
empathize with	6.38	7.10	3.55	stagger	4.15	3.42	4.38
employ	5.00	5.89	3.83	stare at	6.38	4.45	4.68
encourage	6.20	7.16	4.38	start at	5.50	6.41	4.81
energize	6.55	7.43	6.00	startle	4.55	4.65	4.40
engage	6.42	6.60	5.28	starve	3.12	2.53	4.00
enjoy	7.28	7.67	5.00	steady	6.42	6.67	3.00
enlighten	6.30	7.38	3.23	stereotype	3.81	3.33	4.26
enlist	5.58	4.42	3.71	stimulate	7.14	7.38	6.00
entertain	6.70	7.21	5.19	sting	3.45	2.55	4.88
entice	5.15	5.33	4.42	stone	7.26	4.81	3.25
envision	6.64	6.14	3.76	strangle	3.62	3.00	5.43
envy	3.16	3.05	4.35	strengthen	6.00	7.21	4.70
escort	5.63	5.35	5.32	stress about	3.85	1.79	4.72
excite	5.79	7.79	6.61	strike	3.28	3.06	5.52
exhaust	4.36	4.00	4.26	stump	4.54	4.62	3.85
expel	4.17	3.75	4.24	stun	4.19	4.55	5.50
eye	5.72	6.18	3.95	suffer	3.32	2.05	4.50
fancy	7.16	7.43	5.42	suffocate	3.48	2.62	6.09
fascinate	6.32	7.00	6.10	sulk about	3.68	3.22	3.30
fathom	4.30	5.21	4.71	support	6.11	6.89	3.05
fatten	4.65	3.89	3.39	surprise	5.17	7.44	6.57
favor	6.24	6.67	4.61	suspend	4.68	4.32	4.87
faze	5.45	4.82	3.91	sway	6.15	5.25	3.68
fear	3.32	2.93	6.14	swoon at	5.67	5.76	3.83
feel for	5.50	6.27	4.05	sympathize with	7.05	6.00	3.73
find	6.24	6.45	3.52	tail	5.32	5.30	3.27
fire	4.57	4.32	6.05	take	4.83	4.82	4.52
flatter	6.00	6.10	4.61	taunt	3.23	3.40	4.85
flinch from	4.12	4.00	5.28	tease	5.24	4.17	5.21
floor	6.39	5.14	3.33	tempt	4.80	5.00	5.29
follow	4.81	4.82	3.76	terminate	3.25	3.05	4.95
fool	2.94	3.56	4.86	terrify	2.79	2.84	6.39
force	4.22	4.17	5.35	terrorize	3.05	2.50	5.95
fret about	4.24	3.73	5.89	threaten	3.29	2.60	6.05
frighten	2.71	2.95	4.85	thrill	6.09	7.37	7.19
gaze at	6.35	6.15	4.15	throttle	5.71	5.55	5.36
glance at	5.48	5.71	2.63	tickle	5.28	6.14	5.86
glare at	5.53	3.70	4.05	tire of	5.52	4.55	3.09
glimpse	5.75	5.67	3.59	tolerate	5.70	6.19	3.14
glory in	6.72	6.45	6.31	torment	3.96	2.53	6.17
goggle at	6.15	5.00	3.20	torture	2.76	1.40	5.09
grasp	6.48	5.45	4.05	touch	6.24	6.64	4.90
grieve	3.38	2.80	4.56	toughen	5.94	5.37	4.28
guard	4.06	5.89	3.60	track	4.67	5.78	3.76
guide	5.75	5.43	3.33	trail	5.42	6.15	4.00
gush over	5.19	5.32	5.57	train	5.72	6.36	4.05

Verb	Dom	Val	Aro	Verb	Dom	Val	Aro
hail	4.44	4.81	3.83	transport	5.79	5.90	3.76
halt	4.37	4.42	4.57	trap	3.78	3.24	4.36
hammer	5.59	5.17	4.56	treasure	6.04	7.65	6.30
hang	4.61	3.10	4.86	treat	6.66	6.84	5.00
harass	3.58	2.95	6.10	trick	3.22	4.89	5.57
harm	3.95	1.91	5.90	trip	6.11	7.00	5.33
hasten	5.33	4.90	3.86	trouble	4.35	2.87	5.59
hate	4.47	1.96	6.26	trust	6.95	7.24	4.30
haunt	4.39	4.05	4.87	underestimate	5.08	4.35	4.48
heal	5.18	7.41	4.32	understand	6.71	6.68	3.52
hire	6.42	7.09	5.65	upset	4.30	2.45	4.49
hit	5.15	3.95	5.48	value	6.24	7.18	5.79
hound	5.84	5.30	4.27	view	6.84	6.67	3.30
humble	6.27	6.52	3.18	visualize	6.63	6.58	4.36
humiliate	3.96	2.60	5.05	wake	5.71	6.57	3.80
hurt	3.73	2.45	4.72	wallow in	4.53	4.33	4.30
hypnotize	4.67	5.70	5.05	want	5.39	6.00	5.29
identify	6.14	6.00	4.16	warm	6.33	7.50	3.35
imagine	6.92	7.20	4.46	weaken	3.42	3.30	4.19
impress	6.62	6.25	4.82	weary of	4.55	3.25	2.90
improve	6.04	6.14	4.61	weep for	4.17	2.88	4.00
incite	5.67	4.76	4.77	witness	4.44	5.61	3.67
influence	5.96	5.53	4.30	wonder at	6.44	6.68	4.38
inspire	7.11	7.42	5.90	worry about	3.17	2.10	6.33
insult	3.96	2.62	5.30	worship	4.65	5.57	3.78
interest	6.31	6.66	4.36	wound	3.64	3.24	4.65

Appendix B

Chapter 2: Supplementary information

Figure B.1: Two dimensional reduction of the verbal vector space model



Note: Proximity of words denotes degree of semantic similarity, size of text the word frequency

Table B.1: Verbs by Semantic Vector Space Model based Hierarchical Clustering

Cluster	Verbs
REMEMBER	*know, want, like, believe, understand, love, remember, wonder, recognize, accept, imagine, recall, hate*
SEE	*see, look, find, feel*
PUSH	*take, start, lead, follow, cut, reach, drive, push, drop*
CHOOSE	*call, buy, report, choose, represent, note, identify, name, remove, reveal, sign, attend, collect, order, select, prefer*
REVERSE	*change, improve, alter, prompt, reverse, halt, revive, hasten, derail, resuscitate*
PERSUADE	*allow, force, convince, permit, persuade, compel, tempt, oblige*
CHALLENGE	*support, encourage, adopt, judge, defend, pursue, reject, approve, favor, advance, dismiss, toughen*
WARM	*pick, catch, hang, burn, wake, clear, clean, cool, warm, soak, sober*
HIT	*hit, shoot, beat, strike, fire, guard, crush, batter, sack*
VIEW	*describe, define, view, perceive, regard, interpret, characterize, depict, portray, hail, bill*
SAFEGUARD	*protect, preserve, safeguard*
HURT	*miss, hurt, suffer, threaten, fear, blame, upset*
SLAP	*shake, touch, kick, react, slap, grasp, hammer, panic, smack, prod, flinch, steady, cringe, jab, recoil*
ADMIRE	*enjoy, appreciate, respect, admire, praise, value, entertain, applaud, relish, delight, cherish, prize, treasure*
BOTHER	*care, worry, trust, bother, dare, fret, obsess, faze, bullshit*
OBSERVE	*discover, observe, engage, count, bear, balance, witness, satisfy, wallow, glory*
SHADE	*reflect, paint, brighten, shade, shadow*
HEAL	*treat, diagnose, heal, shrink, contract, ache, banish, dull*
RECRUIT	*hire, train, employ, recruit, enlist*
Cluster	Verbs
GAZE	*stare, glance, peer, gaze, glare, squint, marvel, goggle*
WEEP	*cry, regret, exhaust, weep, phone, mourn, overhear, muse, dread, grieve, meditate, recollect, sulk, weary, allure*
WEAKEN	*influence, stress, strengthen, motivate, stimulate, weaken, clarify, underestimate, moderate, energize, aggravate, confound, depress*
JOLT	*slow, track, tire, sway, stagger, jolt, daze, throttle, floor, levitate*
LURE	*inspire, accompany, guide, transport, lure, escort, entice*
APPOINT	*elect, appoint, rank, nominate, designate, commission, certify*
CHASE	*spot, chase, scare, trail, trip, eye, spy, glimpse, sight, spook, peep, swoon, tail, moon, knife*
SOOTHE	*relax, ease, relieve, calm, comfort, reassure, soothe, console, rouse, quiet*
AMAZE	*surprise, interest, amaze, puzzle, enlighten, astound, pain*

INSULT	*impress, cheat, offend, intimidate, embarrass, bully, insult, disappoint, humiliate, amuse, annoy, flatter, taunt, shame, torment, hound, pester, disgust, displease, disgrace*
ASPHYXIATE	*trap, drown, choke, stab, poison, starve, strangle, smother, gush, suffocate, electrocute*
FRIGHTEN	*confuse, distract, disturb, trouble, overwhelm, startle, frighten, terrify, alarm, agitate, distress, hypnotize*
TORTURE	*abuse, wound, torture, assault, harass, deport, terrorize, apprehend, stone*
VISUALIZE	*picture, conceive, manipulate, envision, comprehend, visualize, fancy, fathom*
SUSPEND	*suspend, expel, terminate, reinstate*
ASTONISH	*shock, haunt, stun, excite, thrill, fascinate, intrigue, seduce, charm, dazzle, astonish, humble, dismay, awe*
CONDONE	*discourage, harm, tolerate, sanction, disapprove, condone*
WORSHIP	*proclaim, worship, crown, behold, rejoice, crucify*
PROVOKE	*provoke, anger, rage, arouse, incite, degenerate*
BUG	*fool, tease, sniff, trick, sting, con, irritate, boot, tickle, bug, stump, dirty, snoop*
FATTEN	*mature, bait, mellow, fatten, quail*
DESPISE	*resent, dislike, adore, envy, despise, loathe, pity, detest, disdain*
BLACKMAIL	*pressure, repay, disarm, coerce, bribe, blackmail, pacify*
DELUDE	*alienate, misunderstand, deceive, mislead, sympathize, corrupt, distrust, dupe, empathize, delude, antagonize, revolt, mistrust, railroad, stereotype*
REPEL	*degrade, deflect, repel, diffuse, purify*

Table B.2: Verb stimuli by VerbNet class and thematic role

VerbNet Class	VerbNet Meaning	Thematic Role	Example
77	accept	AgEvo	accept
40.7	accept	AgEvo	buy
77	accept	AgEvo	discourage
77	accept	AgEvo	encourage
77	accept	AgEvo	reject
51.7	accompany	AgEvo	accompany
51.7	accompany	AgEvo	escort
51.7	accompany	AgEvo	guide
51.7	accompany	AgEvo	lead
64	allow	AgEvo	allow
64	allow	AgEvo	permit
64	allow	AgEvo	sanction
64	allow	AgEvo	tolerate
29.1	appoint	AgEvo	adopt
29.1	appoint	AgEvo	appoint
29.1	appoint	AgEvo	crown
29.1	appoint	AgEvo	designate
29.1	appoint	AgEvo	elect
29.1	appoint	AgEvo	name
29.1	appoint	AgEvo	nominate
29.1	appoint	AgEvo	proclaim
29.1	appoint	AgEvo	want
10.2	banish	AgEvo	banish
10.2	banish	AgEvo	boot
10.2	banish	AgEvo	deport
10.2	banish	AgEvo	expel
10.2	banish	AgEvo	recall
10.2	banish	AgEvo	remove
29.2	characterize	AgEvo	bill
29.2	characterize	AgEvo	certify
29.2	characterize	AgEvo	characterize
29.2	characterize	AgEvo	conceive
29.2	characterize	AgEvo	count
29.2	characterize	AgEvo	define
29.2	characterize	AgEvo	depict
29.2	characterize	AgEvo	describe
29.2	characterize	AgEvo	diagnose
29.2	characterize	AgEvo	envision
29.2	characterize	AgEvo	hail
29.2	characterize	AgEvo	identify
29.2	characterize	AgEvo	imagine
29.2	characterize	AgEvo	interpret
29.2	characterize	AgEvo	judge
29.2	characterize	AgEvo	know
29.2	characterize	AgEvo	paint
29.2	characterize	AgEvo	picture
29.2	characterize	AgEvo	portray
29.2	characterize	AgEvo	praise

VerbNet Class	VerbNet Meaning	Thematic Role	Example
29.2	characterize	AgEvo	rank
29.2	characterize	AgEvo	recollect
29.2	characterize	AgEvo	regard
29.2	characterize	AgEvo	remember
29.2	characterize	AgEvo	report
29.2	characterize	AgEvo	represent
29.2	characterize	AgEvo	reveal
29.2	characterize	AgEvo	see
29.2	characterize	AgEvo	select
29.2	characterize	AgEvo	stereotype
29.2	characterize	AgEvo	take
29.2	characterize	AgEvo	treat
29.2	characterize	AgEvo	underestimate
29.2	characterize	AgEvo	visualize
51.6	chase	AgEvo	chase
51.6	chase	AgEvo	follow
51.6	chase	AgEvo	pursue
51.6	chase	AgEvo	shadow
51.6	chase	AgEvo	tail
51.6	chase	AgEvo	track
51.6	chase	AgEvo	trail
72.2	defend	AgEvo	defend
72.2	defend	AgEvo	guard
72.2	defend	AgEvo	preserve
72.2	defend	AgEvo	protect
72.2	defend	AgEvo	safeguard
72.2	defend	AgEvo	shade
10.1	fire	AgEvo	dismiss
10.1	fire	AgEvo	drop
10.1	fire	AgEvo	fire
10.1	fire	AgEvo	sack
10.1	fire	AgEvo	suspend
10.1	fire	AgEvo	terminate
13.5.1	get	AgEvo	call
13.5.1	get	AgEvo	catch
13.5.1	get	AgEvo	choose
13.5.1	get	AgEvo	find
13.5.1	get	AgEvo	order
13.5.1	get	AgEvo	phone
13.5.1	get	AgEvo	pick
13.5.1	get	AgEvo	reach
13.5.3	hire	AgEvo	employ
13.5.3	hire	AgEvo	enlist
13.5.3	hire	AgEvo	hire
13.5.3	hire	AgEvo	recruit
13.5.3	hire	AgEvo	reinstate
13.5.3	hire	AgEvo	sign
13.5.3	hire	AgEvo	train
33	judge	AgEvo	abuse

VerbNet Class	VerbNet Meaning	Thematic Role	Example
33	judge	AgEvo	assault
33	judge	AgEvo	blame
33	judge	AgEvo	condone
33	judge	AgEvo	repay
40.7	suffocate	AgEvo	choke
40.7	suffocate	AgEvo	drown
40.7	suffocate	AgEvo	starve
40.7	suffocate	AgEvo	suffocate
59	force	AgPat	allure
59	force	AgPat	bait
59	force	AgPat	blackmail
59	force	AgPat	bribe
59	force	AgPat	bullshit
59	force	AgPat	bully
59	force	AgPat	cheat
59	force	AgPat	coerce
59	force	AgPat	commission
59	force	AgPat	compel
59	force	AgPat	con
59	force	AgPat	dare
59	force	AgPat	deceive
59	force	AgPat	delude
59	force	AgPat	drive
59	force	AgPat	dupe
59	force	AgPat	fool
59	force	AgPat	force
59	force	AgPat	harass
59	force	AgPat	hound
59	force	AgPat	incite
59	force	AgPat	influence
59	force	AgPat	lure
59	force	AgPat	manipulate
59	force	AgPat	mislead
59	force	AgPat	motivate
59	force	AgPat	oblige
59	force	AgPat	panic
59	force	AgPat	persuade
59	force	AgPat	pressure
59	force	AgPat	prod
59	force	AgPat	prompt
59	force	AgPat	push
59	force	AgPat	railroad
59	force	AgPat	rouse
59	force	AgPat	seduce
59	force	AgPat	sway
59	force	AgPat	trap
59	force	AgPat	trick
18.1	hit	AgPat	batter
18.1	hit	AgPat	beat

VerbNet Class	VerbNet Meaning	Thematic Role	Example
18.1	hit	AgPat	hammer
18.1	hit	AgPat	hit
18.1	hit	AgPat	jab
18.1	hit	AgPat	kick
18.1	hit	AgPat	slap
18.1	hit	AgPat	smack
18.1	hit	AgPat	strike
45.4	other-cos	AgPat	advance
45.4	other-cos	AgPat	alter
45.4	other-cos	AgPat	balance
45.4	other-cos	AgPat	brighten
45.4	other-cos	AgPat	burn
45.4	other-cos	AgPat	change
45.4	other-cos	AgPat	clarify
45.4	other-cos	AgPat	clean
45.4	other-cos	AgPat	clear
45.4	other-cos	AgPat	collect
45.4	other-cos	AgPat	contract
45.4	other-cos	AgPat	cool
45.4	other-cos	AgPat	corrupt
45.4	other-cos	AgPat	deflect
45.4	other-cos	AgPat	degenerate
45.4	other-cos	AgPat	degrade
45.4	other-cos	AgPat	derail
45.4	other-cos	AgPat	diffuse
45.4	other-cos	AgPat	dirty
45.4	other-cos	AgPat	dull
45.4	other-cos	AgPat	ease
45.4	other-cos	AgPat	energize
45.4	other-cos	AgPat	fatten
45.4	other-cos	AgPat	halt
45.4	other-cos	AgPat	hasten
45.4	other-cos	AgPat	heal
45.4	other-cos	AgPat	improve
45.4	other-cos	AgPat	levitate
45.4	other-cos	AgPat	mature
45.4	other-cos	AgPat	mellow
45.4	other-cos	AgPat	moderate
45.4	other-cos	AgPat	purify
45.4	other-cos	AgPat	quiet
45.4	other-cos	AgPat	resuscitate
45.4	other-cos	AgPat	reverse
45.4	other-cos	AgPat	revive
45.4	other-cos	AgPat	slow
45.4	other-cos	AgPat	soak
45.4	other-cos	AgPat	sober
45.4	other-cos	AgPat	steady
45.4	other-cos	AgPat	strengthen
45.4	other-cos	AgPat	toughen

VerbNet Class	VerbNet Meaning	Thematic Role	Example
45.4	other-cos	AgPat	trip
45.4	other-cos	AgPat	wake
45.4	other-cos	AgPat	warm
45.4	other-cos	AgPat	weaken
42.2	poison	AgPat	crucify
42.2	poison	AgPat	electrocute
42.2	poison	AgPat	hang
42.2	poison	AgPat	knife
42.2	poison	AgPat	poison
42.2	poison	AgPat	shoot
42.2	poison	AgPat	smother
42.2	poison	AgPat	stab
42.2	poison	AgPat	stone
42.2	poison	AgPat	strangle
42.2	poison	AgPat	throttle
31.2	admire	ExpStim	admire
31.2	admire	ExpStim	adore
31.2	admire	ExpStim	applaud
31.2	admire	ExpStim	appreciate
31.2	admire	ExpStim	bear
31.2	admire	ExpStim	believe
31.2	admire	ExpStim	cherish
31.2	admire	ExpStim	despise
31.2	admire	ExpStim	detest
31.2	admire	ExpStim	disdain
31.2	admire	ExpStim	dislike
31.2	admire	ExpStim	distrust
31.2	admire	ExpStim	dread
31.2	admire	ExpStim	enjoy
31.2	admire	ExpStim	envy
31.2	admire	ExpStim	fancy
31.2	admire	ExpStim	favor
31.2	admire	ExpStim	fear
31.2	admire	ExpStim	hate
31.2	admire	ExpStim	like
31.2	admire	ExpStim	loathe
31.2	admire	ExpStim	love
31.2	admire	ExpStim	miss
31.2	admire	ExpStim	mistrust
31.2	admire	ExpStim	mourn
31.2	admire	ExpStim	pity
31.2	admire	ExpStim	prefer
31.2	admire	ExpStim	prize
31.2	admire	ExpStim	regret
31.2	admire	ExpStim	relish
31.2	admire	ExpStim	resent
31.2	admire	ExpStim	respect
31.2	admire	ExpStim	suffer
31.2	admire	ExpStim	support

VerbNet Class	VerbNet Meaning	Thematic Role	Example
31.2	admire	ExpStim	treasure
31.2	admire	ExpStim	trust
31.2	admire	ExpStim	value
31.2	admire	ExpStim	worship
87.2	comprehend	ExpStim	apprehend
87.2	comprehend	ExpStim	comprehend
87.2	comprehend	ExpStim	fathom
87.2	comprehend	ExpStim	grasp
87.2	comprehend	ExpStim	misunderstand
87.2	comprehend	ExpStim	understand
88.2	empathize	ExpStim	empathize with
88.2	empathize	ExpStim	sympathize with
40.5	flinch	ExpStim	cringe at
40.5	flinch	ExpStim	flinch from
40.5	flinch	ExpStim	quail at
40.5	flinch	ExpStim	recoil from
40.5	flinch	ExpStim	shrink from
31.3	marvel	ExpStim	ache for
31.3	marvel	ExpStim	approve of
31.3	marvel	ExpStim	care about
31.3	marvel	ExpStim	cry for
31.3	marvel	ExpStim	disapprove of
31.3	marvel	ExpStim	feel for
31.3	marvel	ExpStim	fret about
31.3	marvel	ExpStim	glory in
31.3	marvel	ExpStim	gush over
31.3	marvel	ExpStim	marvel at
31.3	marvel	ExpStim	meditate on
31.3	marvel	ExpStim	moon on
31.3	marvel	ExpStim	muse on
31.3	marvel	ExpStim	obsess over
31.3	marvel	ExpStim	rage at
31.3	marvel	ExpStim	react over
31.3	marvel	ExpStim	reflect on
31.3	marvel	ExpStim	rejoice about
31.3	marvel	ExpStim	start at
31.3	marvel	ExpStim	stress about
31.3	marvel	ExpStim	sulk about
31.3	marvel	ExpStim	swoon at
31.3	marvel	ExpStim	tire of
31.3	marvel	ExpStim	wallow in
31.3	marvel	ExpStim	weary of
31.3	marvel	ExpStim	weep for
31.3	marvel	ExpStim	wonder at
31.3	marvel	ExpStim	worry about
30.3	peer	ExpStim	attend to
30.3	peer	ExpStim	gaze at
30.3	peer	ExpStim	glance at
30.3	peer	ExpStim	glare at

VerbNet Class	VerbNet Meaning	Thematic Role	Example
30.3	peer	ExpStim	goggle at
30.3	peer	ExpStim	look at
30.3	peer	ExpStim	peep at
30.3	peer	ExpStim	peer at
30.3	peer	ExpStim	snoop on
30.3	peer	ExpStim	squint at
30.3	peer	ExpStim	stare at
30.2	sight	ExpStim	behold
30.2	sight	ExpStim	discover
30.2	sight	ExpStim	eye
30.2	sight	ExpStim	glimpse
30.2	sight	ExpStim	note
30.2	sight	ExpStim	observe
30.2	sight	ExpStim	overhear
30.2	sight	ExpStim	perceive
30.2	sight	ExpStim	recognize
30.2	sight	ExpStim	sight
30.2	sight	ExpStim	sniff
30.2	sight	ExpStim	spot
30.2	sight	ExpStim	spy
30.2	sight	ExpStim	view
30.2	sight	ExpStim	witness
31.1	amuse	StimExp	aggravate
31.1	amuse	StimExp	agitate
31.1	amuse	StimExp	alarm
31.1	amuse	StimExp	alienate
31.1	amuse	StimExp	amaze
31.1	amuse	StimExp	amuse
31.1	amuse	StimExp	anger
31.1	amuse	StimExp	annoy
31.1	amuse	StimExp	antagonize
31.1	amuse	StimExp	arouse
31.1	amuse	StimExp	astonish
31.1	amuse	StimExp	astound
31.1	amuse	StimExp	awe
31.1	amuse	StimExp	bother
31.1	amuse	StimExp	bug
31.1	amuse	StimExp	calm
31.1	amuse	StimExp	charm
31.1	amuse	StimExp	comfort
31.1	amuse	StimExp	confound
31.1	amuse	StimExp	confuse
31.1	amuse	StimExp	console
31.1	amuse	StimExp	convince
31.1	amuse	StimExp	crush
31.1	amuse	StimExp	cut
31.1	amuse	StimExp	daze
31.1	amuse	StimExp	dazzle
31.1	amuse	StimExp	delight

VerbNet Class	VerbNet Meaning	Thematic Role	Example
31.1	amuse	StimExp	depress
31.1	amuse	StimExp	disappoint
31.1	amuse	StimExp	disarm
31.1	amuse	StimExp	disgrace
31.1	amuse	StimExp	disgust
31.1	amuse	StimExp	dismay
31.1	amuse	StimExp	displease
31.1	amuse	StimExp	distract
31.1	amuse	StimExp	distress
31.1	amuse	StimExp	disturb
31.1	amuse	StimExp	embarrass
31.1	amuse	StimExp	engage
31.1	amuse	StimExp	enlighten
31.1	amuse	StimExp	entertain
31.1	amuse	StimExp	entice
31.1	amuse	StimExp	excite
31.1	amuse	StimExp	exhaust
31.1	amuse	StimExp	fascinate
31.1	amuse	StimExp	faze
31.1	amuse	StimExp	flatter
31.1	amuse	StimExp	floor
31.1	amuse	StimExp	frighten
31.1	amuse	StimExp	grieve
31.1	amuse	StimExp	harm
31.1	amuse	StimExp	haunt
31.1	amuse	StimExp	humble
31.1	amuse	StimExp	humiliate
31.1	amuse	StimExp	hurt
31.1	amuse	StimExp	hypnotize
31.1	amuse	StimExp	impress
31.1	amuse	StimExp	inspire
31.1	amuse	StimExp	insult
31.1	amuse	StimExp	interest
31.1	amuse	StimExp	intimidate
31.1	amuse	StimExp	intrigue
31.1	amuse	StimExp	irritate
31.1	amuse	StimExp	jolt
31.1	amuse	StimExp	offend
31.1	amuse	StimExp	overwhelm
31.1	amuse	StimExp	pacify
31.1	amuse	StimExp	pain
31.1	amuse	StimExp	pester
31.1	amuse	StimExp	provoke
31.1	amuse	StimExp	puzzle
31.1	amuse	StimExp	reassure
31.1	amuse	StimExp	relax
31.1	amuse	StimExp	relieve
31.1	amuse	StimExp	repel
31.1	amuse	StimExp	revolt

VerbNet Class	VerbNet Meaning	Thematic Role	Example
31.1	amuse	StimExp	satisfy
31.1	amuse	StimExp	scare
31.1	amuse	StimExp	shake
31.1	amuse	StimExp	shame
31.1	amuse	StimExp	shock
31.1	amuse	StimExp	soothe
31.1	amuse	StimExp	spook
31.1	amuse	StimExp	stagger
31.1	amuse	StimExp	startle
31.1	amuse	StimExp	stimulate
31.1	amuse	StimExp	sting
31.1	amuse	StimExp	stump
31.1	amuse	StimExp	stun
31.1	amuse	StimExp	surprise
31.1	amuse	StimExp	taunt
31.1	amuse	StimExp	tease
31.1	amuse	StimExp	tempt
31.1	amuse	StimExp	terrify
31.1	amuse	StimExp	terrorize
31.1	amuse	StimExp	threaten
31.1	amuse	StimExp	thrill
31.1	amuse	StimExp	tickle
31.1	amuse	StimExp	torment
31.1	amuse	StimExp	torture
31.1	amuse	StimExp	touch
31.1	amuse	StimExp	transport
31.1	amuse	StimExp	trouble
31.1	amuse	StimExp	upset
31.1	amuse	StimExp	wound

Table B.3: Gender Bias by Verb

Verb	Gender Bias	Verb	Gender Bias
abuse	0.73	intimidate	16.39
accept	12.12	intrigue	14.92
accompany	11.62	irritate	9.38
ache	-6.17	jab	12.93
admire	12.30	jolt	6.55
adopt	5.02	judge	12.07
adore	-1.09	kick	4.04
advance	18.01	knife	13.04
aggravate	16.15	know	8.36
agitate	12.13	lead	10.28
alarm	10.73	levitate	7.16
alienate	19.46	like	6.68
allow	7.88	loathe	6.78
allure	-25.00	look	4.69
alter	10.27	love	5.17
amaze	2.36	lure	16.24
amuse	3.98	manipulate	23.41
anger	13.26	marvel	11.82
annoy	9.00	mature	13.29
antagonize	30.67	meditate	16.61
applaud	12.90	mellow	9.52
appoint	12.36	mislead	17.00
appreciate	9.19	miss	3.85
apprehend	15.77	mistrust	14.32
approve	14.07	misunderstand	8.70
arouse	4.77	moderate	7.52
assault	3.25	moon	24.26
astonish	14.06	motivate	17.17
astound	13.59	mourn	15.21
awe	8.60	muse	4.68
bait	16.39	name	12.87
balance	8.27	nominate	15.36
banish	8.01	note	7.15
batter	14.81	oblige	10.19
bear	15.05	observe	5.38
beat	8.75	obsess	10.21
behold	4.54	offend	10.03
believe	5.57	order	6.72
bill	8.56	overhear	0.57
blackmail	19.92	overwhelm	12.88
blame	7.68	pacify	18.82
boot	22.85	pain	8.64
bother	4.79	paint	5.06
bribe	24.67	panic	7.76
brighten	2.50	peep	13.79
bug	17.40	peer	1.10
bullshit	37.49	perceive	11.06
bully	9.23	permit	7.12
burn	5.18	persuade	18.64
buy	7.22	pester	5.01

Verb	Gender Bias	Verb	Gender Bias
call	7.39	phone	0.42
calm	-1.65	pick	6.53
care	4.52	picture	7.88
catch	9.35	pity	2.96
certify	11.89	poison	8.06
change	7.05	portray	9.69
characterize	14.36	praise	15.97
charm	4.74	prefer	3.85
chase	5.71	preserve	15.38
cheat	2.51	pressure	14.00
cherish	6.16	prize	13.99
choke	3.99	proclaim	10.24
choose	7.02	prod	10.36
clarify	8.94	prompt	21.75
clean	4.92	protect	9.07
clear	7.07	provoke	14.63
coerce	11.71	purify	17.86
collect	8.37	pursue	13.95
comfort	1.71	push	4.22
commission	17.21	puzzle	10.76
compel	10.33	quail	-2.13
comprehend	12.10	quiet	7.31
con	11.31	rage	21.05
conceive	19.53	railroad	15.63
condone	18.06	rank	9.04
confuse	12.11	reach	6.73
console	-1.90	react	4.28
contract	8.33	reassure	2.72
convince	8.89	recall	10.11
cool	14.30	recognize	8.20
corrupt	15.95	recoil	11.73
count	9.40	recollect	7.31
cringe	3.70	recruit	21.06
crown	12.49	reflect	9.19
crucify	22.23	regard	11.45
crush	12.24	regret	11.06
cry	4.74	reinstate	27.40
cut	7.60	reject	15.28
dare	3.79	rejoice	14.74
daze	4.79	relax	0.37
dazzle	4.90	relieve	8.88
deceive	19.60	relish	6.70
defend	11.98	remember	10.63
define	11.78	remove	4.62
deflect	17.88	repay	11.93
degenerate	9.76	repel	17.96
degrade	18.25	report	7.45
delight	6.00	represent	9.66
delude	9.19	resent	6.43
depict	14.02	respect	10.85
deport	3.52	resuscitate	8.22

Verb	Gender Bias	Verb	Gender Bias
depress	7.41	reveal	9.92
derail	21.16	reverse	22.41
describe	5.83	revive	20.87
designate	23.07	revolt	23.73
despise	9.25	rouse	8.66
detest	9.66	sack	21.34
diagnose	6.68	safeguard	17.72
diffuse	30.34	sanction	21.00
dirty	14.11	satisfy	17.43
disappoint	9.59	scare	8.13
disapprove	17.29	seduce	8.02
disarm	18.33	see	8.12
discourage	12.96	select	12.59
discover	7.58	shade	4.54
disdain	19.23	shadow	11.38
disgrace	13.85	shake	6.24
disgust	5.53	shame	4.93
dislike	18.23	shock	6.43
dismay	4.13	shoot	8.30
dismiss	8.35	shrink	11.28
displease	4.92	sight	2.68
distract	4.95	sign	13.50
distress	12.99	slap	3.01
distrust	26.13	slow	11.97
disturb	10.51	smack	10.48
dread	-4.76	smother	2.85
drive	5.58	sniff	5.42
drop	5.27	snoop	2.89
drown	7.71	soak	6.57
dull	9.83	sober	1.00
dupe	9.47	soothe	2.90
ease	12.80	spook	16.74
elect	12.35	spot	5.76
electrocute	9.49	spy	10.41
embarrass	13.50	squint	4.92
empathize	13.97	stab	6.66
employ	12.45	stagger	8.92
encourage	8.85	stare	2.92
energize	7.31	start	8.17
engage	8.84	startle	3.93
enjoy	3.96	starve	10.70
enlighten	16.62	steady	4.56
enlist	19.70	stereotype	23.81
entertain	4.76	stimulate	19.96
entice	17.12	sting	7.28
envision	7.86	stone	5.35
envy	9.45	strangle	0.81
escort	-3.87	strengthen	12.99
excite	16.08	stress	6.78
exhaust	10.63	strike	7.11
expel	20.74	stump	31.24

Verb	Gender Bias	Verb	Gender Bias
eye	2.87	stun	10.03
fancy	5.74	suffer	3.65
fascinate	10.67	suffocate	-6.85
fathom	15.86	sulk	-1.25
fatten	12.82	support	13.81
favor	13.29	surprise	4.37
faze	33.14	suspend	8.71
fear	5.75	sway	9.19
feel	4.09	swoon	15.89
find	6.01	sympathize	11.25
fire	12.33	tail	28.38
flatter	5.87	take	5.30
flinch	5.77	taunt	20.18
floor	19.04	tease	6.48
follow	8.39	tempt	10.46
fool	12.66	terminate	15.69
force	11.88	terrify	12.72
fret	8.75	terrorize	5.31
frighten	3.81	threaten	6.70
gaze	0.23	thrill	8.92
glance	1.22	throttle	27.77
glare	6.28	tickle	2.40
glimpse	9.08	tire	15.23
glory	23.58	tolerate	12.56
goggle	28.00	torment	7.08
grasp	6.09	torture	6.12
grieve	6.01	touch	4.81
guard	18.88	toughen	4.77
guide	8.32	track	10.79
gush	0.30	trail	16.76
hail	13.71	train	10.54
halt	16.96	transport	17.64
hammer	13.64	trap	3.05
hang	5.56	treasure	14.42
harass	-1.35	treat	6.56
harm	10.37	trick	1.34
hasten	12.25	trip	7.33
hate	4.06	trouble	14.65
haunt	11.76	trust	14.04
heal	11.07	underestimate	19.21
hire	12.54	understand	8.30
hit	5.96	upset	7.06
hound	9.78	value	7.70
humble	17.78	view	10.47
humiliate	1.80	visualize	16.15
hurt	4.34	wake	-0.66
hypnotize	0.30	wallow	15.62
identify	8.61	want	2.79
imagine	7.21	warm	5.04
impress	10.89	weaken	18.13
improve	13.08	weary	10.39

Verb	Gender Bias	Verb	Gender Bias
incite	17.43	weep	8.41
influence	27.29	witness	13.89
inspire	13.52	wonder	4.45
insult	12.75	worry	3.93
interest	15.27	worship	17.32
interpret	10.57	wound	18.93

Table B.4: Results of linear mixed effects model for the NP1 gender bias for the SVM clustered corpus data

Scaled residuals:				
Min	1Q	Median	3Q	Max
-1.968	−0.221	0.112	0.764	1.623
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.009	0.03	
Register	(Intercept)	0.016	0.04	
Residual		4.080	0.66	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	−16.271	7.316	−2.224	*
log(Valence)	18.588	5.115	3.634	***
log(Dominance)	18.300	4.797	3.815	***
amaze	4.741	2.335	2.031	*
appoint	0.071	2.084	0.034	
astonish	−3.188	2.264	−1.408	
blackmail	2.278	2.090	1.090	
bother	−0.188	1.939	−0.097	
bug	0.392	1.903	0.206	
challenge	−3.630	2.446	−1.484	
chase	0.076	1.987	0.038	
choose	−4.906	1.903	−2.578	*
condone	0.481	1.717	0.280	
delude	5.283	2.239	2.359	*
despise	2.447	2.252	1.087	
fatten	3.327	2.504	1.329	
frighten	3.626	2.216	1.637	
gaze	−0.404	2.432	−0.166	
heal	−2.176	1.819	−1.196	
hit	−1.790	1.971	−0.908	
hurt	−5.842	2.084	−2.803	**
insult	3.484	1.862	1.871	.
jolt	0.659	1.998	0.330	
lure	1.597	1.765	0.904	
observe	2.940	1.789	1.643	
persuade	−2.430	2.179	−1.115	
provoke	8.066	2.487	3.244	**

	Estimate	Std. Error	t value	
push	−2.057	1.648	−1.248	
recruit	−0.581	2.377	−0.245	
remember	−2.728	1.576	−1.731	.
repel	8.458	3.801	2.225	*
reverse	−2.383	1.740	−1.370	
safeguard	0.009	1.931	0.005	
see	−2.720	1.824	−1.491	
shade	−2.269	1.772	−1.281	
slap	−1.996	1.810	−1.103	
soothe	−2.467	1.976	−1.248	
suffocate	−1.705	2.598	−0.656	
suspend	3.710	2.271	1.634	
torture	−2.724	2.048	−1.330	
view	0.286	2.152	0.133	
visualize	3.765	2.924	1.287	
warm	1.773	1.728	1.026	
weaken	−2.095	1.975	−1.061	
weep	1.466	2.482	0.591	
worship	3.351	2.476	1.353	
log(Valence) x log(Dominance)	−12.211	3.136	−3.894	***

Appendix C

Chapter 3: Supplementary information

Table C.1: Items in the Socio-political Questionnaire

1. First Language:
2. Country of Birth:
3. Country of Residence:
4. Gender:
5. Age:
6. For the following statements, use the following scale: *completely for, for, somewhat for, somewhat against, against, completely against*.
   a. Are you for or against the following? [Prayer in school]
   b. Are you for or against the following? [Pro-choice (abortion)]
   c. Are you for or against the following? [Cuts to welfare programs]
   d. Are you for or against the following? [National healthcare]
   e. Are you for or against the following? [Sex education in elementary schools]
   f. Are you for or against the following? [Gun control]
   g. Are you for or against the following? [Stronger labour unions
   h. Are you for or against the following? [Contraception]
   i. Are you for or against the following? [Food stamp programs]
   j. Are you for or against the following? [Same-sex marriage]
   k. Are you for or against the following? [Aid/care for the homeless]
   l. Are you for or against the following? [Minimum wages]
   m. Are you for or against the following? [Political correctness]

n. Are you for or against the following? [Racial quotas in the workforce]
o. Are you for or against the following? [Capital punishment]

7. For the following statements, use the following scale: *completely agree, agree, somewhat agree, somewhat disagree, disagree, completely disagree*.
a. It is better to keep things the way they are.
b. People are essentially selfish; they need to be controlled.
c. Individuals have free will; they are responsible for their own lives and problems.
d. The traditional family must be preserved at all costs.
e. Government regulations are needed to control monopolies.
f. A free market economy is the best way to ensure prosperity and fulfilment of individual needs.
g. Sometimes revolutions are necessary.
h. This country would be better off if most government programs were eliminated.
i. People are basically good but they can be corrupted.
j. The free market economic system is basically exploitive and inherently unfair to working people.
k. Helping the poor encourages laziness.

Table C.2: VerbNet class and thematic role for each of the target verbs

Verb	Class	Meaning	Thematic Role
accept	77	accept	AgEvo
buy	77	accept	AgEvo
discourage	77	accept	AgEvo
encourage	77	accept	AgEvo
reject	77	accept	AgEvo
accompany	51.7	accompany	AgEvo
escort	51.7	accompany	AgEvo
guide	51.7	accompany	AgEvo
lead	51.7	accompany	AgEvo
allow	64	allow	AgEvo
permit	64	allow	AgEvo
sanction	64	allow	AgEvo
tolerate	64	allow	AgEvo
adopt	29.1	appoint	AgEvo
appoint	29.1	appoint	AgEvo
crown	29.1	appoint	AgEvo
designate	29.1	appoint	AgEvo
elect	29.1	appoint	AgEvo
name	29.1	appoint	AgEvo
nominate	29.1	appoint	AgEvo
proclaim	29.1	appoint	AgEvo
want	29.1	appoint	AgEvo
banish	10.2	banish	AgEvo
boot	10.2	banish	AgEvo
deport	10.2	banish	AgEvo
expel	10.2	banish	AgEvo
recall	10.2	banish	AgEvo
remove	10.2	banish	AgEvo
bill	29.2	characterize	AgEvo
certify	29.2	characterize	AgEvo
characterize	29.2	characterize	AgEvo
conceive	29.2	characterize	AgEvo
count	29.2	characterize	AgEvo
define	29.2	characterize	AgEvo
depict	29.2	characterize	AgEvo
describe	29.2	characterize	AgEvo
diagnose	29.2	characterize	AgEvo
envision	29.2	characterize	AgEvo
hail	29.2	characterize	AgEvo
identify	29.2	characterize	AgEvo
imagine	29.2	characterize	AgEvo
interpret	29.2	characterize	AgEvo
judge	29.2	characterize	AgEvo
know	29.2	characterize	AgEvo
paint	29.2	characterize	AgEvo
picture	29.2	characterize	AgEvo
portray	29.2	characterize	AgEvo
praise	29.2	characterize	AgEvo
rank	29.2	characterize	AgEvo
recollect	29.2	characterize	AgEvo

Verb	Class	Meaning	Thematic Role
regard	29.2	characterize	AgEvo
remember	29.2	characterize	AgEvo
report	29.2	characterize	AgEvo
represent	29.2	characterize	AgEvo
reveal	29.2	characterize	AgEvo
see	29.2	characterize	AgEvo
select	29.2	characterize	AgEvo
stereotype	29.2	characterize	AgEvo
take	29.2	characterize	AgEvo
treat	29.2	characterize	AgEvo
underestimate	29.2	characterize	AgEvo
visualize	29.2	characterize	AgEvo
chase	51.6	chase	AgEvo
follow	51.6	chase	AgEvo
pursue	51.6	chase	AgEvo
shadow	51.6	chase	AgEvo
tail	51.6	chase	AgEvo
track	51.6	chase	AgEvo
trail	51.6	chase	AgEvo
defend	72.2	defend	AgEvo
guard	72.2	defend	AgEvo
preserve	72.2	defend	AgEvo
protect	72.2	defend	AgEvo
safeguard	72.2	defend	AgEvo
shade	72.2	defend	AgEvo
dismiss	10.1	fire	AgEvo
drop	10.1	fire	AgEvo
fire	10.1	fire	AgEvo
sack	10.1	fire	AgEvo
suspend	10.1	fire	AgEvo
terminate	10.1	fire	AgEvo
call	13.5.1	get	AgEvo
catch	13.5.1	get	AgEvo
choose	13.5.1	get	AgEvo
find	13.5.1	get	AgEvo
order	13.5.1	get	AgEvo
phone	13.5.1	get	AgEvo
pick	13.5.1	get	AgEvo
reach	13.5.1	get	AgEvo
employ	13.5.3	hire	AgEvo
enlist	13.5.3	hire	AgEvo
hire	13.5.3	hire	AgEvo
recruit	13.5.3	hire	AgEvo
reinstate	13.5.3	hire	AgEvo
sign	13.5.3	hire	AgEvo
train	13.5.3	hire	AgEvo
abuse	33	judge	AgEvo
assault	33	judge	AgEvo
blame	33	judge	AgEvo
condone	33	judge	AgEvo
repay	33	judge	AgEvo

Verb	Class	Meaning	Thematic Role
choke	40.7	suffocate	AgEvo
drown	40.7	suffocate	AgEvo
starve	40.7	suffocate	AgEvo
suffocate	40.7	suffocate	AgEvo
allure	59	force	AgPat
bait	59	force	AgPat
blackmail	59	force	AgPat
bribe	59	force	AgPat
bullshit	59	force	AgPat
bully	59	force	AgPat
cheat	59	force	AgPat
coerce	59	force	AgPat
commission	59	force	AgPat
compel	59	force	AgPat
con	59	force	AgPat
dare	59	force	AgPat
deceive	59	force	AgPat
delude	59	force	AgPat
drive	59	force	AgPat
dupe	59	force	AgPat
fool	59	force	AgPat
force	59	force	AgPat
harass	59	force	AgPat
hound	59	force	AgPat
incite	59	force	AgPat
influence	59	force	AgPat
lure	59	force	AgPat
manipulate	59	force	AgPat
mislead	59	force	AgPat
motivate	59	force	AgPat
oblige	59	force	AgPat
panic	59	force	AgPat
persuade	59	force	AgPat
pressure	59	force	AgPat
prod	59	force	AgPat
prompt	59	force	AgPat
push	59	force	AgPat
railroad	59	force	AgPat
rouse	59	force	AgPat
seduce	59	force	AgPat
sway	59	force	AgPat
trap	59	force	AgPat
trick	59	force	AgPat
batter	18.1	hit	AgPat
beat	18.1	hit	AgPat
hammer	18.1	hit	AgPat
hit	18.1	hit	AgPat
jab	18.1	hit	AgPat
kick	18.1	hit	AgPat
slap	18.1	hit	AgPat
smack	18.1	hit	AgPat

Verb	Class	Meaning	Thematic Role
strike	18.1	hit	AgPat
advance	45.4	other-cos	AgPat
alter	45.4	other-cos	AgPat
balance	45.4	other-cos	AgPat
brighten	45.4	other-cos	AgPat
burn	45.4	other-cos	AgPat
change	45.4	other-cos	AgPat
clarify	45.4	other-cos	AgPat
clean	45.4	other-cos	AgPat
clear	45.4	other-cos	AgPat
collect	45.4	other-cos	AgPat
contract	45.4	other-cos	AgPat
cool	45.4	other-cos	AgPat
corrupt	45.4	other-cos	AgPat
deflect	45.4	other-cos	AgPat
degenerate	45.4	other-cos	AgPat
degrade	45.4	other-cos	AgPat
derail	45.4	other-cos	AgPat
diffuse	45.4	other-cos	AgPat
dirty	45.4	other-cos	AgPat
dull	45.4	other-cos	AgPat
ease	45.4	other-cos	AgPat
energize	45.4	other-cos	AgPat
fatten	45.4	other-cos	AgPat
halt	45.4	other-cos	AgPat
hasten	45.4	other-cos	AgPat
heal	45.4	other-cos	AgPat
improve	45.4	other-cos	AgPat
levitate	45.4	other-cos	AgPat
mature	45.4	other-cos	AgPat
mellow	45.4	other-cos	AgPat
moderate	45.4	other-cos	AgPat
purify	45.4	other-cos	AgPat
quiet	45.4	other-cos	AgPat
resuscitate	45.4	other-cos	AgPat
reverse	45.4	other-cos	AgPat
revive	45.4	other-cos	AgPat
slow	45.4	other-cos	AgPat
soak	45.4	other-cos	AgPat
sober	45.4	other-cos	AgPat
steady	45.4	other-cos	AgPat
strengthen	45.4	other-cos	AgPat
toughen	45.4	other-cos	AgPat
trip	45.4	other-cos	AgPat
wake	45.4	other-cos	AgPat
warm	45.4	other-cos	AgPat
weaken	45.4	other-cos	AgPat
crucify	42.2	poison	AgPat
electrocute	42.2	poison	AgPat
hang	42.2	poison	AgPat
knife	42.2	poison	AgPat

Verb	Class	Meaning	Thematic Role
poison	42.2	poison	AgPat
shoot	42.2	poison	AgPat
smother	42.2	poison	AgPat
stab	42.2	poison	AgPat
stone	42.2	poison	AgPat
strangle	42.2	poison	AgPat
throttle	42.2	poison	AgPat
admire	31.2	admire	ExpStim
adore	31.2	admire	ExpStim
applaud	31.2	admire	ExpStim
appreciate	31.2	admire	ExpStim
bear	31.2	admire	ExpStim
believe	31.2	admire	ExpStim
cherish	31.2	admire	ExpStim
despise	31.2	admire	ExpStim
detest	31.2	admire	ExpStim
disdain	31.2	admire	ExpStim
dislike	31.2	admire	ExpStim
distrust	31.2	admire	ExpStim
dread	31.2	admire	ExpStim
enjoy	31.2	admire	ExpStim
envy	31.2	admire	ExpStim
fancy	31.2	admire	ExpStim
favor	31.2	admire	ExpStim
fear	31.2	admire	ExpStim
hate	31.2	admire	ExpStim
like	31.2	admire	ExpStim
loathe	31.2	admire	ExpStim
love	31.2	admire	ExpStim
miss	31.2	admire	ExpStim
mistrust	31.2	admire	ExpStim
mourn	31.2	admire	ExpStim
pity	31.2	admire	ExpStim
prefer	31.2	admire	ExpStim
prize	31.2	admire	ExpStim
regret	31.2	admire	ExpStim
relish	31.2	admire	ExpStim
resent	31.2	admire	ExpStim
respect	31.2	admire	ExpStim
suffer	31.2	admire	ExpStim
support	31.2	admire	ExpStim
treasure	31.2	admire	ExpStim
trust	31.2	admire	ExpStim
value	31.2	admire	ExpStim
worship	31.2	admire	ExpStim
apprehend	87.2	comprehend	ExpStim
comprehend	87.2	comprehend	ExpStim
fathom	87.2	comprehend	ExpStim
grasp	87.2	comprehend	ExpStim
misunderstand	87.2	comprehend	ExpStim
understand	87.2	comprehend	ExpStim

Verb	Class	Meaning	Thematic Role
empathize with	88.2	empathize	ExpStim
sympathize with	88.2	empathize	ExpStim
cringe at	40.5	flinch	ExpStim
flinch from	40.5	flinch	ExpStim
quail at	40.5	flinch	ExpStim
recoil from	40.5	flinch	ExpStim
shrink from	40.5	flinch	ExpStim
ache for	31.3	marvel	ExpStim
approve of	31.3	marvel	ExpStim
care about	31.3	marvel	ExpStim
cry for	31.3	marvel	ExpStim
disapprove of	31.3	marvel	ExpStim
feel for	31.3	marvel	ExpStim
fret about	31.3	marvel	ExpStim
glory in	31.3	marvel	ExpStim
gush over	31.3	marvel	ExpStim
marvel at	31.3	marvel	ExpStim
meditate on	31.3	marvel	ExpStim
moon on	31.3	marvel	ExpStim
muse on	31.3	marvel	ExpStim
obsess over	31.3	marvel	ExpStim
rage at	31.3	marvel	ExpStim
react over	31.3	marvel	ExpStim
reflect on	31.3	marvel	ExpStim
rejoice about	31.3	marvel	ExpStim
start at	31.3	marvel	ExpStim
stress about	31.3	marvel	ExpStim
sulk about	31.3	marvel	ExpStim
swoon at	31.3	marvel	ExpStim
tire of	31.3	marvel	ExpStim
wallow in	31.3	marvel	ExpStim
weary of	31.3	marvel	ExpStim
weep for	31.3	marvel	ExpStim
wonder at	31.3	marvel	ExpStim
worry about	31.3	marvel	ExpStim
attend to	30.3	peer	ExpStim
gaze at	30.3	peer	ExpStim
glance at	30.3	peer	ExpStim
glare at	30.3	peer	ExpStim
goggle at	30.3	peer	ExpStim
look at	30.3	peer	ExpStim
peep at	30.3	peer	ExpStim
peer at	30.3	peer	ExpStim
snoop on	30.3	peer	ExpStim
squint at	30.3	peer	ExpStim
stare at	30.3	peer	ExpStim
behold	30.2	sight	ExpStim
discover	30.2	sight	ExpStim
eye	30.2	sight	ExpStim
glimpse	30.2	sight	ExpStim
note	30.2	sight	ExpStim

Verb	Class	Meaning	Thematic Role
observe	30.2	sight	ExpStim
overhear	30.2	sight	ExpStim
perceive	30.2	sight	ExpStim
recognize	30.2	sight	ExpStim
sight	30.2	sight	ExpStim
sniff	30.2	sight	ExpStim
spot	30.2	sight	ExpStim
spy	30.2	sight	ExpStim
view	30.2	sight	ExpStim
witness	30.2	sight	ExpStim
aggravate	31.1	amuse	StimExp
agitate	31.1	amuse	StimExp
alarm	31.1	amuse	StimExp
alienate	31.1	amuse	StimExp
amaze	31.1	amuse	StimExp
amuse	31.1	amuse	StimExp
anger	31.1	amuse	StimExp
annoy	31.1	amuse	StimExp
antagonize	31.1	amuse	StimExp
arouse	31.1	amuse	StimExp
astonish	31.1	amuse	StimExp
astound	31.1	amuse	StimExp
awe	31.1	amuse	StimExp
bother	31.1	amuse	StimExp
bug	31.1	amuse	StimExp
calm	31.1	amuse	StimExp
charm	31.1	amuse	StimExp
comfort	31.1	amuse	StimExp
confound	31.1	amuse	StimExp
confuse	31.1	amuse	StimExp
console	31.1	amuse	StimExp
convince	31.1	amuse	StimExp
crush	31.1	amuse	StimExp
cut	31.1	amuse	StimExp
daze	31.1	amuse	StimExp
dazzle	31.1	amuse	StimExp
delight	31.1	amuse	StimExp
depress	31.1	amuse	StimExp
disappoint	31.1	amuse	StimExp
disarm	31.1	amuse	StimExp
disgrace	31.1	amuse	StimExp
disgust	31.1	amuse	StimExp
dismay	31.1	amuse	StimExp
displease	31.1	amuse	StimExp
distract	31.1	amuse	StimExp
distress	31.1	amuse	StimExp
disturb	31.1	amuse	StimExp
embarrass	31.1	amuse	StimExp
engage	31.1	amuse	StimExp
enlighten	31.1	amuse	StimExp
entertain	31.1	amuse	StimExp

Verb	Class	Meaning	Thematic Role
entice	31.1	amuse	StimExp
excite	31.1	amuse	StimExp
exhaust	31.1	amuse	StimExp
fascinate	31.1	amuse	StimExp
faze	31.1	amuse	StimExp
flatter	31.1	amuse	StimExp
floor	31.1	amuse	StimExp
frighten	31.1	amuse	StimExp
grieve	31.1	amuse	StimExp
harm	31.1	amuse	StimExp
haunt	31.1	amuse	StimExp
humble	31.1	amuse	StimExp
humiliate	31.1	amuse	StimExp
hurt	31.1	amuse	StimExp
hypnotize	31.1	amuse	StimExp
impress	31.1	amuse	StimExp
inspire	31.1	amuse	StimExp
insult	31.1	amuse	StimExp
interest	31.1	amuse	StimExp
intimidate	31.1	amuse	StimExp
intrigue	31.1	amuse	StimExp
irritate	31.1	amuse	StimExp
jolt	31.1	amuse	StimExp
offend	31.1	amuse	StimExp
overwhelm	31.1	amuse	StimExp
pacify	31.1	amuse	StimExp
pain	31.1	amuse	StimExp
pester	31.1	amuse	StimExp
provoke	31.1	amuse	StimExp
puzzle	31.1	amuse	StimExp
reassure	31.1	amuse	StimExp
relax	31.1	amuse	StimExp
relieve	31.1	amuse	StimExp
repel	31.1	amuse	StimExp
revolt	31.1	amuse	StimExp
satisfy	31.1	amuse	StimExp
scare	31.1	amuse	StimExp
shake	31.1	amuse	StimExp
shame	31.1	amuse	StimExp
shock	31.1	amuse	StimExp
soothe	31.1	amuse	StimExp
spook	31.1	amuse	StimExp
stagger	31.1	amuse	StimExp
startle	31.1	amuse	StimExp
stimulate	31.1	amuse	StimExp
sting	31.1	amuse	StimExp
stump	31.1	amuse	StimExp
stun	31.1	amuse	StimExp
surprise	31.1	amuse	StimExp
taunt	31.1	amuse	StimExp
tease	31.1	amuse	StimExp

Verb	Class	Meaning	Thematic Role
tempt	31.1	amuse	StimExp
terrify	31.1	amuse	StimExp
terrorize	31.1	amuse	StimExp
threaten	31.1	amuse	StimExp
thrill	31.1	amuse	StimExp
tickle	31.1	amuse	StimExp
torment	31.1	amuse	StimExp
torture	31.1	amuse	StimExp
touch	31.1	amuse	StimExp
transport	31.1	amuse	StimExp
trouble	31.1	amuse	StimExp
upset	31.1	amuse	StimExp
wound	31.1	amuse	StimExp

Appendix D

Chapter 4: Supplementary information

Table D.1: List of stimuli used in Experiment I (Self-paced reading)

1. The secretary submitted the request because consistently [PN] received more applications.
2. The receptionist jeopardized the merger because arguably [PN] spoke too informally.
3. The au pair refuelled the vehicle because hastily [PN] fetched the children from school.
4. The babysitter belittled the nightmare because rationally [PN] explained everything was fine.
5. The beautician withstood the critique because adamantly [PN] loved the new style.
6. The cashier reduced the price because conventionally [PN] gave discounts on damaged merchandise.
7. The cheerleader subdued the crowd because enthusiastically [PN] discouraged the home team.
8. The childcare worker replenished the juice boxes because occasionally [PN] forgot and the children cried.
9. The cleaner suffered the odour because sensibly [PN] needed the bleach to soak the stain.
10. The dancer complicated the routine because selfishly [PN] wanted to show off.
11. The dental assistant disclosed the information because generally [PN] submitted all the insurance claims.
12. The dietician prohibited the red meat because adamantly [PN] thought it was unhealthy.
13. The dressmaker straddled the table because insistently [PN] swore to finish the alterations.
14. The embroiderer detached the spool because thankfully [PN] finished the garment.
15. The florist discovered the plant food because opportunely [PN] read about it online.
16. The fortune teller predicted the outcome because eerily [PN] saw the future.
17. The hairdresser learned new techniques because periodically [PN] found something very useful.

18. The housekeeper accomplished the tasks because routinely [PN] received a list of chores.
19. The model ascended the staircase because rationally [PN] heard the photoshoot was there.
20. The nanny unravelled the string because eagerly [PN] wished to play cat's cradle with the children.
21. The nurse juggled many tasks because today [PN] was quite over worked.
22. The prostitute solicited the block because innocently [PN] believed it was an easy way to make money.
23. The psychology student violated the trust because often [PN] gossiped about other patients.
24. The sales assistant inspected the merchandise because sometimes [PN] found defective items in the delivery.
25. The servant managed the household because obediently [PN] respected the wishes of the family.
26. The social worker examined the house because importantly [PN] reported on the family's living conditions.
27. The typist reiterated the passage because thoughtfully [PN] tried to be as accurate as possible.
28. The weaver connected the strands of silk because deftly [PN] spun the pieces into a single braid.
29. The boss reassigned the desk spaces because occasionally [PN] liked to change things in the office.
30. The bricklayer rebuilt the wall because diligently[PN] wanted to help the reconstruction effort.
31. The butcher sterilized the equipment because reliably [PN] maintained a high level of sanitary standards.
32. The carpenter adhered to the guidelines because last month [PN] joined the union.
33. The chauffeur validated the parking slip because today [PN] stopped at the concierge with the ticket.
34. The electrician aborted the job because cautiously [PN] thought the conditions were unsafe.
35. The engineer rejected the new plans because frankly [PN] thought the changes were unnecessary.
36. The farmer stole the piglets because stubbornly [PN] refused to give up the animals.
37. The firefighter smothered the blaze because boldly [PN] sprayed the water into the open window.
38. The golfer retrieved the ball because accidentally [PN] shot it into the stream.
39. The grave digger exhumed the coffin because strangely [PN] believed it was empty.
40. The judge upheld the law because unfailingly [PN] believed in the judicial system.
41. The paratrooper concealed the weapon because strategically [PN] wanted the element of surprise.
42. The physics student won first place because studiously [PN] designed the winning concept.
43. The pilot finalized the flight plan because today [PN] was the captain of the airplane.
44. The plasterer reconstructed the ceiling because erroneously [PN] applied too much plaster the previous day.

45. The plumber dissolved the blockage because logically [PN] carried the proper equipment.
46. The police officer diverted the traffic because mainly [PN] worried about another accident taking place.
47. The porter unloaded the baggage because speedily [PN] needed to return to the hotel lobby.
48. The president eradicated all employee bonuses because defiantly [PN] argued they cost too much money.
49. The soldier detonated the explosive because courageously [PN] fought for the citizen's freedom.
50. The statistician multiplied the numbers because appropriately [PN] accounted for small deviations.
51. The surgeon removed the clamp because confidently [PN] believed the operation was a success.
52. The taxi driver forgot the address because absently [PN] was distracted on the drive.
53. The technician developed the software because justifiably [PN] cared to protect the computer server.
54. The truck driver unfolded the map because wrongly [PN] exited off of the interstate.
55. The undertaker uncovered the casket because reluctantly [PN] prepared for the funeral service.
56. The worker achieved a higher pay grade because eagerly [PN] served the company for many years.
57. The art historian recited the fable because studiously [PN] memorized the entire tale.
58. The artist manipulated the clay because creatively [PN] shaped the body of a horse.
59. The astrologer considered the planets because weekly [PN] updated the horoscopes.
60. The bank clerk distributed the funds because accurately [PN] calculated the exchange rate.
61. The cinema goer redeemed a free popcorn because patiently [PN] collected enough points to afford it.
62. The concert goer possessed a backstage pass because luckily [PN] won a radio contest.
63. The cook misunderstood the recipe because mistakenly [PN] skipped a page in the book.
64. The interpreter summarized the conversation because coincidentally [PN] spoke Mandarin quite fluently.
65. The journalist divulged the information because annoyingly [PN] needed the editor's approval.
66. The lawyer suppressed the evidence because legally [PN] thought it was irrelevant to the case.
67. The missionary repented because honestly [PN] believed greed was a sin.
68. The musician lightened the mood because cheerfully [PN] hoped to entertain the crowd.
69. The neighbour assembled the swing set because quickly [PN] saw the storm clouds coming closer.
70. The newscaster exposed the scandal because smartly [PN] reported the story first.
71. The novelist deleted the last paragraph because accidentally [PN] hit the wrong button.

72. The pedestrian polluted the environment because usually [PN] tossed trash onto the street.
73. The pediatrician cancelled the surgery because sincerely [PN] felt it may complicate the child's condition.
74. The physiotherapist created an exercise routine because sensibly [PN] cared for the patient's well being.
75. The psychologist weakened the medication because respectfully [PN] believed the dosage was too high.
76. The school child unlocked the cage because fanatically [PN] wished to play with the hamster.
77. The set designer negotiated the costs because plainly [PN] worked on a very tight budget.
78. The singer memorized the words because nervously [PN] performed in front of a live audience.
79. The skier explored the terrain because quickly [PN] prepared for the afternoon's race.
80. The spectator enjoyed the performance because cleverly [PN] preordered the tickets online.
81. The student discontinued the research because unfortunately [PN] concluded the results were inconclusive.
82. The tennis player delivered the winning point because firmly [PN] played the stronger game.
83. The trapeze artist unhooked the safety rope because amazingly [PN] performed the last act without it.
84. The writer misled the readers because mysteriously [PN] wrote a sudden plot twist.

Table D.2: List of fillers used in Experiment I (Self-paced reading)

1. The aunt baked the cake because early she awoke to prepare for the party.
2. The daughter repainted the shed because regularly she did her chores as asked.
3. The grandmother took the medication because afterwards she felt like a new woman.
4. The mother built the cabinet because independently she followed the instructions.
5. The niece inherited the money because actually she was the oldest of the heirs.
6. The princess understood the agreement because proudly she studied it for months.
7. The queen approved the changes because afterwards she controlled the entire court.
8. The father approved the marriage because greedily he accepted the rich dowry.
9. The grandfather felt re-energized because youthfully he played with the grandchildren.
10. The king read the document because hastily he wanted to return to his chambers.
11. The nephew unfroze the patties because tonight he cooked at the family barbecue.
12. The prince renounced the court because loyally he stood by the king.
13. The son bought a trolley because weekly he delivered newspapers in the neighbourhood.
14. The uncle kept the secret because proudly he had a reputation for being trustworthy.
15. The advocates collected information because soon they were going to the press.
16. The bakers sweetened the dough because now they made all of the desserts.
17. The celebrities endorsed the product because really they believed the product worked.
18. The city planners revived the downtown core because unquestionably they acted in the city's best interest.
19. The coaches assigned the positions because confidently they understood the rules of the game.
20. The consumers participated in the survey because early on they heard about the reward.
21. The creditors advertised the property because apparently they wanted to sell it quite badly.
22. The critics revealed the plot because fairly they said there were spoilers in the review.
23. The diplomats reconsidered the trade agreement because calmly they listened to the other party.
24. The editors assessed the reports because nightly they decided the content of the news broadcast.
25. The gardeners mowed the lawn because likely they would return in over a month.
26. The guards authenticated the identities because professionally they could never be too careful.
27. The hikers unpacked the water because consciously they tried to stay hydrated.
28. The investors maximized the profits because economically they knew where to put their money.
29. The kindergarteners invaded the zoo because excitedly they came to see the animals.
30. The mathematicians simplified the problem because redundantly they included too many factors.
31. The members disbanded the club because eventually they had to grow up.
32. The owners absorbed the initial costs because rationally they made money in the end.
33. The peasants ate the bread because meagrely they could afford nothing else.
34. The pharmacists prescribed the antibiotics because correctly they thought it looked infected.

35. The philosophers pondered the dilemma because esoterically they believed there must be a solution.
36. The players underestimated the weather because soon they ran for shelter.
37. The residents withheld the rent because accusingly they said the furnace was still broken.
38. The riders dismounted the motorcycles because wearily they needed to find something to eat.
39. The sailors tethered the ship because quickly they realized a storm was coming.
40. The scientists replicated the study because surely they had the technology to clone a sheep.
41. The surveyors expanded the territory because visibly they found an error on the map.
42. The wedding planners oversaw the evening because purposefully they kept cool under pressure.

Table D.3: Summary of linear mixed effect model for the first segment during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.865	−0.619	−0.091	0.504	4.995
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.10	
Subject	(Intercept)	0.06	0.25	
Residual		0.15	0.38	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.91	0.11	65.72	***
Stereo(Male)	−0.05	0.02	−2.35	*
log(Length)	0.23	0.05	4.81	***

Table D.4: Summary of linear mixed effect model for the second segment during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.120	−0.622	−0.110	0.505	4.700
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.11	
Subject	(Intercept)	0.08	0.2877	
Residual		0.10	0.31	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.366	0.07	86.501	***
log(Dominance)	0.064	0.03	2.069	*

Table D.5: Summary of linear mixed effect model for the third segment during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.285	−0.629	−0.166	0.427	6.258
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.10	
Subject	(Intercept)	0.05	0.22	
Residual		0.07	0.26	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.16	0.06	103.57	***
log(Dominance)	0.07	0.03	2.54	*

Table D.6: Summary of linear mixed effect model for the fourth segment during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-5.897	−0.657	−0.030	0.583	3.325
Random effects:				
Groups	Name	Variance	Std.Dev.	
Block	(Intercept)	0.02	0.12	
Subject	(Intercept)	0.06	0.24	
Residual		0.13	0.36	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.80	0.09	72.42	***
log(Arousal)	−0.13	0.06	−2.35	*

Table D.7: Summary of linear mixed effect model for the summed third and fourth segments during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.58	−0.65	−0.06	0.62	3.64
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Item	(Intercept)	0.021	0.145	
	Stereotype (Male)	0.017	0.132	-0.360
Subject	(Intercept)	0.055	0.235	
	Stereotype (Male)	0.002	0.048	-0.410
Residual		0.058	0.241	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	7.27	0.07	104.29	***
Pronoun (she)	−0.14	0.06	−2.33	*
Bias (congruent)	−0.15	0.06	−2.36	*
log(Dominance)	−0.04	0.03	−1.48	
log(Arousal)	−0.06	0.02	−2.92	**
log(Valence)	0.02	0.02	1.26	
Pronoun (she) x Bias (congruent)	0.20	0.09	2.29	*
Pronoun (she) x log(Dom)	0.10	0.04	2.87	**
Bias (congruent) x log(Dom)	0.11	0.04	3.07	**
Pronoun (she) x Bias (con) x log(Dom)	−0.16	0.05	−3.17	**

Table D.8: Summary of linear mixed effect model for the gender matching summed third and fourth segments during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.814	−0.618	−0.059	0.590	3.275
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Block	(Intercept)	0.03	0.19	
	Stereo(Male)	0.04	0.20	-0.62
Subject	(Intercept)	0.07	0.26	
	Stereo(Male)	0.01	0.11	-0.53
Residual		0.05	0.23	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	7.003	0.05	132.62	***
log(D.Mean.Sum)	0.110	0.02	5.96	***

Table D.9: Summary of linear mixed effect model for the gender mismatching summed third and fourth segments during gender stereotype self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.057	−0.617	−0.062	0.575	3.094
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Block	(Intercept)	0.04	0.20	
	Stereo(Male)	0.04	0.20	-0.53
Subject	(Intercept)	0.07	0.27	
	Stereo(Male)	0.01	0.09	-0.63
Residual		0.04	0.21	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	7.24	0.06	111.99	***
Pro(she)	−0.23	0.06	−3.75	***
log(Dominance)	−0.06	0.02	−2.48	*
Pro(she) x log(Dom)	0.15	0.03	4.65	***

Table D.10: List of stimuli used in Experiment II (Eye-tracking)

1	The housekeeper accomplished the tasks because routinely he received a list of chores from the home owner.
2	The artist manipulated the clay because creatively he shaped the clay into a statue.
3	The florist discovered the plant food because opportunely he read about the recipe on a web forum.
4	The bank clerk distributed the funds because accurately he calculated the exchange rate on that day.
5	The beautician withstood the critique because adamantly he explained the new hairstyle suited the client.
6	The boss reassigned the desk spaces because occasionally he liked to change things in the office.
7	The butcher sterilized the equipment because reliably he maintained a high level of sanitary standards.
8	The chauffeur validated the parking slip because today he stopped at the concierge with the ticket.
9	The typist reiterated the passage because thoughtfully he tried to be as accurate as possible.
10	The weaver connected the strands of silk because deftly he spun the different pieces into a single braid.
11	The concert goer possessed a backstage pass because luckily he won two tickets during a radio contest.
12	The servant managed the household because obediently he respected the wishes of the family.
13	The model ascended the staircase because rationally he heard the photo shoot was at the top.
14	The engineer rejected the new plans because frankly he thought the changes were unnecessary.
15	The fire-fighter smothered the blaze because boldly he sprayed the hose into the open window.
16	The fortune teller predicted the outcome because eerily he saw the future in a crystal ball.
17	The grave digger exhumed the coffin because strangely he believed the casket might be empty.
18	The prostitute solicited the block because innocently he believed it was an easy way to make money.
19	The interpreter summarized the conversation because coincidentally he spoke fluent Mandarin on top of French.
20	The lawyer suppressed the evidence because legally he thought it was irrelevant to the case.
21	The sales assistant inspected the merchandise because sometimes he found defective items in the delivery.
22	The musician lightened the mood because cheerfully he hoped to entertain the crowd in the bar.
23	The newscaster exposed the scandal because smartly he reported the headlines in the evening news.
24	The dancer complicated the routine because selfishly he wanted the attention of the audience.
25	The paratrooper concealed the weapon because strategically he wanted the element of surprise.
26	The pedestrian polluted the environment because usually he tossed empty coffee cups onto the street.

27 The physiotherapist created an exercise routine because sensibly he determined an appropriate plan for each client.
28 The pilot finalized the flight plan because accordingly he navigated the aircraft throughout the journey.
29 The plumber dissolved the blockage because logically he carried the proper equipment in the work van.
30 The porter unloaded the baggage because speedily he needed to go back to the hotel lobby.
31 The nanny unravelled the string because eagerly he wished to play cat's cradle with the children.
32 The school child unlocked the cage because fanatically he wished to cuddle with the hamster.
33 The cleaner suffered the odour because sensibly he needed the bleach to soak the stain.
34 The singer memorized the words because nervously he performed in front of an audience for the first time.
35 The soldier detonated the explosive because courageously he fought for freedom in the world.
36 The spectator enjoyed the performance because cleverly he ordered the tickets online before the show.
37 The surgeon removed the clamp because confidently he believed the operation was a success.
38 The technician developed the software because justifiably he cared to protect the computer server.
39 The tennis player delivered the winning point because firmly he played the stronger game during that match.
40 The babysitter belittled the nightmare because rationally he explained the monster was imaginary.
41 The undertaker uncovered the casket because reluctantly he prepared for the funeral service that morning.
42 The writer misled the readers because mysteriously he wrote a sudden plot twist as the story unfolded.
43 The hairdresser learned new techniques because periodically she found a different method was very useful.
44 The art historian recited the poem because studiously she memorized every story in the collection.
45 The astrologer considered the planets because daily she updated the horoscopes in the newspaper.
46 The au pair refuelled the vehicle because hastily she fetched the children after school.
47 The bricklayer rebuilt the wall because diligently she wanted to help the reconstruction effort.
48 The carpenter adhered to the guidelines because last month she joined the union as an apprentice.
49 The childcare worker replenished the juice boxes because occasionally she forgot the drinks in the cupboard.
50 The cheerleader subdued the crowd because enthusiastically she discouraged the home team from winning.
51 The cinema goer redeemed a free popcorn because patiently she collected enough points to afford it.
52 The cook misunderstood the recipe because mistakenly she skipped a page in the instructions.
53 The dental assistant disclosed the information because generally she submitted the claims to the insurance company.
54 The social worker examined the house because importantly she reported on the living conditions inside the home.

55 The electrician aborted the job because cautiously she thought the conditions were unsafe.
56 The embroiderer detached the spool because thankfully she finished the garment before leaving work.
57 The farmer stole the piglets because stubbornly she decided to keep them with their mother.
58 The dressmaker straddled the table because insistently she swore to finish the alterations in one hour.
59 The golfer retrieved the ball because accidentally she swung the club harder than expected.
60 The cashier reduced the price because conventionally she gave small discounts on damaged merchandise.
61 The journalist divulged the information because annoyingly she needed the paper's editor to approve the story.
62 The judge upheld the law because unfailingly she trusted the judicial system to avail.
63 The missionary repented because honestly she believed being greedy was a sin.
64 The nurse juggled many tasks because today she worked a double shift for extra money.
65 The neighbour assembled the swing set because quickly she saw the storm clouds coming closer.
66 The novelist deleted the last paragraph because accidentally she hit the wrong button on the keyboard.
67 The pediatrician cancelled the surgery because sincerely she felt it may complicate the child's condition.
68 The physics student won first place because studiously she designed the winning concept in the science fair.
69 The plasterer reconstructed the ceiling because erroneously she applied too much plaster on the previous day.
70 The police officer diverted the traffic because mainly she worried about another accident on the street.
71 The president eradicated all employee bonuses because defiantly she argued they cost the company too much money.
72 The secretary submitted the request because consistently she received more applications every morning.
73 The psychologist weakened the medication because respectfully she believed the dosage too extreme for this patient.
74 The receptionist jeopardized the merger because arguably she spoke too informally to the client.
75 The set designer negotiated the costs because plainly she worked on a tight budget for this production.
76 The skier explored the terrain because quickly she prepared for the afternoon's race through the mountains.
77 The dietician prohibited red meat because adamantly she thought beef was linked to health issues.
78 The statistician multiplied the numbers because appropriately she accounted for small deviations in population size.
79 The student discontinued the research because unfortunately she concluded the results were inconclusive for the experiment.
80 The taxi driver forgot the address because absently she was distracted on the drive through the traffic.
81 The trapeze artist unhooked the safety rope because amazingly she performed the last act without the line.
82 The truck driver unfolded the map because wrongly she exited the interstate at the last turn off.

83	The psychology student violated the trust because often she gossiped about other patients in the clinic.
84	The worker achieved a higher pay grade because eagerly she served the company for many years.

Table D.11: List of fillers used in Experiment II (Eye-tracking)

1	The advocates collected information because soon they were going to the press.
2	The aunt baked the cake because early she awoke to prepare for the party.
3	The bakers sweetened the dough because now the bakers made all of the desserts.
4	The celebrities endorsed the product because really the celebrities believed the product worked.
5	The city planners revived the downtown core because unquestionably they acted in the city's best interest.
6	The coaches assigned the positions because confidently they understood the rules of the game.
7	The consumers participated in the survey because early on they heard about the reward.
8	The creditors advertised the property because apparently they wanted to sell it quite badly.
9	The critics revealed the plot because fairly they said there were spoilers in the review.
10	The daughter repainted the shed because regularly the daughter did her chores as asked.
11	The diplomats reconsidered the trade agreement because calmly they listened to the other party.
12	The editors assessed the reports because nightly they decided the content of the news broadcast.
13	The father approved the marriage because greedily the father accepted the rich dowry.
14	The gardeners mowed the lawn because likely they would return in over a month.
15	The grandfather felt re-energized because youthfully he played with the grandchildren.
16	The grandmother took the medication because afterwards she felt like a new woman.
17	The guards authenticated the identities because professionally they could never be too careful.
18	The hikers unpacked the water because consciously they tried to stay hydrated.
19	The investors maximized the profits because economically they knew where to put their money.
20	The kindergarteners invaded the zoo because excitedly they came to see the animals.
21	The king read the document because hastily he wanted to return to his chambers.
22	The mathematicians simplified the problem because redundantly they included too many factors.
23	The members disbanded the club because eventually they had to grow up.
24	The mother built the cabinet because independently she followed the instructions.
25	The niece inherited the money because actually the niece was the oldest of the heirs.
26	The nephew unfroze the patties because tonight he cooked at the family barbecue.
27	The owners absorbed the initial costs because rationally they made money in the end.
28	The peasants ate the bread because meagrely they could afford nothing else.
29	The pharmacists prescribed the antibiotics because correctly the pharmacists thought it looked infected.
30	The philosophers pondered the dilemma because esoterically they believed there must be a solution.
31	The players underestimated the weather because soon they ran for shelter.
32	The prince renounced the court because loyally the prince stood by the king.

33 The princess understood the agreement because proudly she studied it for months.
34 The queen approved the changes because afterwards she controlled the entire court.
35 The residents withheld the rent because accusingly the residents said the furnace was still broken.
36 The riders dismounted the motorcycles because wearily they needed to find something to eat.
37 The sailors tethered the ship because instinctively they realized a storm was coming.
38 The scientists replicated the study because surely they had the technology to clone a sheep.
39 The son bought a little wagon because weekly he delivered newspapers in the neighbourhood.
40 The surveyors expanded the territory because visibly they found an error on the map.
41 The uncle kept the secret because proudly he had a reputation for being trustworthy.
42 The wedding planners oversaw the evening because purposefully they kept cool under pressure.

Table D.12: Linear mixed effects model for the logged go past time in the first interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.684	−0.271	0.253	0.578	1.493
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	<0.001	<0.001	
Subject	(Intercept)	0.147	0.382	
Residual		1.09	1.04	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	5.9739	0.3477	17.182	
Stereotype (M)	1.0745	0.4755	2.260	*
log(Dominance)	0.2815	0.2046	1.376	
Stereotype (M) x log(Dom)	−0.6246	0.2899	−2.154	*

Table D.13: Linear mixed effects model for the logged first fixation duration in the third interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-5.6324	−0.3147	0.0741	0.5064	1.9743
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.008	0.091	
Subject	(Intercept)	0.042 775	0.206	
Residual		0.788	0.888	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	4.804 07	0.067 61	71.05	***
Bias (incongruent)	−0.131 63	0.062 94	−2.09	*

Table D.14: Linear mixed effects model for the logged first gaze duration in the third interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-7.636	−0.069	0.175	0.389	1.314
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	<0.001	<0.001	
Subject	(Intercept)	0.003	0.017	
Residual		0.072	0.085	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.530 93	0.059 66	109.47	***
Bias (incongruent)	−0.128 53	0.059 81	−2.15	*

Table D.15: Linear mixed effects model for the logged dwell time in the third interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.988	−0.694	0.007	0.692	2.794
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.007	0.083	
Subject	(Intercept)	0.111	0.334	
Residual		0.278	0.527	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	5.3148	0.1849	28.742	***
log(Dominance)	0.4589	0.1013	4.530	***
Pronoun(Male)	0.6875	0.2345	2.932	**
log(Dom) x Pronoun(Male)	−0.4342	0.1429	−3.039	**

Table D.16: Linear mixed effects model for the logged dwell time in the fourth interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-6.61	−0.105	0.204	0.44	1.079
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.028	0.167	
Subject	(Intercept)	0.01	0.102	
Residual		0.923	0.961	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.547 70	0.054 75	119.60	***
Bias (incongruent)	−0.128 83	0.066 75	−1.93	.

Table D.17: Linear mixed effects model for the logged go past time in the fifth interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-6.577	−0.173	0.295	0.573	1.222
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.003 384	0.058 17	
Subject	(Intercept)	0.025 416	0.159 42	
Residual		0.789 476	0.888 52	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.5231	0.2851	22.882	***
Pronoun(Male)	0.7650	0.4103	1.864	.
log(Dominance)	0.1148	0.1717	0.669	
Pronoun(Male) x log(Dom)	−0.5091	0.2496	−2.040	*

Table D.18: Linear mixed effects model for the logged second gaze duration in the third interest area with gender stereotyped stimuli

Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.647	−0.86	0.114	0.872	2.032
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	0.045 03	0.2122	
Subject	(Intercept)	0.402 45	0.6344	
Residual		2.863 66	1.6922	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	2.2267	0.5557	4.007	***
Bias (Incongruent)	0.2412	0.1203	2.005	*
Pronoun(Male)	1.9299	0.7511	2.569	*
log(Dominance)	0.9200	0.3242	2.838	**
Pronoun(Male) x log(Dom)	−1.1651	0.4576	−2.546	*

Appendix E

Chapter 5: Supplementary information

Table E.1: List of verbs used in Experiment I (Self-paced reading) by dominance, valence, arousal and semantic class

Verb	Dom	Val	Aro	Semantic Class
accuse	4.00	2.68	5.32	AgEvo
apologize	4.22	4.94	3.52	AgEvo
applaud	5.91	6.70	5.05	AgEvo
bless	6.26	7.00	4.57	AgEvo
celebrate	6.12	7.84	6.73	AgEvo
commend	6.14	7.00	3.23	AgEvo
condemn	4.17	2.62	5.33	AgEvo
congratulate	7.00	6.33	4.77	AgEvo
criticize	4.70	2.41	5.27	AgEvo
denounce	4.00	4.24	4.08	AgEvo
disparage	3.52	3.00	3.96	AgEvo
forgive	6.44	7.06	3.62	AgEvo
prosecute	5.12	3.15	4.62	AgEvo
punish	3.81	2.86	5.85	AgEvo
scold	4.59	2.77	4.19	AgEvo
thank	6.89	7.77	3.33	AgEvo
abandon	3.32	2.84	3.73	AgPat
accompany	5.63	5.47	3.85	AgPat
advise	6.41	5.44	3.38	AgPat
compensate	6.20	6.36	5.47	AgPat
deceive	4.58	2.95	5.90	AgPat
dominate	5.54	4.40	6.40	AgPat
follow	4.81	4.82	3.76	AgPat
greet	6.54	6.25	3.86	AgPat
instruct	6.23	5.81	4.25	AgPat
interrupt	3.93	3.26	4.36	AgPat
kill	3.61	1.81	6.81	AgPat
protect	5.83	6.83	3.70	AgPat
provoke	5.23	3.30	6.72	AgPat
pursue	6.12	5.39	4.45	AgPat

Verb	Dom	Val	Aro	Semantic Class
admire	6.94	7.25	5.95	ExpStim
adore	6.26	7.37	5.96	ExpStim
appreciate	7.00	7.33	3.10	ExpStim
believe	6.56	7.05	3.33	ExpStim
cherish	7.32	6.75	4.14	ExpStim
despise	4.38	3.08	4.77	ExpStim
detest	4.65	3.05	5.09	ExpStim
loathe	4.77	2.68	5.18	ExpStim
love	6.68	7.65	5.59	ExpStim
mourn	4.08	2.40	4.95	ExpStim
resent	4.21	3.28	4.05	ExpStim
tolerate	5.70	6.19	3.14	ExpStim
want	5.39	6.00	5.29	ExpStim
yearn	5.18	5.95	3.73	ExpStim
aggravate	4.85	2.55	5.90	StimExp
amaze	5.83	7.24	5.00	StimExp
amuse	6.80	7.10	5.17	StimExp
confuse	4.39	4.50	3.95	StimExp
disappoint	4.07	3.38	3.91	StimExp
discourage	3.50	3.18	3.38	StimExp
enlighten	6.30	7.38	3.23	StimExp
fascinate	6.32	7.00	6.10	StimExp
frighten	2.71	2.95	4.85	StimExp
harass	3.58	2.95	6.10	StimExp
inspire	7.11	7.42	5.90	StimExp
intimidate	5.75	2.84	5.27	StimExp
pacify	5.32	5.67	2.55	StimExp
reassure	6.07	6.55	3.70	StimExp
startle	4.55	4.65	4.40	StimExp
worry	3.17	2.10	6.33	StimExp

Table E.2: List of target stimuli used in Experiment I (Self-paced reading)

1. [NP1] accused [NP2] because supposedly [PN] witnessed the crime in their building.
2. [NP1] abandoned [NP2] because stupidly [PN] carried enough money for one ticket.
3. [NP1] celebrated [NP2] because effortlessly [PN] threw a perfect anniversary party.
4. [NP1] deceived [NP2] because bewilderingly [PN] hid well amongst the crowd.
5. [NP1] instructed [NP2] because afterwards [PN] needed to show the rest of the class.
6. [NP1] criticized [NP2] because ethically [PN] made no exceptions for a friend.
7. [NP1] provoked [NP2] because subtlety [PN] implied they were applying for the same position.
8. [NP1] prosecuted [NP2] because initially [PN] decided to be lead in the trial.
9. [NP1] inspired [NP2] because truly [PN] wanted to live a healthier lifestyle.
10. [NP1] appreciated [NP2] because internally [PN] realized they shared similar points of view.
11. [NP1] frightened [NP2] because honestly [PN] believed they were in real danger.
12. [NP1] mourned [NP2] because nevertheless [PN] remained a good friend in their youth.
13. [NP1] loathed [NP2] because today [PN] swore they were breaking up for good.
14. [NP1] intimidated [NP2] because shockingly [PN] took a gun out of hidden coat pocket.
15. [NP1] reassured [NP2] because inwardly [PN] understood what it was like to be a kid.
16. [NP1] apologized to [NP2] because graciously [PN] took the blame for their accident.
17. [NP1] accompanied [NP2] because reluctantly [PN] inquired if they could go together.
18. [NP1] dominated [NP2] because daily [PN] played tennis until complete exhaustion.
19. [NP1] commended [NP2] because yesterday [PN] marked all of the students' exams.
20. [NP1] interrupted [NP2] because quickly [PN] interjected when the question was first asked.
21. [NP1] denounced [NP2] because regularly [PN] spoke for their entire congregation.
22. [NP1] pursued [NP2] because arrogantly [PN] thought the chase could not last long.
23. [NP1] punished [NP2] because sadly [PN] had to take responsibility for their actions.
24. [NP1] pacified [NP2] because calmly [PN] hoped to avoid a heated argument.
25. [NP1] believed [NP2] because always [PN] spoke honestly and was trusting
26. [NP1] cherished [NP2] because thankfully [PN] was there when times were tough.
27. [NP1] worried [NP2] because often [PN] dreamed about both their deaths.
28. [NP1] despised [NP2] because lately [PN] groaned whenever they saw each other.
29. [NP1] aggravated [NP2] because annoyingly [PN] panicked if they stood too close together.
30. [NP1] startled [NP2] because embarrassingly [PN] thought no one else was around.
31. [NP1] applauded [NP2] because officially [PN] recommended the company merger.
32. [NP1] advised [NP2] because genuinely [PN] supported their partnership.
33. [NP1] followed [NP2] because logically [PN] scouted the forest trail before today.
34. [NP1] condemned [NP2] because earnestly[PN] thought religion should be taught in school.
35. [NP1] killed [NP2] because dangerously [PN] was distracted while driving.
36. [NP1] disparaged [NP2] because frankly [PN] wanted the arranged marriage to fail.
37. [NP1] scolded [NP2] because evidently [PN] disapproved strongly of the others in the group.
38. [NP1] confused [NP2] because unsurprisingly [PN] struggled to follow the conversation.
39. [NP1] adored [NP2] because frequently [PN] implied they were best friends.
40. [NP1] admired [NP2] because undoubtably [PN] respected others and was polite.
41. [NP1] amazed [NP2] because secretly [PN] had hoped they might fall in love.
42. [NP1] yearned for [NP2] because thrillingly [PN] lived life in the pursuit of adventure.

43. [NP1] loved [NP2] because daily [PN] awoke to make breakfast for the whole family.
44. [NP1] enlightened [NP2] because thankfully [PN] attended most of the class lectures.
45. [NP1] disappointed [NP2] because ordinarily [PN] held everyone to the highest standard.
46. [NP1] blessed [NP2] because faithfully [PN] attended the church for over a decade.
47. [NP1] compensated [NP2] because regularly [PN] forgot to bring money for coffee.
48. [NP1] congratulated [NP2] because often [PN] spoke about the competition.
49. [NP1] greeted [NP2] because always [PN] seemed interested in meeting new people.
50. [NP1] protected [NP2] because defensively [PN] suggested they watch each other's backs.
51. [NP1] forgave [NP2] because honestly [PN] hoped the argument to be over.
52. [NP1] thanked [NP2] because sincerely [PN] believed kindness was important to their friendship.
53. [NP1] discouraged [NP2] because personally [PN] believed their lives would be apart.
54. [NP1] resented [NP2] because recently [PN] questioned if they were equals.
55. [NP1] amused [NP2] because joyfully [PN] recognized they had a similar sense of humour.
56. [NP1] tolerated [NP2] because happily [PN] found they actually had a lot in common.
57. [NP1] detested [NP2] because lazily [PN] preferred to leave dirty dishes in the sink.
58. [NP1] wanted [NP2] because impressively [PN] tried hard to win every game they played.
59. [NP1] fascinated [NP2] because unbelievably [PN] worked for the circus as a teen too.
60. [NP1] harassed [NP2] because mockingly [PN] made an embarrassing joke while together in public.

Table E.3: List of filler stimuli used in Experiment I (Self-paced reading)

1. Howard chastised Steve because again he caught him acting naughty.
2. Carlos defamed Russell because angrily he was jealous of all his success.
3. Jacqueline confessed to Andrea because rationally she was tired of lying.
4. Martin corrected Ernest because notably he excelled in his field of study.
5. Herman echoed Maurice because eagerly he wanted to impress him.
6. Laurie answered Katie because normally she knew the right answer.
7. Vanessa defied Kristen because today she thought she was doing the right thing.
8. Anna dreamed about Vivian because instinctively she felt she was in trouble.
9. Jon missed Ronnie because absently he lost track of the time.
10. Wayne bothered Billy because aggressively he pushed him into the wall.
11. Lori bored Jane because constantly she told the same stories all the time.
12. Holly intrigued Brittany because casually she spoke whatever was on her mind.
13. Sam jolted Rick because silently he fell asleep at the wheel.
14. Shane angered Hector because generally he was rather rude.
15. Lester rebuked Brent because normally he trusted him to do his job.
16. Ramon rewarded Lauren because thankfully they found the lost puppy.
17. Melanie blamed Alma because already she gave up before the game had ended.
18. Zachary honoured Jill because proudly they came in first in the talent show.
19. June mocked Marion because unfortunately she misunderstood sarcasm.
20. Gordon excused Tim because afterwards he practiced for the big game.
21. Jerome complimented Gail because recently they started dating monogamously.
22. Audrey praised Erica because thankfully she appreciated help around the house.
23. Lynn snubbed Tommy because last week they had a serious falling out.
24. Dean victimized Greg because supposedly he was self conscious about himself.
25. Warren reprimanded Derek because aggravatingly he arrived late once again this morning.

26. Tom saluted Cathy because appropriately they followed the work place protocol.
27. Alvin pardoned Floyd because accidentally he knocked into him on the street.
28. Stacy called Samantha because anxiously she needed to hear the news immediately.
29. April approached Leslie because awkwardly she stood right in the doorway.
30. Marcus deserted Jay because sadly he injured his leg and could not keep up.
31. Bill chased Alex because callously he stole the laptop from the classroom.
32. Darlene avoided Veronica because unfortunately she smelled absolutely awful.
33. Clifford helped Eleanor because methodically they worked together to solve the puzzle.
34. Bernard hugged Debbie because romantically they celebrated their anniversary.
35. Theodore left Joanne because contently they were returning to their homes after work.
36. Amber warned Barry because seriously they were both in real danger.
37. Dustin played with Annette because coincidentally they went to the same preschool.
38. Meghan pitied Alicia because ignorantly she ignored the instructions on the exam.
39. Pedro feared Wesley because dangerously he thought he was a murderer.
40. Leroy idolized Alexander because habitually he acted like a father figure.
41. Clara noticed Lucille because remarkably she toned down her makeup.
42. Sara disliked Anne because sourly she smiled at her through gritted teeth.
43. Valerie envied Danielle because recently she won the provincial lottery.
44. Calvin trusted Oscar because always he acted quite truthfully.
45. Lloyd respected Jim because officially he had the highest participation mark.
46. Randall forgot Hazel because honestly they had not seen each other in years.
47. Rhonda treasured Troy because faithfully they committed to each other in marriage.
48. Don fancied Emma because coincidentally they shared a love for jazz music.
49. Pauline deplored Edwin because previously they attended the same junior high.
50. Jamie revered Michael because recently they went through the cult's initiation rites.
51. Sheila insulted Ethel because truthfully she said what she was thinking.
52. Kim shook Victoria because unintentionally she fell asleep on the couch
53. Alfred flattered Melvin because recently he got a new hair cut.
54. Carrie exhausted Charlotte because playfully she acted like a child.
55. Joel distracted Ray because otherwise he would witness the theft.
56. Shannon wounded Lee because confidently they ran to catch the fly ball at once.
57. Kyle surprised Ellen because slowly they entered the room full of hiding guests.
58. Sylvia encouraged Jeff because gladly they worked as a team.
59. Thelma concerned Jacob because unfortunately they had been down this road before.
60. Grace affected Allen because sensibly they were in tune with each other's moods.

Table E.4: List of content questions used in Experiment I (Self-paced reading)

1. Did [NP2] accuse [NP1] of the crime?
2. Had [PN] brought more than enough money?
3. Did [PN] throw the party?
4. Did [NP2] deceive [NP1]?
5. Was [NP1] currently teaching the class?
6. Was [NP2] acting morally?
7. Was [NP2] trying to provoke [NP1]?
8. Did [NP1] prosecute [NP2]?
9. Did [NP1] likely eat a lot of pizza and beer?
10. Do [NP1] and [NP2] disagree on many manners?
11. Was [PN] worried only about their safety?
12. Were [NP1] and [NP2] friends during adulthood?
13. Does [NP1] hate [NP2]?
14. Did [PN] have a gun?
15. Was [PN] still an adult?
16. Did [PN] avoid taking responsibility for the accident?
17. Was [PN] reluctant to go with anyone?
18. Did [NP1] beat [NP2] in the game?
19. Did [PN] mark all of the midterms today?
20. Did [NP2] interrupt [NP1]?
21. Was [PN] a member of the congregation?
22. Did [NP1] chase [NP2]?
23. Did [NP1] want to punish [NP2]?
24. Did [PN] want to avoid an argument?
25. Did [NP1] think [NP2] was being dishonest?
26. Do you think [NP2] and [NP1] love each other?
27. Did [PN] rarely have bad dreams?
28. Does [NP1] dislike [NP2]?
29. Does [PN] act a little strangely?
30. Did [NP2] startle [NP1]?
31. Were [NP1] and [NP2] business associates?
32. Did [NP2] give advice to [NP1]?
33. Had [PN] been in the forest before?
34. Did [PN] think they should attend the class?
35. Was [NP1] driving a car?
36. Does [PN] not want the marriage to happen?
37. Did [NP2] scold [NP1]?
38. Did [NP2] confuse [NP1]?
39. Did [NP1] like [NP2]?
40. Does [NP1] admire [NP2]?
41. Did [NP1] amaze [NP2]?
42. Did [PN] live a boring life?
43. Did [PN] always make dinner?
44. Did [PN] attend very few of the classes?
45. Did [NP2] disappoint [NP1]?
46. Did [NP1] bless [NP2]?
47. Was [PN] somewhat forgetful?
48. Did [NP1] congratulate [NP2]?
49. Do you think [PN] liked meeting new people?
50. Were [NP1] and [NP2] in no danger whatsoever?
51. Did [NP2] forgive [NP1]?

52. Was [PN] a mean and ignorant person?
53. Did [NP2] discourage [NP1]?
54. Do [NP1] and [NP2] get along?
55. Did [NP2] often laugh with [NP1]?
56. Do [NP1] and [NP2] have similar interests?
57. Did [PN] always leave dishes on the coffee table?
58. Did [NP1] want [NP2] to be on the same team?
59. Did NP work in the circus before?
60. Have [NP1] and [NP2] been together in public?
61. Did Steve chastise Howard?
62. Was Carlos happy for Russell?
63. Did Andrea tire of lying?
64. Was Ernest incorrect?
65. Did Herman echo Maurice?
66. Was Laurie smart?
67. Did Kristen defy Vanessa?
68. Did Ana dream about Vivian?
69. Did Ronnie lose track of time?
70. Did Billy push Wayne?
71. Was Lori boring?
72. Did Brittany speak her mind?
73. Had Rick fallen asleep?
74. Was Hector rude?
75. Did Lester fail at his job today?
76. Is the puppy still missing?
77. Did Melanie and Alma win the game?
78. Was Jill talented?
79. Was June mean to Marion?
80. Did Tim have to go to practice?
81. Were Jerome and Gail dating?
82. Was Erica a well behaved daughter?
83. Did Lynn and Sally have lunch this week?
84. Was Greg victimized by Dean?
85. Was Derek often on time?
86. Tom and Cathy in the military?
87. Were the two men on the street?
88. Did Stacy call Samantha?
89. Was Leslie approaching April?
90. Was Jay hurt?
91. Was Bill a thief?
92. Did Veronica smell bad?
93. Were Clifford and Eleanor partners?
94. Were Bernard and Debbie siblings?
95. Did Theodore and Joanne live together?
96. Was Amber in danger?
97. Is Annette in highschool?
98. Had Alicia lived a difficult life?
99. Did Wesley think Pedro was a killer?
100. Was Alexander older than Leroy?
101. Did Clara think Lucille wore too little make-up?
102. Did Anne smile sourly at Sara?
103. Did Danielle envy Valerie?
104. Did Oscar lie?

105. Did Jim have the lowest participation mark?
106. Do Hazel and Randall see each other often?
107. Were Rhonda and Troy in love?
108. Did Emma hate Jazz?
109. Did Pauline and Edwin go to college together?
110. Was Jamie brainwashed?
111. Could Sheila be rude?
112. Did Kim fall asleep?
113. Did Alfred have a new hair style?
114. Was Charlotte acting her age?
115. Was Ray knowingly involved in the crime?
116. Was Lee playing hockey?
117. Did Kyle plan a surprise party for Ellen?
118. Did Jeff team up with Sylvia?
119. Did Jacob concern Thelma?
120. Did Allen sense Grace's mood?

Table E.5: Summary of linear mixed effects model of the first segment during implicit causality-based self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-9.128	−0.597	−0.064	0.533	4.824
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Block	(Intercept)	0.01	0.09	
Subject	(Intercept)	0.16	0.40	
	NP1(Male)	0.00	0.06	0.96
Residual		0.15	0.38	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.52	0.13	51.91	***
log(Dominance)	0.12	0.04	2.82	**
IC-Bias(NP2)	0.57	0.11	5.18	***
log(Length)	0.28	0.04	7.32	***
log(Dom) x IC-Bias(NP2)	−0.35	0.07	−5.21	***

Table E.6: Summary of linear mixed effects model of the second segment during implicit causality-based self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.32	−0.65	−0.10	0.51	4.49
Random effects:				
Groups	Name	Variance	Std.Dev.	
Block	(Intercept)	0.02	0.15	
Subject	(Intercept)	0.14	0.37	
Residual		0.14	0.38	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.69	0.06	120.85	***
IC-Bias(NP2)	−0.04	0.02	−2.33	*
NP(Male)	−0.03	0.02	−2.09	*

Table E.7: Summary of linear mixed effects model of the third segment during implicit causality-based self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-7.759	−0.610	−0.144	0.448	5.343
Random effects:				
Groups	Name	Variance	Std.Dev.	
Block	(Intercept)	0.02	0.12	
Subject	(Intercept)	0.09	0.30	
Residual		0.13	0.36	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.04	0.11	56.80	***
log(Dominance)	0.08	0.03	2.54	*
log(Length)	0.15	0.04	4.08	***

Table E.8: Summary of linear mixed effects model of the fourth segment during implicit causality-based self-paced reading

Scaled residuals:				
Min	1Q	Median	3Q	Max
-9.314	−0.606	−0.051	0.580	5.922
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.12	
Subject	(Intercept)	0.15	0.38	
Residual		0.13	0.36	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.30	0.23	27.26	***
log(Dominance)	0.62	0.15	4.22	***
log(Valence)	0.21	0.17	1.26	
log(Dom) x Log(Val)	−0.26	0.10	−2.64	**

Table E.9: List of target stimuli used in Experiment II (Eye-tracking)

1. James accused Mary because supposedly he witnessed the crime in their building.
2. John abandoned Patrica because stupidly he carried enough money for one ticket.
3. Robert celebrated Linda because effortlessly he threw a perfect anniversary party that evening.
4. Michael deceived Barbara because bewilderingly he could hide amongst the people in the crowd.
5. William instructed Elizabeth because afterwards he needed to teach the rest of the class.
6. David criticized Jennifer because ethically he made no exceptions for a friend.
7. Richard provoked Maria because subtlety he implied they were applying for the same position.
8. Charles prosecuted Susan because initially he decided to be the head lawyer in the trial.
9. Joseph inspired Margaret because truly he wanted to live a healthier lifestyle from now on.
10. Thomas appreciated Dorothy because internally he realized they shared similar points of view.
11. Chris frightened Lisa because honestly he believed there was a real danger.
12. Daniel mourned Nancy because nevertheless he had remained a good friend in their youth.
13. Paul loathed Karen because today he swore they were breaking up for the last time.
14. Mark intimidated Betty because shockingly he threatened to tell the journalist about the scandal.
15. Donald reassured Helen because inwardly he understood what it was like to be a kid.
16. Sandra apologized to George because graciously she took the blame for their accident.
17. Donna accompanied Kenneth because reluctantly she inquired if they could go together.
18. Carol dominated Steven because daily she played on the tennis court until complete exhaustion.
19. Ruth commended Edward because yesterday she marked all of the papers for the final exam.
20. Sharon interrupted Brian because quickly she interjected when the question was first asked.
21. Michelle denounced Ronald because regularly she spoke for their entire congregation without asking first.
22. Laura pursued Anthony because arrogantly she thought the chase could not last very long.
23. Sarah punished Kevin because sadly she had to take all the responsibility for their actions.
24. Kimbery pacified Jason because calmly she hoped to avoid another heated argument.
25. Deborah believed Matthew because always she spoke honestly with a trusting tone of voice.
26. Jessica cherished Gary because thankfully she was there when times were tough.
27. Shirley worried Tim because often she dreamed about both of their deaths.
28. Angela despised Larry because lately she groaned whenever they saw each other.
29. Melissa aggravated Jeffrey because annoyingly she panicked if they stood too close together.
30. Brenda startled Frank because embarrassingly she thought no one else was around.
31. Amy applauded Scott because officially he recommended the company merger should go forward.
32. Anna advised Eric because genuinely he supported their partnership in the venture.
33. Rebecca followed Stephen because logically he scouted the forest trail before today.

34. Kathleen condemned Andrew because earnestly he thought religion belonged in classrooms.
35. Pamela killed Gregory because dangerously he was distracted while driving that night.
36. Martha disparaged Joshua because frankly he wanted the arranged marriage to be cancelled.
37. Debra scolded Jerry because evidently he disapproved strongly of the others in the group.
38. Amanda confused Dennis because unsurprisingly he struggled to follow the conversation.
39. Stephanie adored Walter because frequently he implied they were best friends.
40. Carolyn admired Patrick because undoubtably he behaved in a polite manner to everyone.
41. Christine amazed Peter because secretly he had hoped they might fall in love this summer.
42. Marie yearned for Harold because thrillingly he lived life in the pursuit of adventure.
43. Janet loved Douglas because daily he awoke to make breakfast for the whole family.
44. Chatherine enlightened Henry because thankfully he attended most of the lectures this semester.
45. Ann disappointed Arthur because ordinarily he held their family to the highest standard.
46. Ryan blessed Joyce because faithfully she attended the church for over a decade.
47. Roger compensated Dianne because regularly she forgot to bring money for coffee.
48. Joe congratulated Alice because often she spoke about the day of the competition.
49. Jack greeted Heather because always she seemed interested in meeting new people.
50. Albert protected Teresa because defensively she suggested they should watch eachother's backs.
51. Jonathan forgave Doris because honestly she hoped the argument would be finished.
52. Justin thanked Julie because sincerely she believed kindness was important to their friendship.
53. Keith discouraged Cheryl because personally she believed they would be better living apart.
54. Ralph resented Joan because recently she questioned if they were equals in their field.
55. Brandon amused Nicole because joyfully she recognized they had a similar sense of humour.
56. Adam tolerated Judy because happily she found they actually had much in common.
57. Harry detested Christina because lazily she preferred to leave dirty dishes in the sink.
58. Fred wanted Kathy because impressively she tried hard to win each game they played.
59. Jeremy fascinated Rose because unbelievably she also worked for the circus in Calgary.
60. Alan harassed Lois because mockingly she made an embarrassing joke while together in public.

Table E.10: List of filler stimuli used in Experiment II (Eye-tracking)

1. Howard chastised Steve because again Howard caught him acting naughty.
2. Carlos defamed Russell because angrily he was jealous of all his success.
3. Jacqueline confessed to Andrea because rationally she was tired of lying.
4. Martin corrected Ernest because notably he excelled in his field of study.
5. Herman echoed Maurice because eagerly Herman wanted to impress him.
6. Laurie answered Katie because normally she knew the right answer.
7. Vanessa defied Kristen because today Vanessa thought she was doing the right thing.
8. Ana dreamed about Vivian because instinctively Ana felt she was in trouble.
9. Jon missed Ronnie because absently he lost track of the time.
10. Wayne bothered Billy because aggressively Wayne pushed him into the wall.

11. Lori bored Jane because constantly she told the same stories all the time.
12. Holly intrigued Brittany because casually she spoke whatever was on her mind.
13. Sam jolted Rick because silently he fell asleep at the wheel.
14. Shane angered Hector because generally he was rather rude.
15. Lester rebuked Brent because normally Lester trusted him to do his job.
16. Ramon rewarded Lauren because thankfully they found the lost puppy.
17. Melanie blamed Alma because already Melanie gave up before the game had ended.
18. Zachary honoured Jill because proudly they came in first in the talent show.
19. June mocked Marion because unfortunately she misunderstood sarcasm.
20. Gordon excused Tim because afterwards he practiced for the big game.
21. Jerome complimented Gail because recently they started dating monogamously.
22. Audrey praised Erica because thankfully she appreciated help around the house.
23. Lynn snubbed Tommy because last week they had a serious falling out.
24. Dean victimized Greg because supposedly he was self conscious about himself.
25. Warren reprimanded Derek because aggravatingly he arrived late once again this morning.
26. Tom saluted Cathy because appropriately they followed the work place protocol.
27. Alvin pardoned Floyd because accidentally Floyd knocked into him on the street.
28. Stacy called Samantha because anxiously Samantha needed to hear the news immediately.
29. April approached Leslie because awkwardly she stood right in the doorway.
30. Marcus deserted Jay because sadly Jay injured his leg and could not keep up.
31. Bill chased Alex because callously Alex stole the laptop from the classroom.
32. Darlene avoided Veronica because unfortunately Veronica smelled absolutely awful.
33. Clifford helped Eleanor because methodically they worked together to solve the puzzle.
34. Bernard hugged Debbie because romantically they celebrated their anniversary.
35. Theodore left Joanne because contently they were returning to their homes after work.
36. Amber warned Barry because seriously they were both in real danger.
37. Dustin played with Annette because coincidentally they went to the same preschool.
38. Meghan pitied Alicia because ignorantly Alicia ignored the instructions on the exam.
39. Pedro feared Wesley because dangerously he thought he was a murderer.
40. Leroy idolized Alexander because habitually he acted like a father figure.
41. Clara noticed Lucille because remarkably she toned down her make-up.
42. Sara disliked Anne because sourly she smiled at her through gritted teeth.
43. Valerie envied Danielle because recently Danielle won the provincial lottery.
44. Calvin trusted Oscar because always Oscar acted quite truthfully.
45. Lloyd respected Jim because officially he had the highest participation mark.
46. Randall forgot Hazel because honestly they had not seen each other in years.
47. Rhonda treasured Troy because faithfully they committed to each other in marriage.
48. Don fancied Emma because coincidentally they shared a love for jazz music.
49. Pauline deplored Edwin because previously they attended the same junior high.
50. Jamie revered Michael because recently they went through the cult's initiation rites.
51. Sheila insulted Ethel because truthfully Sheila said what she was thinking.
52. Kim shook Victoria because unintentionally she fell asleep on the couch
53. Alfred flattered Melvin because recently he got a new hair cut.
54. Carrie exhausted Charlotte because playfully she acted like a child.
55. Joel distracted Ray because otherwise he would witness the theft.
56. Shannon wounded Lee because confidently they ran to catch the fly ball at once.
57. Kyle surprised Ellen because slowly they entered the room full of hiding guests.
58. Sylvia encouraged Jeff because gladly they worked as a team.
59. Thelma concerned Jacob because unfortunately they had been down this road before.
60. Grace affected Allen because sensibly they were in tune with each other's moods.

Table E.11: List of content questions used in Experiment II (Eye-tracking)

1. Did Mary accuse James of the crime?
2. Had he brought more than enough money?
3. Did he throw the party?
4. Did Barbara deceive Michael?
5. Was William currently teaching the class?
6. Was Jennifer acting morally?
7. Was Maria trying to provoke Richard?
8. Did Charles prosecute Susan?
9. Did Joseph likely eat a lot of pizza and beer?
10. Do Thomas and Dorothy disagree on many manners?
11. Was he worried only about their safety?
12. Were Daniel and Nancy likely friends during adulthood?
13. Does Paul hate Karen?
14. Did he threaten to go to the media with the story?
15. Were Donald and Helen both children?
16. Did she avoid taking responsibility for the accident?
17. Did Donna and Kenneth go together?
18. Did Carol beat Steven in the game?
19. Did she mark all of the midterms today?
20. Did Brian interrupt Sharon?
21. Was Ronald a member of the congregation?
22. Did Laura chase Anthony?
23. Were they both in trouble?
24. Did she want to avoid an argument?
25. Did Deborah think Matthew was being dishonest?
26. Do you think Gary and Jessica care for each other?
27. Did she rarely have bad dreams?
28. Does Angela dislike Larry?
29. Does she act a little strangely?
30. Did Frank startle Brenda?
31. Were Amy and Scott business associates?
32. Did Eric give advice to Anna?
33. Had he been in the forest before?
34. Did he think religion should be taught at school?
35. Was Pamela driving a car?
36. Does he not want the marriage to happen?
37. Did Jerry scold Debra?
38. Did Dennis confuse Amanda?
39. Did Stephanie like Walter?
40. Does Carolyn admire Patrick?
41. Did Christine amaze Peter?
42. Did he live a boring life?
43. Did he always make dinner every day?
44. Did he attend very few of the classes?
45. Did Arthur disappoint Ann?
46. Did Ryan bless Joyce?
47. Was she somewhat forgetful?
48. Did Joe congratulate Alice?
49. Do you think she liked meeting new people?
50. Were Albert and Teresa in no danger whatsoever?
51. Did Doris forgive Jonathan?

52. Was she a mean and ignorant person?
53. Did Cheryl discourage Keith?
54. Do Ralph and Joan get along?
55. Did Nicole often laugh with Brandon?
56. Do Adam and Judy have similar interests?
57. Did she always leave dishes on the coffee table?
58. Did Fred want Kathy to be on the same team?
59. Did she work in the circus?
60. Have Alan and Lois been together in public?
61. Did Steve chastise Howard?
62. Was Carlos happy for Russell?
63. Did Andrea tire of lying?
64. Was Ernest incorrect?
65. Did Herman echo Maurice?
66. Was Laurie smart?
67. Did Kristen defy Vanessa?
68. Did Ana dream about Vivian?
69. Did Ronnie lose track of time?
70. Did Wayne push Billy?
71. Was Lori boring?
72. Did Brittany speak her mind?
73. Had Rick fallen asleep?
74. Was Hector rude?
75. Did Lester fail at his job today?
76. Is the puppy still missing?
77. Did Melanie and Alma win the game?
78. Was Jill talented?
79. Was June mean to Marion?
80. Did Tim have to go to practice?
81. Were Jerome and Gail dating?
82. Was Erica a well behaved daughter?
83. Did Lynn and Sally have lunch this week?
84. Was Greg victimized by Dean?
85. Was Derek often on time?
86. Tom and Cathy in the military?
87. Were the two men on the street?
88. Did Stacy call Samantha?
89. Was Leslie approaching April?
90. Was Jay hurt?
91. Was Bill a thief?
92. Did Veronica smell bad?
93. Were Clifford and Eleanor partners?
94. Were Bernard and Debbie siblings?
95. Did Theodore and Joanne live together?
96. Was Amber in danger?
97. Is Annette in high school?
98. Did Alicia likely fail the exam?
99. Did Wesley think Pedro was a killer?
100. Was Alexander older than Leroy?
101. Did Clara think Lucille wore too little make up?
102. Did Anne smile sourly at Sara?
103. Did Valarie win the lottery?
104. Did Oscar lie?

105. Did Jim have the lowest participation mark?
106. Do Hazel and Randall see each other often?
107. Were Rhonda and Troy in love?
108. Did Emma hate Jazz?
109. Did Pauline and Edwin go to college together?
110. Was Jamie brainwashed?
111. Could Sheila be rude?
112. Did Kim fall asleep?
113. Did Alfred have a new hair style?
114. Was Charlotte acting her age?
115. Was Ray knowingly involved in the crime?
116. Was Lee playing hockey?
117. Did Kyle plan a surprise party for Ellen?
118. Did Jeff team up with Sylvia?
119. Did Jacob concern Thelma?
120. Did Allen sense Grace's mood?

Table E.12: Summary of linear mixed effect model for first fixation duration in the first interest area during implicit causality-based eye tracking

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.887	−0.248	−0.004	0.430	3.270
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Item	(Intercept)	0.00	0.05	
	NP1(Male)	0.01	0.09	1.00
Subject	(Intercept)	0.36	0.60	
	NP1(Male)	0.10	0.31	1.00
Residual		1.54	1.24	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	3.77	0.41	9.28	***
log(Dominance)	0.54	0.24	2.27	*
NP1 Gender(Male)	1.08	0.58	1.86	
IC-Bias(NP2)	1.03	0.62	1.65	
log(Dominance) x NP1 Gender(Male)	−0.73	0.36	−2.06	*
log(Dominance) x IC-Bias(NP2)	−0.63	0.38	−1.69	
NP1 Gender(Male) x IC-Bias(NP2)	−1.86	0.90	−2.08	*
log(Dom) x NP1 Gen(Male) x IC-Bias(NP2)	1.17	0.54	2.15	*

Table E.13: Summary of linear mixed effect model for second-pass gaze duration in the first interest area during implicit causality-based eye tracking

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.314	−0.289	0.320	0.636	2.304
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.0001	0.0001	
Subject	(Intercept)	0.46	0.68	
Residual		2.60	1.61	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	5.54	0.14	40.77	***
IC-Bias(NP2)	−0.24	0.08	−2.86	**

Table E.14: Linear mixed effects model for the logged dwell time in the first interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-5.846	−0.543	0.117	0.663	2.504
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	>0.001	0.03	
Subject	(Intercept)	0.06	0.24	
Residual		0.18	0.42	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	7.16	0.09	75.72	***
NP1 (Male)	−0.07	0.02	−3.25	**
log(Length)	0.10	0.04	2.32	*

Table E.15: Summary of linear mixed effect model for first fixation duration in the second interest area during implicit causality-based eye tracking

Scaled residuals:				
Min	1Q	Median	3Q	Max
-6.001	−0.298	0.080	0.500	3.103
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Item	(Intercept)	0.0001	0.0001	
Subject	(Intercept)	0.16	0.40	
Residual		0.78	0.88	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	4.36	0.27	15.92	***
log(Dominance)	0.32	0.16	1.98	
NP1 Gender(Male)	0.57	0.38	1.51	
IC-Bias(NP2)	1.19	0.42	2.80	**
log(Dominance)xNP1 Gender(Male)	−0.36	0.23	−1.52	
log(Dominance)xIC-Bias(NP2)	−0.66	0.25	−2.61	**
NP1 Gender(Male)xIC-Bias(NP2)	−1.54	0.59	−2.59	**
log(Dom)xNP1 Gen(Male)xIC-Bias(NP2)	0.86	0.36	2.40	*

Table E.16: Summary of linear mixed effect model for second-pass gaze duration in the second interest area during implicit causality-based eye tracking

Scaled residuals:				
-3.205	−0.670	0.289	0.680	2.301
Min	1Q	Median	3Q	Max
Item	(Intercept)	0.01	0.08	
Subject	(Intercept)	0.70	0.83	
Residual		2.99	1.73	
Random effects:				
Groups	Name	Variance	Std.Dev.	
(Intercept)	4.95	0.17	28.88	***
NP1 Gender(Male)	−0.30	0.08	−3.60	***
IC-Bias(NP2)	−0.30	0.08	−3.65	***
IC-Bias(Incongruent)	0.19	0.08	2.31	*
Fixed effects:				
	Estimate	Std. Error	*t* value	

Table E.17: Linear mixed effects model for the logged dwell time in the second interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-4.389	−0.612	0.081	0.669	2.811
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.08	
Subject	(Intercept)	0.10	0.31	
	Residual	0.27	0.52	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.73	0.17	40.22	
log(Dominance)	0.02	0.10	0.21	
NP1 Gen(Male)	0.11	0.23	0.48	
IC-Bias(NP2)	0.09	0.25	0.36	
IC-Bias(Incongruent)	0.08	0.02	3.06	**
log(Dominance) x NP1 Gen(Male)	−0.11	0.14	−0.78	
log(Dominance) x IC-Bias(NP2)	−0.10	0.15	−0.64	
NP1 Gen(Male) x IC-Bias(NP2)	−0.73	0.35	−2.06	*
log(Dom) x NP1 Gen(Male) x IC-Bias(NP2)	0.44	0.21	2.07	*

Table E.18: Linear mixed effects model for the logged dwell time in the third interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.951	−1.013	0.334	0.814	2.099
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.08	0.28	
Subject	(Intercept)	0.47	0.69	
Residual		3.38	1.84	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	4.23	0.14	29.82	***
IC Bias (Incongruent)	0.22	0.09	2.44	*

Table E.19: Linear mixed effects model for the logged dwell time in the third interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.459	−0.707	0.038	0.704	2.860
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	0.01	0.09	
Subject	(Intercept)	0.07	0.26	
Residual		0.32	0.57	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.38	0.05	118.59	***
IC-Bias(NP2)	−0.12	0.03	−4.30	**
IC-Bias(Incongruent)	0.07	0.03	2.33	*

Table E.20: Summary of the linear mixed effect model of the fourth interest area dwell time during implicit causality-based eye-tracking

Scaled residuals:				
Min	1Q	Median	3Q	Max
-2.949	−0.651	0.058	0.684	2.922
Random effects:				
Groups	Name	Variance	Std.Dev.	Corr
Item	(Intercept)	0.17	0.41	
	dmeansum	0.004	0.06	-1.00
Subject	(Intercept)	0.01	0.11	
	dmeansum	0.003	0.06	-0.44
Residual		0.30	0.55	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	6.45	0.05	140.52	***
IC-Bias(Incongruent)	0.05	0.03	1.68	.

Table E.21: Linear mixed effects model for the logged first fixation duration in the fifth interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-5.556	−0.317	0.076	0.494	2.694
Random effects:				
Groups	Name	Variance	Std.Dev.	
Verb	(Intercept)	<0.001	<0.001	
Subject	(Intercept)	0.1404	0.3746	
Residual		0.9739	0.9869	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	5.2491	0.3950	13.290	***
log(Dominance)	−0.2211	0.2327	−0.950	
IC Bias(NP1)	−0.9152	0.5106	−1.792	.
NP1(Male)	−1.2313	0.5440	−2.263	*
log(Dom) x IC Bias(NP1)	0.5216	0.3091	1.687	.
log(Dom) x NP1 (Male)	0.7175	0.3255	2.205	*
IC Bias(NP1) x NP1(Male)	1.6319	0.7083	2.304	*
log(Dom) x IC Bias(NP1) x NP1(Male)	−1.0063	0.4291	−2.345	*

Table E.22: Linear mixed effects model for the dwell time in the fifth interest area for implicit causality constructions

Scaled residuals:				
Min	1Q	Median	3Q	Max
-3.884	−0.709	0.075	0.729	2.95
Random effects:				
Groups	Name	Variance	Std.Dev.	
Item	(Intercept)	<0.001	<0.001	
Subject	(Intercept)	0.13	0.36	
Residual		0.36	0.60	
Fixed effects:				
	Estimate	Std. Error	*t* value	
(Intercept)	7.04	0.12	56.61	***
log(Dominance)	−0.43	0.06	−6.64	***