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Modality-specific Effects of Processing Fluency on Cognitive Judgments

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Modality-specific Effects of Processing Fluency on Cognitive Judgments

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Modality-specific Effects of Processing Fluency on Cognitive Judgments

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Fluency of processing – the ease with which one extracts information from stimuli – affects a variety of cognitive processes over and above the influence of declarative content. Although this influence has been extensively demonstrated in a variety of different domains (Alter & Oppenheimer, 2009), there are virtually no studies exploring this effect with auditory material. Moreover, although research on modality differences suggests that people process auditory information differently than they process visual or written information (Conway & Gathercole, 1987; Markman, Taylor & Gentner, 2007), there are no studies that directly compare the effects of processing fluency on judgments across different modalities. The current dissertation reports two sets of studies, one investigating the effects of processing fluency on cognitive judgments in the auditory modality, and a second exploring cross-modal differences in processing fluency. The first set of studies showed that although foreign-accented speech is more difficult to process, this disfluency does not affect cognitive judgments. In the second set of studies, two experiments show that disfluency in processing affects judgments of truth (Experiment 1) and the intention to purchase a product (Experiment 2) only with written – non-verbal – material. Experiment 3 investigates one possible explanation for the limited influence of processing fluency in speech: because people tend to focus on conceptual information

over low-level acoustic information when processing language (Lahiri & Marslen-Wilson, 1991; Gow & Gordon, 1995; Mattys, White & Melhorn, 2005; Norris, McQueen & Cutler, 1995), distortions to the superficial features of the speech signal is likely to have limited impact on how people process the conceptual content. In Experiment 3 participants are primed to attend to the superficial features of foreign-accented speech. The results showed that when people are primed to attend to features that make foreign-accented speech difficult, non-native speech has an impact on subsequent judgments of truth. Overall, the studies presented here show that listeners can extract content from speech, even when it is distorted. They also show that when attention is directed to low-level acoustic features of speech, processing fluency effects becomes apparent.

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Introduction

In May 2007, after completing my Master's thesis in Brazil, I was offered a job as a high school teacher in a Brazilian school located in Japan. At around the same time, I was accepted as a Ph.D. student at The University of Texas at Austin. I was faced with the task of deciding whether I should accept the job offer and move to Japan or whether I should reject the offer and pursue the Ph.D. degree in the U.S. Although, it is now clear what my final choice was, this situation is an example of a mental process that pervades our everyday life, namely, decision-making. Of course, we do not have to make big decisions like this one on a daily basis but we do engage in several decision-making processes that end up shaping the things we do, the places we go and the preferences we have.

Decision-making is a difficult concept to define. Medin, Ross and Markman (2005) define decision-making as the mental process that involves the generation, evaluation and selection – among explicit choices – of an option. The decision-making process involves a series of judgments about several aspects related to the decision at hand. For instance, in deciding whether to go to Japan, one might evaluate (judge) the financial aspects of the offer and decide that going to Japan is a profitable choice. One might also look more closely at the cultural aspects of the new country and choose not to go to avoid profound changes as compared to his/her own culture, etc. The bottom line is: to evaluate each one of these aspects one needs to make judgments about a number of aspects and features of the options available (i.e., credibility, confidence, risk, certainty, etc.) Because decision making is pervasive and important in shaping our lives, it is

necessary that we understand the factors that influence the decisions we make. More specifically, it is important to comprehend more systematically the factors that influence the way we make judgments that ultimately lead to appropriate decisions.

In the process of making a decision or judging different stimuli, individuals make use of both external (e.g., contextual) and internal (e.g., cognitive) cues (Oppenheimer, 2008). One of the most influential – yet complex – internal cues that people implicitly use to make judgments is *processing fluency* – the experienced degree of effort associated with how people process information (Unkelbach, 2011, Oppenheimer, 2008; Oppenheimer, 2008; Reber, Winkielman & Schwarz, 1998). A number of studies in cognitive and social psychology have demonstrated that processing fluency affects our judgments in a variety of domains. Fluency of processing influences how we estimate the degree of familiarity (Jacoby & Whitehouse, 1989), clarity (Whittlesea, Jacoby & Girard, 1990), riskiness (Song & Schwarz, 2009), location (Alter & Oppenheimer, 2008), truthfulness (Reber & Schwarz, 1999; Unkelbach, 2007), liking (Winkielman & Cacioppo, 2001) and confidence (Koriat, 1993).

Schwarz (2004) argues that the effects of processing fluency on cognitive judgments is robust and independent of the content being evaluated. Indeed, any mechanism or tool that increases the degree of processing fluency has an effect on later judgments. This claim is supported by a number of studies that manipulated the ease with which people process information (e.g., perceptual, conceptual and linguistic information) and later showed that this manipulation influenced a variety of proximal

cognitive systems (Begg, Anas & Farinacci, 1992; Reber & Schwarz, 1999; McGlone & Tofighbakhsh, 2000).

Foreign accented-speech is a natural way to affect the processing fluency in the auditory modality. A foreign accent can make a statement less intelligible and harder to understand, thereby imposing a cognitive burden for the listener (Munro & Derwing, 1995b). Indeed, foreign accent is one of the linguistic features that is frequently investigated for the social judgments it triggers. More specifically, several studies have shown that listeners express definite and consistent negative attitudes towards speakers who use particular accent. Native speakers exhibit higher levels of irritation, downgrading of attitude, lower credibility and outright discrimination towards people with non-native accents (Munro & Derwing, 1995; Cargile, Giles, Ryan & Bradac, 1994). Despite these findings, the cognitive mechanisms that underlie these negative outcomes remain largely unexplored and unclear (Dixon & Mahoney, 2004). The present dissertation explores the possibility that the negative attitudes towards foreign-accented speakers is, in fact, a byproduct of the metacognitive experience of disfluency involved in the processing of accented speech. To do this, I asked participants to rate the degree to which they believed in trivia statements spoken by (1) native speakers, (2) non-native speakers and (3) native speakers in the presence of background noise.

A further question that the present dissertation explores is the extent to which there are modality differences in the effects of processing fluency on cognitive judgments. In a typical experiment of processing fluency, participants are exposed to written (or visual) material that is either easy of difficult to process, and are asked to

make a judgment about the declarative content of the material. Research on modality differences in cognitive processing (Conway & Gathercole, 1987; Jakimik & Glenberg, 1990; Carroll & Korukina, 1999) shows that people process written information in fundamentally different ways than they process auditory information. However, there are virtually no studies that directly explores processing fluency effects in auditory vs. written modalities. Because we are constantly acquiring and providing information using both modalities (Clark, 1996), it is relevant to verify whether disfluency has different effects for auditory information compared to visual information. To explore this question, I presented participants with both visual and auditory information and manipulated the degree of effort required to process that information. Later, I asked participants to provide judgments about the content of the information provided.

The dissertation is organized as follows: Section 1 presents an overview of the different types of processing fluency (i.e., perceptual fluency, conceptual fluency and linguistic fluency), and a comprehensive review of the studies demonstrating that processing fluency affects cognitive judgments. Section 2 brings an extensive review of the research on the processing of accented speech, and the research on the social attitudes triggered by accented speech. Section 3 reviews some of the studies suggesting that information presented in the auditory modality is processed differently than information provided in the written or visual modalities. The next three Sections (4, 5 and 6) present the results of the proposed experiments followed by Section 7 with a general discussion and conclusion.

1. Processing Fluency

In the previous section, I talked about a decision I had to make about accepting a job offer in Japan or pursuing the Ph.D. in the U.S. Part of what makes a decision-making process complex is that it involves a series of evaluative tasks, that is, the assessment of the valence of a series of aspects about each available option. For instance, in the process of making my decision, I was told that "*meals in Japan are cheap,*" but that "*fruits are really expensive there*." At the same time, I had some information about graduate school in Texas. I read in a brochure that "*funding during the summer is not guaranteed*" and that "*it gets really warm in Austin during the Summer*." In order to use these pieces of information effectively to decide whether to go to Japan or to pursue a Ph.D., I needed to make judgments about the truthfulness of the statements: is it true that fruits in Japan are expensive? Is it really true that summer time in Texas is very warm?

To make such evaluations and judgments, human beings use a range of different cognitive processes and cues from different sources. Indeed, these cognitive processes vary considerably with respect to the sources of information they use as primary input (Winkielman, Schwarz, Fazendeiro & Reber, 2003). Generally, there are two sources of information that one might use when engaging in evaluative judgments: one can make use of declarative information (e.g., features contained in the stimuli being evaluated) or one can use experiential information (e.g., feelings and emotional reactions about the stimuli being evaluated). For instance, a person wanting to purchase a car might evaluate

the features of the car (e.g., color, number of seats, type of transmission, etc.) and use this evaluation to decide whether to buy the car. Alternatively, this person might rely on the feelings and emotions associated with his/her experience with the car (e.g., how comfortable it felt when test-driving it) at the expense of the superficial and structural features of the car.

Psychological research on the use of declarative information has traditionally focused on understanding the aspects of the information we most readily attend to. Research has explained influences on our attention to certain features of the stimuli. Research has also focused on how we integrate the features we attend to in order to form a cohesive and integrated judgment about the stimuli being evaluated (Anderson, 1981). The features of the stimuli that we most readily attend to or recall from memory are a function of the information itself and a function of our mood at the time of the judgment (Bower, 1981; Schwarz & Bless, 1992). The characteristics of the information being evaluated as well as our emotional state at the time of the judgment render some features more accessible than others. According to this model of judgment, after attending to certain aspects of the stimuli, people objectively utilize the features they can abstract from the information and use these features as basis for their judgments.

On the other hand, one can base the evaluative judgments on experiential information, that is, on the metacognitive experience of how the information was processed in the first place (Flavell, 1979; Tversky & Kahneman, 1973, Oppenheimer, 2008). One of the most influential metacognitive experience that people use to make evaluative judgments is known as *processing fluency* – the ease or difficulty associated

with how people extract information from stimuli (Unkelbach, 2011, Oppenheimer, 2008). The idea is that in the process of making a judgment or evaluation, people monitor the fluency with which they extract features from the information being evaluated. The affective response resulting from this monitoring process influences the judgment about the stimuli themselves (Winkielman et al., 2003). Reber, Schwarz and Winkielman (2004) argue that fluency signal is hedonically marked so that high fluency (i.e., feelings of ease to process information) produces a positive affective reaction making people prefer stimuli that are easily processed.

Indeed, the cognitive tasks that we engage in on a daily basis can be characterized by the amount of effort they required to be carried out. They can be effortless (e.g., speaking your native language[1]) or highly effortful (e.g., reading a book in a poorly-lit place). The perceived amount of effort associated with a cognitive task produces a metacognitive experience that we classify as either *fluent* or *disfluent* (Alter & Oppenheimer, 2009).

According to Schwarz (2004), any mechanism or tool that manipulates the fluency of information processing should have an effect on later evaluative judgments independently of the declarative features (i.e., content) of the information being evaluated. This assumption is supported by studies that demonstrate that independently of the manipulation used to make information harder to be extracted, they always show consistent results: it influences how information/stimuli are evaluated (Begg, Anas & Farinacci, 1992; Reber & Schwarz, 1999; McGlone & Tofighbakhsh, 2000).

[1] Assuming typically developed individuals.

There are a variety of different ways to trigger the metacognitive experience of disfluency. The spectrum of methods to promote disfluency ranges from purely perceptual (i.e., making the size of the letters in a text extremely small) to disfluencies related to memory or some other form of higher-order cognitive abilities (i.e., priming the concept of *poverty* by showing words related to poverty). In the past 15 years, researchers have used a variety of approaches and methods to manipulate fluency of processing. The variety of techniques used led to researchers to define different types of fluencies (Alter & Oppenheimer, 2009). These types range from fluencies that are conceptual (Begg, Anas & Farinacci, 1992) to fluencies that are phonological or linguistic (McGlone & Tofighbakhsh, 2000).

1.1 PERCEPTUAL FLUENCY

Perceptual fluency is related to the metacognitive experience associated with the degree of effort required to perceive low-level, surface features of stimuli. For instance, assuming that you have been reading this dissertation in a very well-lit place, you probably have not had any problems *seeing* the letters printed on this page. The visual contrast between the letters and the background is one that facilitates the perception of them. Were the letters in the entire dissertation printed like this, you would probably have had a harder time seeing them. Consequently, the cognitive task of reading this dissertation would have been much more effortful that it has been so far[2]. Thus, perceptual fluency is influenced

[2] Reading here focuses on the perception of the letters, not on the cognitive effort to comprehend the information being communicated.

by variables such as form, contrast, repetition, and duration of exposure (Zajonc, 1968; Jacoby, 1983; Roediger, 1990). These variables reliably change the perceptual fluency (i.e., accuracy and perceptual identification) of items. Indeed, perceptual fluency can be operationalized in terms of the speed with which items are recognized (Schooler & Hertwig, 2005). For instance, in a classic word recognition task, Johnston, Dark and Jacoby (1985) showed people a series of words that were gradually revealed by the removal of a mask. They found that people were more accurate and faster to recognize words that were clearly visible.

A related phenomenon is the mere exposure effect (Zajonc, 1968). The mere exposure effect states that repeated exposure to a stimulus will increase perceptual fluency. Indeed, Reber et al. (1998) found that longer presentation of words increased the subject feelings of ease of processing.

1.2 CONCEPTUAL FLUENCY

Conceptual fluency reflects the effort associated with high-level cognitive operations. Conceptual fluency is influenced by variables such as semantic priming, semantic predictability and context congruity (Kelly & Jacoby, 1998; Poldrack & Logan, 1998). For instance, by exposing people to words such as *ball*, *goal keeper* and *referee*, we make it easier for them to extract information from the sentence "*The 2014 World Cup will take place in Brazil*." This facilitation arises from two important aspects of conceptual processing. First, knowledge is an interconnected structure of nodes and links in which each node represents an individual concept (Anderson, 1983; Markman, 1999).

Second, the activation of one node spreads to other related nodes – a concept known as *automatic spreading activation*. The spreading activation of one node prepares the cognitive system to identify and process related nodes. This is the base for what is known as *semantic priming* (Masson, 1995; Neely, 1977). Semantic priming occurs when the activation of one concept facilitates the activation of another concept (Markman, 1999). The facilitative nature of semantic priming creates the metacognitive impression of fluency (Balota, Black & Cheney, 1992).

Several studies have demonstrated that semantic priming makes subsequent information easier to process. Rajaram and Geraci (2000) showed that semantically related primes facilitated the recognition of target words and made participants more willing to report that they had seen the target word before. More recently, Day (2007) presented participants with a passage of a text that was either analogically related, or analogically unrelated to a target passage. They showed that participants who read a target text preceded by an analogically related one (for instance, a target text about genetic coding preceded by a text about computer coding) found the target text a lot easier to process and easier to understand.

1.3 LINGUISTIC FLUENCY

Linguistic fluency is a more specific type of fluency than conceptual fluency. It concerns the metacognitive experience associated with the effort to process linguistic stimuli. Thus, it can only be manifested in domains where some sort of language processing is required. Linguistic fluency is obviously closely related to both perceptual

and conceptual fluency. In order to engage in any sort of conceptual operation with any linguistic material, one needs to first perceive the material. In the case of written linguistic stimuli, one needs to be able to see and identify the printed letters. In the case of auditory material, one needs to be able to auditorily perceive and identify the sounds. Although perceptual and conceptual fluencies are intimately related to linguistic fluency, it is important to note that perceptual and conceptual fluency can be manipulated without the use of any linguistic material. For instance, one can make a picture of a car perceptually easy (Figure 1A) or perceptually difficult (Figure 1B) to be processed. Similarly, concepts can also be activated without the use of language. For instance, by just showing people the pictures in Figure 2, one can facilitate the processing of the sentence "*The next World Cup will take place in Brazil*."[3]

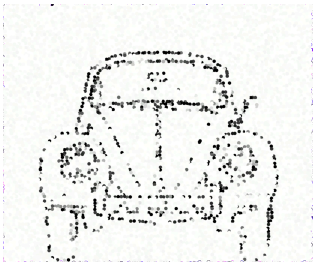
A  B 

Figure 1: Perceptual Fluency in Images.

[3] Although the test does involve the processing of a sentence, the conceptual fluency (i.e., the priming) was triggered without the use of any linguistic material.

Figure 2: Images that prime the concept of *soccer*.

Linguistic fluency can occur at the *phonological*, *lexical* and *syntactic* levels. At the phonological level, linguistic fluency is the metacognitive experience related to how effortful is the pronunciation of certain sounds or sound combinations. For instance, Alter & Oppenheimer (2006) found that participants show linguistic disfluency when asked to pronounce company names such as *Reszvenytarsasag*, or obscure English words such as *euneirophrenia*. McGlone and Tofighbakhsh (2000) showed that people tend to think that it is easier to process aphorisms such as "*Woes unite foes*" than it is to process the semantically similar aphorism "*Woes unite enemies*". According to them, the rhyme present in the first example (e.g., *woes* and *foes*) gives the participant a metacognitive feeling of fluency.

At the lexical level, linguistic fluency reflects the effort to process certain words in conceptual terms. For instance, although the words *lacuna* and *gap* mean the same thing, people tend to show more fluency when reading or saying *gap* than reading or saying *lacuna*. To demonstrate this effect, Oppenheimer (2006) did a study in which he collected a series of academic essays, text and dissertation abstracts and replaced simple words (e.g., *well*) to more complex alternatives (i.e., *satisfactorily*). He found that

although the meanings were pretty much the same, increasing the complexity of a text slowed processing fluency, and gave people the impression that the texts with complex words were less familiar than their simpler counterparts.

Linguistic fluency can also occur at the syntactic level as well. It represents how easily people can parse different syntactic constructions. In a classic study, Lowrey (1998) introduced a new brand of cereal (e.g., *Tooles*) using either a syntactically-complex structure (e.g., *because it's high in fiber and contains no preservatives, Tooles is a healthy choice for breakfast*) or a syntactically-simple construction (e.g., *Tooles is a healthy choice for breakfast, because it's high in fiber and contains no preservatives*). Participants judged the complex structure to be harder to process, therefore less fluent.

A number of studies in cognitive and social psychology have demonstrated that manipulations of fluency affects our evaluative judgments in a variety of different domains (Oppenheimer, 2008; Reber, Winkielman & Schwarz, 1998). For instance, fluency of processing influences how we estimate the degree of familiarity among different items (Jacoby & Whitehouse, 1989), it influences the clarity with which we perceive information (Whittlesea, Jacoby & Girard, 1990), it affects our perception of riskiness (Song & Schwarz, 2009), our perceptions of location and distance (Alter & Oppenheimer, 2008), it affects what we trust (Reber & Schwarz, 1999; Unkelbach, 2007), what we like (Winkielman & Cacioppo, 2001) and what we are confident about (Koriat, 1993). In the next Section, I present a review of this literature and its implications to cognitive processing.

1.2 Effects of Processing Fluency on Cognitive Judgments

It should be clear by now that any cognitive process can feel easy or difficult, and that the information yielded by this feeling is what cognitive psychologists call *processing fluency*. There is robust evidence in the literature that fluency reliably influences people's cognitive judgments across a variety of different domains (Alter & Oppenheimer, 2008). The basic tenet is the idea that evaluative judgments may result from changes in the dynamics of perceptual, conceptual and linguistic processing that do not necessarily derive from analysis of declarative information contained in the stimuli. Several studies, in several different domains have demonstrated this effect.

Reber, Winkielman and Schwarz (1998), for instance, were interested in investigating whether processing fluency affects evaluative judgments of preference. They asked undergraduate students to rate a series of drawings of neutral objects in terms of how pretty they thought the pictures were. The perceptual fluency of the drawings was manipulated to make them either easy or difficult to process. Reber et al. (1998) made the recognition of the object in the drawing more difficult by degrading the foreground of the picture and presenting a prime picture that would either facilitate (e.g., a picture with the contour of the target picture) or hinder (e.g., a picture with the contour of a different picture) the recognition of the target object. Following the idea that perceptual fluency is operationalized in terms of the speed with which items are perceived and recognized (Schooler & Hertwig, 2005), time latencies assured that this manipulation did slow down the processing of the pictures. The pictures containing objects recognized fluently (i.e.,

with a matching prime picture) were judged as prettier than the pictures containing objects that were not fluently recognized (i.e., with mismatching prime). In a similar study, Winkielman and Cacioppo (2000) presented participants with line drawings of everyday objects that were either easy (e.g., preceded by a matching prime) or difficult (e.g., preceded by a non-matching prime) to process and measured the activity of various facial muscles. They found that participants reacted more positively towards the easy-to-process line drawing than towards the hard-to-process ones, showing more positive facial activities towards the easy-to-process stimuli.

To investigate whether conceptual fluency also has an effect on evaluative judgments of preference, Whittlesea (1993) manipulated the conceptual fluency of words by embedding them in either a predictive semantic context (e.g., *stormy seas tossed the* ***boat***) or in non-predictive semantic context (e.g., *stormy seas tossed the* ***lamp***). He later asked participants to rate how much they liked the target words (i.e., the words in bold). He found that people rated the words presented in a predictive context (i.e., easy to process) as significantly more pleasant than the words presented in the non-predictive context (i.e., harder to process).

Fluency of processing is also believed to influence people's evaluative judgments of risk. Risk evaluation is an intuitive process, rather than an analytical one, being therefore susceptible to influences of metacognitive subjective feelings of fluency (Loewenstein, Weber, Hsee & Welch, 2001). Song and Schwarz (2009) did a clever set of studies to investigate whether people judge fluently processed stimuli as less risky than stimuli that are processed less fluently. In one of these studies, they asked participants to

read several food additive labels. Fluency was manipulated in the linguistic domain. Some of the labels were difficult to pronounce (e.g., *euneirophrenia*) whereas others were easy to pronounce (e.g., *beestings*). The participant's task was to rate the degree of hazard posed by the different food additives. They found that the difficult-to-pronounce labels were reliably rated as more harmful and risky than the easy-to-pronounce labels. This research also found that processing fluency affected people's perceived familiarity with the items. In this study, participants rated the difficult-to-pronounce labels as less familiar than the easy-to-pronounce labels.

More recently, Alter and Oppenheimer (2008) presented evidence that perceived psychological distance and mental construal are also affected by different levels of processing fluency. Psychological distance reflects how distant a stimulus is from one's self in an abstract psychological space (Henderson, Fujita, Trope & Lieberman, 2006). Actual perceived physical distance is only one instantiation of psychological distance. In their study, Alter & Oppenheimer (2008) asked participants to respond to a questionnaire that required them to estimate the physical distance (in miles) between their location (the study was performed in Princeton, U.S.) and several other places in the U.S. Half the participants received their questionnaire in an easy-to-read font (e.g., Times New Roman) whereas the other half received the same questionnaire in a hard-to-read font (e.g., italicized ***Haettenschweiler***). The results showed that individuals who responded the hard-to-read questionnaire estimated longer distances between their current location and other cities in the U.S. as compared to the individuals who responded to the same questionnaire printed in an easy-to-read font.

Perceived physical distance is also related to how abstractly people construe a situation or place. Situations that take place in a distant physical location (i.e., far away from the self) are generally construed as more abstract – containing fewer details – than situations that take place in a physical location that is closer to the self (Fujita, Henderson, Eng, Trope & Lieberman, 2006). To investigate whether fluency of processing also influences the level of abstractness with which people construe situations or places, Alter and Oppenheimer (2008) had students write a small description of New York City. Half the participants received the instructions in a fluent font (e.g., 12-point Times New Roman). The other half received the same instructions in a disfluent font (e.g., 10-point, 25% grey, italicized, *Arial*). They found that participants described New York more abstractly (e.g., *New York's lights, shimmering in the foggy sky, remind me of outer space*) in the disfluent condition than the participants in the fluent condition, who were more likely to describe New York more concretely (e.g., *New York City is a large city with five boroughs and about 18 million people*.) Both studies suggested that greater experienced disfluency implies greater perceived distance from a target and leads to perception of the world as more abstract.

Fluency of processing also has a reliable and direct effect on evaluative judgments of confidence. Several studies have shown that people feel greater confidence in their performance and decisions when the task performed is perceived to be easy/fluent (Kelly & Lindsay, 1993; Koriat, 1993). Reder (1987) demonstrated that people are more confident with their assessment of trivia statements such as "*tigers are dangerous*" when primed earlier with related components of the trivia (e.g., *tiger*, *jungle*). There is also

evidence that people are more confident about their performance in a task when the instructions for the task are provided in fluent fonts that are easy to read. Alter, Oppenheimer, Epley and Eyre (2007) showed that participants were reliably more confident in their understanding of consumer reviews when the instructions to read the reviews were presented in an easy-to-read font than when the instructions were presented in a hard-to-read font.

Fluency of processing has reliable and direct effect on judgments of truthfulness. Indeed, the effects of processing fluency on judgments of truthfulness has been extensively investigated in the field. As human beings, we are constantly learning facts from other people. Whether we incorporate the newly learned fact is due in part to the extent in which we believe in it. In the absence of objective information about the truth value of a statement or a fact, other cues come into play (Schwarz, 2004). There are many factors that influence our judgments of credibility and confidence such as how reasonable the information sounds (Miller & Hewgill, 1964) or how much cognitive capacity is available to process the information (Gilbert, 1991).

Reber and Schwarz (1999) investigated whether manipulations designed to either facilitate or hinder fluency of processing affected judgments of the truth of statements. To avoid confounds such as effects of frequency and familiarity, the authors used manipulations of processing fluency that did not require repeated exposure to the same stimuli. They presented participants with a series of statements such as *Osorno is in Chile* or *Lima is in Peru* printed in various different colors against a white background. Some of the colors contrasted really well with the white background (e.g., dark blue, red)

whereas other contrasted only moderately (e.g., yellow, light blue). A manipulation check showed that more contrasting letter-color/background combinations were processed faster (i.e., more fluently) than less contrasting combinations. The participant's task in the experiment was to decide whether they thought the statement was true. The results revealed that statements presented in highly contrasting letter-color/background combination were more likely to be judged as true than statements presented in moderately contrasting letter-color/background combination. This suggests that perceptual fluency affects judgment of truth independent of frequency of exposure and content. The same effect was found in the domain of linguistic fluency. McGlone and Tofighbakhsh (2000), showed that people judged rhyming aphorisms as more true than their non-rhyming counterparts. They concluded that the fluency associated with the rhyming aphorisms created the impression of truth in the participants.

A similar effect was observed in the domain of conceptual fluency. Begg, Anas and Farinacci (1992) found that easily retrieved propositions were considered more true than the propositions that were difficult to remember. In their experiment, they first presented participants with a series of statements labeled as either true or false. Later, they gave participants a series of statements (including new statements and statements presented previously) and asked them to categorize the statements as either true or false. Results showed that, regardless of the valence of the statements presented previously, old statements were more often categorized as a true statement than new statements.

Effects of processing fluency have also been found in domains such as marketing and consumer behavior. The consumer behavior literature suggests that people use a

number of different cues to weight information about certain products before they make any decision about purchasing it, or before they estimate what they think the product should cost (Payne, Bettman & Johnson, 1993). To explore the possibility that people might use processing fluency as an additional cue for weighing information, Shah and Oppenheimer (2007) asked participants to estimate the price of an MP3 player based on its specifications and a negative consumer review about it. They manipulated the fluency with which the consumer review was presented. In the fluent condition, the review was presented in black 12-point Times New Roman font. In the disfluent condition, the review was presented in grey, 12-point italicized *Monotype Corsiva* font. As expected, participants who read the fluent consumer review provided significantly lower price estimates for the MP3 player than participants who read the disfluent review. These results suggest that people place more weight on information that feels easy to process than in information that is difficult to process.

In a more social domain, Lev-Ari and Keysar (2010) explored the role of processing fluency – and its effect on credibility judgments – in the context of foreign accented speech. Accent, a unique mode of phonetic and phonological realization, can make a statement less intelligible and more difficult to understand (Arslan & Hansen, 1996; Edwards, 1997). Lev-Ari and Keysar (2010) asked native speakers of English to listen to a series of trivia statements such as *Ants don't sleep*, and then indicate the degree of veracity of each statement. Participants listened to statements spoken by both native and non-native speakers of American English. The researchers found that accented speech was reliably rated as less truthful than the native, non-accented counterparts. They

suggested that the accented speech received lower credibility ratings because participants confused the processing difficulty involved in comprehending the accented speech with the level of credibility they attributed to the content of the speech.

Indeed, there is an extensive amount of research showing that accented speech takes longer to be processed (Munro & Derwing, 1995). In consonance with all the previous findings reported so far, it is not unreasonable to assume that accented speech might be judged as less credible, less enjoyable and less truthful simply because they are, in general, processed less fluently. In the next Section, I present a brief review of the literature on the processing of accented speech.

2. Processing of Accented Speech

Accent is defined as the manner of pronunciation that is particular to an individual or group of individuals. More specifically, the term *accent* refers to a unique mode of phonetic and phonological realization that is usually influenced by the speaker's dialect and/or native language (Munro & Derwing, 1995; Edwards, 1997). For instance, for some mid-western speakers in the U.S., the words *cot* and *caught* are pronounced the same. For other people, however, the word *cot* is pronounced as [kɑt] whereas the word *caught* is pronounced as [kɔt]. In the case of accent influenced by a different native/first language, the accent is referred to as *foreign-accented speech*, that is, a non-pathological speech pattern that differs from a native speaker's pronunciation patterns (Munro & Derwing, 1995). In that respect, most non-native speakers of English in the U.S. have some sort of foreign accent (Lev-Ari & Keysar, 2010), that is, their speech shows significant phonological as well as prosodic, rhythmic and intonational variation that is directly influenced by their native language (Lippi-Green, 1997).

There is extensive research showing that non-native accent triggers a variety of negative impressions and judgments about a speaker (Cargile, Giles, Ryan & Bradac, 1994; Giles & Sassoon, 1983; Giles & Coupland, 1991; Dixon, Mahoney and Cocks, 2002; Carlson & McHenry, 2006; Seggie, 1983). Although it is not entirely clear which cognitive mechanisms underlie this phenomenon, there is research suggesting that these negative impressions and judgments have to do with the fluency associated with processing accented speech.

A foreign accent can make a statement less intelligible and harder to understand. The main reason for this phenomenon is that foreign accents cause several changes to the

expected native sound pattern (Arslan & Hansen, 1996). These changes create different intonation and stress patterns, as well as variations in timing and spectral domains, such as frequency (Arslan & Hansen, 1997). In addition, there are substantial changes such as phoneme substitutions, additions and deletions that disrupt comprehension (Floccia, Goslin, Girard & Konopczynski, 2006). These changes impose a cognitive burden for both the listener and speaker (Munro & Derwing, 1995b). For instance, an utterance produced in English by a foreign speaker might not be fully understood by a native speaker of English; or, a foreign listener might have difficulties recognizing and categorizing specific sounds and sound sequences, which in turn might influence their intelligibility of a statement (Flege, 1988). The cognitive and communicative costs associated with recognizing and making sense of foreign-accented speech are, in general, operationalized as time latencies. Generally, foreign-accented segments, words and sentences take longer to process than native accented speech. These costs are also the reason why accented speech is known to be processed less fluently.

The costs associated with processing foreign-accented speech affect two distinct, but related dimensions against which accented speech can be evaluated: intelligibility and comprehensibility. Although they are intrinsically associated, they are believed to offer two distinct ways to evaluate and process accented speech. Intelligibility refers to the extent to which the speech signal of an utterance is recognized. For instance, a person who is not a native speaker of German (and not very fluent at it) might listen to a statement such as *aus den Augen aus dem Sinn* and still be able to transcribe it accurately in terms of the sounds and words that compose the statement. This procedure is a common way to assess speech intelligibility (Barefoot, Bochner, Johnson & von Eigen, 1993): after listening to words or sentences, people are asked to transcribe, in standard orthography, what they heard and this transcription is scored for accuracy, based on

target words or the entire sentence (Lane, 1963; Smiljanic & Bradlow, 2009). The more accurate the transcriptions, the more intelligible the word or sentence is for the listener. This method basically shows that the perceptual signal was processed by the listener.

Comprehensibility, on the other hand, has to do with the listener's perception of the difficulty associated with understanding the content of particular sentences. For instance, the same non-native speaker of German from the previous example can accurately transcribe the sentence *aus den Augen aus dem Sinn* (which shows high intelligibility) but still have the metacognitive feeling that the statement was difficult to understand or process. Usually, comprehensibility is measured by asking participants to rate the degree of difficulty associated with understanding a particular word or sentence (Munro & Derwing, 1995b).

Interestingly, the perceived accentedness of an utterance relates differently with intelligibility and comprehensibility. A foreign speaker might have a strong accent and still be highly intelligible. Similarly, strongly accented speech might be perceived as equally comprehensible in comparison to non-accented speech. Munro and Derwing (1995) asked native speakers of English to hear excerpts of spontaneous speech (in English) produced by speakers of Mandarin. Participants had to rate the degree of comprehensibility (i.e., is the excerpt difficult to understand) and accentedness (i.e., how strong is the foreign accent in the excerpt?) They found that although all the excerpts were rated highly comprehensible, the level of accentedness varied considerably, that is, strongly accented speech does not necessarily reduce comprehensibility.

Munro and Derwing (1995) also measured sentence intelligibility in participants. Using a procedure similar to the one used by Gass and Varonis (1984), they asked participants to write down the sentences produced by non-native speakers and then assigned accuracy scores on the basis of the deviations between the transcripts and the

target utterances. They found that intelligibility also did not correlate with measures of accentedness, suggesting that, similarly to the results for comprehensibility, the perceived level of accentedness of an utterance does not seem to influence intelligibility. Indeed, there is research showing that other aspects of language, such as grammar and vocabulary choice are more likely to influence comprehensibility and intelligibility, as opposed to phonetic and phonological aspects such as pronunciation and intonation (Gynan, 1985; Politzer, 1978; Albrechtsen, Henriksen & Faerch, 1987 and Fayer & Krasinski, 1987). This claim is supported by models models of human language processing that assume that variation in low-level acoustic features plays virtually no role in lexical representations (Lahiri & Marseln-Wilson, 1991). According to these models, the acoustic signal is somehow normalized (i.e., cleaned up) before any lexical mapping is performed (Kolinsky, 1998). Thus, the conceptual mappings that are necessary to process spoken language occurs normally, despite the acoustic discrepancies of foreign-accented speech.

It is worth noting that the majority of the experimental work suggesting that accent, intelligibility and comprehensibility are three different dimensions against which foreign-accented speech can be evaluated has only demonstrated this effect under normal and quiet conditions – i.e., no external noise present (Bent & Bradlow, 2003). In naturalistic situations, however, speech is more likely to occur under adverse listening conditions, such as in noisy places, and where the speech signal is compressed as in radio broadcasts and telephone transmissions. Although a number of studies have demonstrated that the intelligibility of native speech is affected under adverse listening conditions (e.g., Egan, Clarke & Carterette, 1956; Miller & Nicely, 1955), few studies have investigated the masking effects of background noise on the intelligibility of accented speech. The effects of background noise for the intelligibility of accented speech might differ from the

effects of background noise for non-accented speech. There is evidence that background noise affects people's recognition of words presented in synthetic speech (i.e., an artificial production of human speech) more than it affects recognition of words presented in natural speech (Pisoni & Koen, 1981). A similar result was found by Lane (1963) in a study where he presented native speakers of English several words spoken by native and non-native speakers of English. He added different levels of white noise (i.e. signal with a flat power spectral density) to the productions. He found that performance on word recognition was significantly lower for the accented speech as compared to the native speech. This effect was true for all different levels of white noise.

To investigate the effect of noise on native speakers' intelligibility, Munro (1998) presented participants with a set of simple true/false statements (e.g., *Ships travel on the water*) either in quiet or mixed with background noise (e.g., babble speech noise). The sentences were produced by both native speakers of English and native speakers of Mandarin. Participants were asked to assess the truth value of the statements as well as to write down what they heard. Intelligibility scores were assigned to each transcribed sentence by computing the percentage of words in the sentence that were correctly transcribed. The results indicated that the noise had a strong effect on the accuracy of the truth-value of the statements (i.e., participants were more likely to say that a statement like *Ships travel on the water* is false) and on intelligibility only for the accented speech. Although Munro (1998) did not explore the effect of different types and levels of noise, the results allow the conclusion that the effect of noise on the intelligibility of speech is greater for accented speech than it is for native speech.

To explore the interaction between noise and proficiency levels, Rogers, Dalby & Nishi (2004) presented native speakers of English with a list of 50 sentences taken from the Harvard sentence list (Egan, 1948; IEEE, 1969). Each sentence was spoken by both a

native and a non-native speaker of English. There were two levels of proficiency for the non-native speakers: high-proficiency and low-proficiency (measured in terms of their intelligibility in quiet). Then, each sentence speech was mixed with multi-talker babble at three different Sound-to-Noise ratio (SNR): +10dB, 0dB and -5dB (the smaller the dB value, the louder the babble noise.) After listening to the sentences, participants were instructed to write down what they heard. Intelligibility scores were derived from the number of content words transcribed correctly. The authors found that the overall intelligibility scores decreased as noise levels increased. Most interesting, however, was the finding that adding noise affected the accented speech significantly more than it affected the native speech. This pattern of data suggests that even high-proficiency non-native speech is less robust in terms of intelligibility than native speech when presented in the presence of noise.

Although past research has shown evidence that intelligibility, comprehensibility and accentedness are different dimensions against which non-native speech can be evaluated, accented speech, regardless of its level of comprehensibility and intelligibility, is known to take longer to be processed. According to Munro and Derwing (1995b), foreign-accented speech takes more time to be processed due to typicality effects that take place at the level of phonemic processing. Because the sounds produced by a non-native speaker differ considerably from the category prototypes (i.e., they are atypical sounds), they take longer to be recognized and accommodated within the category. Although there is virtually no research directly investigating the role of processing time in the perception of accented speech, Munro and Derwing (1995b) hypothesized that listeners tendency to rate accented speech as less comprehensible is partly due to the processing difficulty experienced by listeners.

To explore this possibility, Munro and Derwing (1995b) used a sentence verification task to assess the effect of accent on processing time and its relation with comprehensibility. They had participants listen to sentences spoken in English by native speakers of English and by native speakers of Mandarin. Participants had to assign true/false values to the sentences as quickly as possible, and also had to rate the level of accentedness and comprehensibility of each sentence. Their results showed robust evidence that accented speech did take more time to be evaluated than the native speech. They also found a significant correlation between different levels of comprehensibility and processing time. More specifically, they found that sentences rated as less comprehensible tended to have higher time latencies (i.e., took longer to be processed) than the sentences rated as moderately or highly comprehensible. On the other hand, they did not find the same relation between different levels of accentedness and processing time. Although, these results are consonant with the idea that comprehensibility and accentedness are two different dimensions, they also show evidence in favor of the idea that accent per se is likely not the dimension that triggers any increase in time latencies for accented speech.

Independently of the aspects of accented speech that might cause the delay in processing, the metacognitive experience of difficulty associated with processing accented speech (i.e. processing fluency) might be what drives the negative attitudes towards speakers who use particular accent.

2.1 Accented Speech and Social Attitudes

Language is more than just a simple collection of sounds, words and sentences detached from any social function. It is a fundamental tool that plays an important role in

the formation and structuring of people's social identity. It can be seen as the most salient cue that triggers the way individuals reason about other people's abilities, beliefs, competence and credibility. The linguistic features that speakers adopt – as well as their performance in terms of the choice of lexical items, intonation patterns, speech rate, and accents – will directly influence the social attitudes of the listener towards them. The social psychological area of research that investigates 'language attitudes' of listeners toward speakers focuses primarily on the attempt to understand people's processing of contextual and situated language use and the subsequent treatment extended to the speakers of such language (Cargile, Giles, Ryan & Bradac, 1994).

Accent is one of the linguistic features that is frequently investigated for the social judgments it triggers. More specifically, studies have shown that listeners express definite and consistent negative attitudes towards speakers who use particular accent. Native speakers exhibit higher levels of irritation, downgrading of attitude, lower credibility and outright discrimination towards people with non-native accents (Munro & Derwing, 1995; Cargile, Giles, Ryan & Bradac, 1994).

Like any other linguistic feature, accent is capable of influencing the listener's judgments and perceptions about several traits of a speaker. Usually it influences judgments associated with competence or status such as intelligence, confidence, guilt, success and fluency (Ryan & Giles, 1982). The social psychological literature on language attitudes provides evidence for the overall idea that listeners evaluate standard, non-accented speech more favorably across these different traits compared to their nonstandard, accented counterparts (Giles & Sassoon, 1983; Giles & Coupland, 1991; Dixon, Mahoney & Cocks, 2002; Carlson & McHenry, 2006). This phenomenon has a profound social impact in the lives of non-native speakers and has been found in several

different social domains such as education, health, employment and even in legal contexts (Seggie, 1983; Dixon, Mahoney & Cocks, 2002; Dixon & Mahoney, 2004).

Seggie (1983), for instance, examined the effects of three different accents (British Received Pronunciation – BRP, Australian-accented speech and Asian-accented speech) on attributions of guilt. Participants, who were speakers of the Australian-accented English, listened to a conversation between a police officer and a criminal suspect pleading his innocence for one of two types of crime: blue collar vs. white collar crimes. After they listened to the conversation, participants were asked to rate the degree to which they thought the suspect was guilty. Seggie found a reliable interaction between the type of crime and the suspect's accent on the participant's ratings of guilt. The Australian-accented suspect was rated as more guilty only if he pleaded his innocence for a blue collar crime (e.g., assault), whereas more guilt was attributed to BRP when the suspect was being accused of a white collar crime (e.g., theft). This result suggests that people make associations of specific types of crimes with specific kinds of accent.

Using a similar methodology, Dixon, Mahoney and Cocks (2002) were interested in investigating whether the effect of two types of accent (the Birmingham accent – also known as "Brummie" and the BRP) on the attribution of guilt would be mediated by race. Similar to Seggie (1983), they had participants – speakers of BRP – listen to a conversation between a police officer and a criminal suspect pleading his innocence for either a white collar crime – fraud – or a blue collar crime – armed robbery. This time, however, they also included information about the race of the suspect (either black or white). The researchers found that accent reliably influenced participant's ratings of guilt, regardless of the type of crime and race. Overall, Birmingham-accented suspects were rated as more likely to be guilty than BRP-accented suspects. They also found a moderate three-way interaction revealing that Birmingham-accented, black suspect committing a

blue collar crime had the highest guilt rating then all the other possible combinations. The results supported the idea that speakers of standard accents benefit from a range of social stereotypes. Interestingly, these researchers also found a positive correlation between participant's ratings of guilt and their general perceptions of the suspect's competence and attractiveness – measured with the Speech Evaluation Instrument, an instrument used to assess general language attitudes (Zahn & Hopper, 1985).

According to the so-called *liberation hypothesis* (Kalven & Zeisel, 1966), external (i.e., non-legal) variables will only influence judgments of guilt if there is not enough relevant evidence for the crime. In the presence of strong incriminating evidence, more attention is given to that evidence and, consequently, extralegal social stereotypes have less of an effect on judgments of guilt (Bodenhausen, 1988). Using a similar procedure as the ones presented previously, Dixon and Mahoney (2004) investigated whether the presence of strong evidence incriminating a suspect would override the effects of accent found in the previous studies. To prime strong evidence, participants were told that "*the suspect had a criminal record and that goods* (for the robbery) *and checks* (for the fraud) *were found in the suspect's home*." For the weak evidence, participants were told that "*the suspect had no prior criminal record and that nothing was found in the suspect's home*." The investigators have also assessed participants' perceptions of criminality by having them rate how typical of a criminal the suspect was and how likely the suspect was to reoffend (Gordon, 1993). Although, contrary to previous findings, accent did not affect attributions of guilt – they also did not find any significant interaction between accent and contextual cues such as type of crime and race – they did find that accent reliably influenced people's perceptions of criminality regardless of all the other variables. Birmingham-accented suspect were viewed as more typical criminals and more likely to re-commit the crime than the BRP suspects.

Although Dixon and Mahoney (2004) did not replicate the previous findings on the effects of accent on attributions of guilt, they did find supporting evidence for the overall idea that individuals tend to evaluate nonstandard accents more negatively than they do with standard accents in terms of other stereotypes. Social psychological research has also found this effect in contexts other than the legal one, such as employability and credibility.

Carlson and McHenry (2006), for instance, had three female confederates play the role of job applicants for a company. The applicants varied in their accent and the dialect they used during the presentation of their qualifications and skills (African American Vernacular English, Spanish-accented English and Asian-accented English). They also varied in the degree of accent (minimally accented speech and maximally accented speech). The content of their speech (brief description of their skills and qualifications) was kept constant across all three applicants. Sixty human resources professionals listened to the descriptions and were asked to rate the degree of employability of each applicant for an entry-level position at their company. Results showed that participants with maximally accented speech received lower employability ratings (with Asian-accented descriptions receiving the lowest ratings). The researchers also found that Asian-accented speech was rated as less comprehensible, suggesting that the low comprehensibility of their speech might have influenced the low employability ratings.

Recent developmental research has suggested that the social attitudes signaled by accent seem to start early in life. Infants, for instance, tend to look longer at people with standard (non-accented) speech, and prefer to reach toys and other objects from people with native accents (Kinzler, Dupox & Spelke, 2007). By the age of 5, children explicitly prefer to play and interact with peers that speak their native language without any sort of accent as opposed to playing and interacting with peers that speak their native language

with a foreign accent (Hirschfeld & Gelman, 1997; Kinzler, Shutts, DeJesus & Spelke, 2009). Research has also found that accent preferences override racial preferences. When presented with silent target children, 5-year-olds preferred to be friends with same-race children. However, they chose other-race children when accent was present, that is, they preferred to be friends with a child from a different race than to be friends with a child that had a foreign accent. This result suggested that accent had a stronger influence than race in children's preferences.

More recently, Kinzler, Corriveau and Harris (2011) showed that preschool-aged children tend to trust native-accented speakers more than foreign-accented speakers, even when both speakers provided non-sense and unreliable information previously. They presented 4 and 5-year-old children with videos of two speakers: a native speaker of English and a Spanish-accented speaker. After each speaker spoke for a few minutes, children were presented with a novel object whose function was unclear. Children were then asked which speaker they would like to ask about the function of the novel object. After that, each speaker silently pantomimed a function for the novel object, and then children were asked which of the two functions they wanted to endorse. They found that children endorsed the function provided by the non-accented speaker reliably more often than they endorsed the function presented by the accented speaker. They also found that children preferred to ask the native speaker about the function of the novel object. This effect was present even when both speakers spoke non-sense speech – still with noticeable accent – suggesting that the effect cannot be attributed to comprehensibility.

Although both the social psychological and developmental research has consistently found that listeners' attitudes towards accented speakers are fundamentally different than their attitudes towards non-accented speakers, the cognitive mechanisms that underlie these outcomes remain largely unexplored and unclear (Dixon & Mahoney,

2004). As seen previously, however, there is no doubt that accented speech entails a variety of communicative costs (Munro & Derwing, 1995). The difficulty of understanding accented speech might directly influence the processing of the information conveyed and, consequently, affect people's affective judgments (Reber, Winkielman & Schwarz, 1998).

Indeed, Lev-Ari and Keysar (2010) attributed their finding that accented speech received lower credibility ratings as compared to native speech to processing fluency. According to them, participants confused the processing difficulty involved in comprehending the accented speech with the level of credibility they attributed to the content of the speech. Although not directly tested, the same might have happened in all other studies presented previously reporting negative attitudes towards foreign accented speakers.

Two intriguing points are worth mentioning at this point. For the first point, let us assume for a moment that it is the case that foreign-accented speech is indeed more difficult to process, therefore, more likely to be judged negatively. The empirical evidence for this effect in the context of accented speech is not as robust as the similar effects found in the context of visual perceptual fluency (see Alter & Oppenheimer, 2008 for an extensive review of these findings.) In fact, except for the study by Lev-Ari and Keysar (2010), virtually all other studies that have explored the effects of processing fluency on cognitive judgments have been done with visual or written stimuli. The second (related) point is that although one might expect the same effects to take place with the auditory stimuli, research on modality differences for memory and comprehension of complex texts suggests that the effects might be different. In fact, auditory presentations lead to a better memory for words, more complex interpretations, and better retrieval from relational cues (Conway & Garthercole, 1987; Carroll &

Korukina, 1999; Markman, Taylor & Gentner, 2007). It is possible that previous work on processing fluency might have underestimated modality differences for this effect. Given that it is generally harder (if not impossible) to backtrack information with spoken language, it is reasonable to think that people will focus more on the conceptual aspect of the message and more rapidly extract information from it – paying less attention to the surface, perceptual information (Gow & Gordon, 1995). In the next Section, I present a review of the work that shows modality differences in the way people process information.

3. Modality Differences in Cognitive Processing

Humans are linguistic beings. We are constantly using language to convey information, acquire knowledge and express our ideas. In formal terms, we do all these using both written and/or spoken language. For example, I can *write* my roommate a note to remind him about taking the trash out or, alternatively, I can just give him a call to *tell* him about the trash. Although people use both written and spoken language quite fluently and automatically, several studies have suggested that different representations are derived when people *read* information as opposed to when they *listen* to the same information. More specifically, there is evidence showing that spoken material leads to a better memory for words (Conway & Gathercole, 1987), better comprehension of complex texts (Carroll & Korukina, 1999), better reasoning about the temporal structure of a text (Jakimik & Glenberg, 1990), less interference of distracting tasks (Margolin, Griebel & Wolford, 1982) and better retrieval of relational information (Markman, Taylor & Gentner, 2007).

Carroll and Korukina (1999), for instance, were interested in the effects of text coherence (*ordered sentences* versus *disordered sentences*) and presentation modality (*written* versus *spoken*) on people's recall of specific elements from a variety of texts. They presented participants with sentences from four short stories about different topics. In the coherent condition, the sentences were arranged as in the original story. In the non-coherent condition, the same sentences were presented, but in random order. The modality manipulation consisted of presenting the sentences printed in cards or presenting the sentences in a cassette player. Two weeks after the presentation of the sentences, participants went back to the lab to answer a series of questions about the

sentences. Among the questions, they were asked to recall certain items (objects) that were mentioned in the sentences. Results showed that both coherence and modality affected the proportion of items recalled two weeks later, that is, participants who heard the sentences recalled significantly more items than participants who read the sentences. The authors concluded that auditory modality improves the encoding of the information, making it more conceptually accessible.

Modality differences can also be observed in the way people understand temporal anaphora (Jakimik & Glenberg, 1990). An anaphor is a deictic expression (i.e., *pro-form*) that refers to another word or expression in a given discourse. Temporal anaphors are expressions that make the reference by mentioning the order in which the expression it refers to appeared in the discourse. The word *former* in (1) is an example of a temporal anaphor as it refers to the last country (of the two) mentioned in the sentence.

(1) Argentina and *Brazil* revive historic tussle. The *former* has better chances to win this time.

The processing of temporal anaphors is particularly challenging because it requires that the person keeps the order of presentantion of the elements in the memory. Jakimik and Glenberg (1990) investigated whether the comprehension of temporal anaphors would be better for discourse presented in the visual format as opposed to discourse presented in the auditory format. They had participants either read or listen to a series of passages containing two types of anaphors: temporal (e.g., *The repertoire of calls includes an excited yodeling sound and a long mournful wail. The first call is given when an intruder comes near the nest*) and semantic (e.g., *The repertoire of calls includes an excited yodeling sound and a long mournful wail. The agitated call is given when an intruder comes near the nest*). Then they measured the proportion of correct responses

participants provided about the correct referent for the anaphor (i.e., *the first call* = *excited yodeling sound*). They showed that participants who heard the passages performed better with the temporal anaphors than participants who read them, The modality effect was not present in the semantic anaphors. Jakimik and Glenberg (1990) explain the findings in terms of the *temporal distinctiveness theory* (Glenberg & Swanson, 1986) which states that there is a distinction between visual and auditory modalities in terms of how people encode temporal information. According to this theory, temporal information presented auditorily is represented more accurately than temporal information presented visually.

An interesting way to investigate how information is processed is by looking at how distracting tasks interfere with information processing. According to a general notion of interference, a distracting task should not interfere with information that is easy to process. Margolin, Griebel and Wolford (1982) investigated the interference of speech-related and non-speech-related distracting tasks on information presented both visually and auditorily. They presented participants with 64 unrelated sentences either visually via a cathode-ray monitor or binaurally via a cassette player. As participants listened (or read) the sentences, they had to perform one of two tasks: (a) count aloud from 1 to 10 or (b) press a button, as quickly as possible after being presented with a mild current shock during the presentation of the sentence. In the test phase, participants were presented with a series of sentences – some of them presented previously – and had to decide whether the sentence was old or new. Results showed that the interference task only affected the recall of the sentences when they were presented visually. More specifically, there was less interference in the sentences that were heard than in the sentences that were read. These results suggested that it is easier to encode auditory information than visual (written) information.

More recently, Markman, Taylor and Gentner (2007) investigated whether auditory presentation leads to a better retrieval of analogical information. Although people are good at retrieving relational information when comparing two stimuli, several studies have shown that retrieval of object similarities is much better than retrieval of relational similarities (Gentner, Ratterman & Forbus, 1993). Markman et al. (2007) suggested that this discrepancy might be a function of the way the information is usually presented. To investigate this possibility, they presented participants with a list containing pairs of proverbs that shared either object or relational similarity. The pairs of proverbs were presented either in the written format (i.e., printed on an index card) or auditorily (i.e., spoken by a female). After the presentation, participants were asked to recall the proverbs. Results showed that a higher proportion of proverbs was recalled for cues with a relational match for spoken proverbs than for written ones. From these findings, the authors suggested that people encode relational information more effectively in auditory material than in written material.

All these findings together suggest that our cognitive system treats auditory information differently than it treats visual or written information. One of the main objectives of the current dissertation is to explore this claim in the context of processing fluency. The next Section presents an overview of the studies that were proposed for the current dissertation.

4. Proposed Experiments

The current dissertation has two related objectives: (1) investigate the effects of processing fluency on cognitive judgments in the auditory modality and (2) directly compare the effects of processing fluency on judgments across the written and auditory modalities.

There is a total of six studies in the dissertation. They are divided into two Sections. Section 5 presents three experiments that explore the effects of processing fluency in the auditory modality. More specifically, they explore (1) whether mixing noise to speech affects judgments of truth (Section 5.1 and Section 5.2) and (2) whether foreign-accented speech also affects cognitive judgments of truth (Section 5.3). Each experiment in Section 5 uses a paradigm similar to Lev-Ari & Keysar (2010), in which they presented participants with various trivia statements and asked them to rate the degree of truthfulness of each statement. If the claim that any type of noise that affects the processing fluency of the speech also affects subsequent credibility judgments is correct, we should observe different credibility ratings between speech presented with noise and speech presented without noise.

Section 6 presents three experiments designed to directly compare the effects of processing fluency on judgments across the written and auditory modalities. The experiment described in Section 6.1 presents participants with both written and auditory stimuli (i.e., trivia statements) that are either easy or difficult to process. Participants are then asked to rate the degree of truthfulness of the statements. The prediction is that if processing fluency affects cognitive judgments no matter what modality the information is present, we should observe the same processing fluency effects across the two different

modalities. On the other hand, consonant with the idea that auditory information is processed differently, processing fluency should only affects cognitive judgments in the written modality. Section 6.2 describes a similar experiment but explores a different cognitive judgment (intention to purchase a product). Section 6.3 describes an attempt to trigger effects of processing fluency in the auditory modality. For this study, people are presented with audio material in both native and non-native speech. Previously to listening to the audio material, people are primed with either foreign words or English words. The prediction is that if reading foreign words makes the perceptual characteristics of the input more salient, then subsequent judgments should be affected by the processing fluency manipulation.

5. Processing Fluency Experiments

The study by Lev-Ari and Keysar (2010) suggested that the processing difficulty associated with understanding non-native accented speech influenced the level of credibility participants attributed to the content of the speech. If accent is only affecting the processing difficulty and is not conveying any other type of processing bias, one would expect that any type of signal that makes speech difficult to be processed should have an effect on subsequent affective judgments. For instance, if a statement is spoken in a very noisy environment – that presumably makes it harder to be processed – that statement should be viewed as less credible, just as the statements spoken by a non-native speaker are. The studies presented in this Section aimed at investigating this possibility.

5.1 White Noise and Credibility Judgments

Participants

Twenty-six native speakers of English participated in this experiment. Participants were undergraduate students at The University of Texas at Austin and participated for course credit.

Materials

A female native English speaker recorded 70 trivia statements such as *A rat can last longer without water than a camel* in a sound-attenuated booth (See Appendix A). To obtain equivalent overall amplitude levels for all statements, the sound files were equated for Root Mean Square (RMS) amplitude. To manipulate the perceptual difficulty associated with the speech, each sound file was mixed with white noise (i.e., noise with a

flat power spectral density) at a four different Sound-to-Noise Ratio (SNR): Level 0 corresponded to +17dB SNR (68dB for the speech signal and 51dB for the noise), Level 1 corresponded to +12dB SNR, Level 2 to +6dB SNR and Level 3 corresponded to 0dB SNR (the smaller the SNR, the noisier the signal.) All the mixed files were presented to participants using the software *E-prime 2.0*. To ensure the validity of the noise manipulation, an additional set of 24 native speakers of English rated the difficulty associated with each noise level for each trivia statement. Overall, the mean perceived difficulty across the four different noise levels suggested a main effect of noise level (see Figure 3, plot on the left). This effect was statistically reliable, $F(4,80) = 60.59$, $p < .0001$.

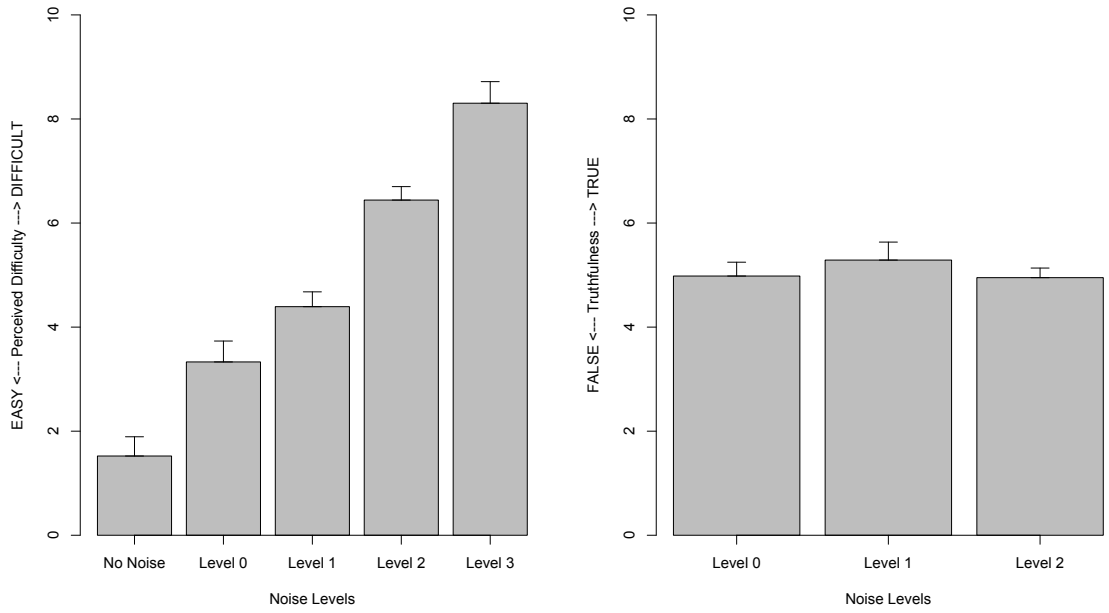


Figure 3: Perceived Difficulty (plot on the left) and Truthfulness Ratings (plot on the right) as a Function of Noise Levels.

Procedure

Participants sat in front of a computer screen with headphones on. They listened to each statement and were asked to rate the degree to which they believed the statement – using a *Likert* scale ranging from 1 (false) to 10 (true). Participants were also asked to indicate whether they knew for a fact that the statement was true. As the statements with Level 3 noise were rather difficult to understand (M = 8.3, SD = 1.89), I decided to exclude this level of noise from the present pilot study. Also, to avoid suspicion about the noise manipulation (by having some statements with noisy backgrounds and others with silent backgrounds), the minimum noise level used was Level 0.

Results

Contrary to the prediction, results showed that although the addition of background noise did make the speech more difficult to understand, it did not affect the truthfulness judgments. The mean truthfulness ratings were very similar across all three different levels of noise (Figure 3, plot on the right), $F(2,50) = .81$, $p = .45$. The next experiment was performed to test the same hypothesis, that is, that any type of signal that makes speech difficult to be processed should have an effect on subsequent affective judgments, but this time using a more pragmatic type of background noise: babble speech.

5.2 Multi-talker Babble Noise and Credibility Judgments

Participants

Twelve native speakers of English participated in experiment. Participants were undergraduate students at The University of Texas at Austin and participated for course credit. None of the participants from the previous experiment participated in this one.

Materials

The same 70 statements used in the previous experiment were used for the present experiment. The speech files were mixed with multi-talker speech babble. The speech babble was constructed out of the speech of six different people superimposed using *Audacity 1.3.13-beta*. To ensure that the babble noise did not contain understandable linguistic material, three of the files used were played backwards. Three research assistants listened to the speech babble file and indicated they could not identify any word or phrase. Each statement was mixed with the speech babble noise at a four different SNR's: Level 0 (+17dB SNR), Level 1 (+12dB), Level 2 (+6dB) and Level 3 (0dB SNR). To ensure the validity of the noise manipulation, a different set of 13 native speakers of English rated the level of difficulty associated with processing each statement. As before, there was a reliable main effect of noise level, $F(4,48) = 24.80$, $p < .0001$ (Figure 4, plot on the left), suggesting that the noise manipulation was indeed effective.

Procedure

The procedure was identical to the previous experiment.

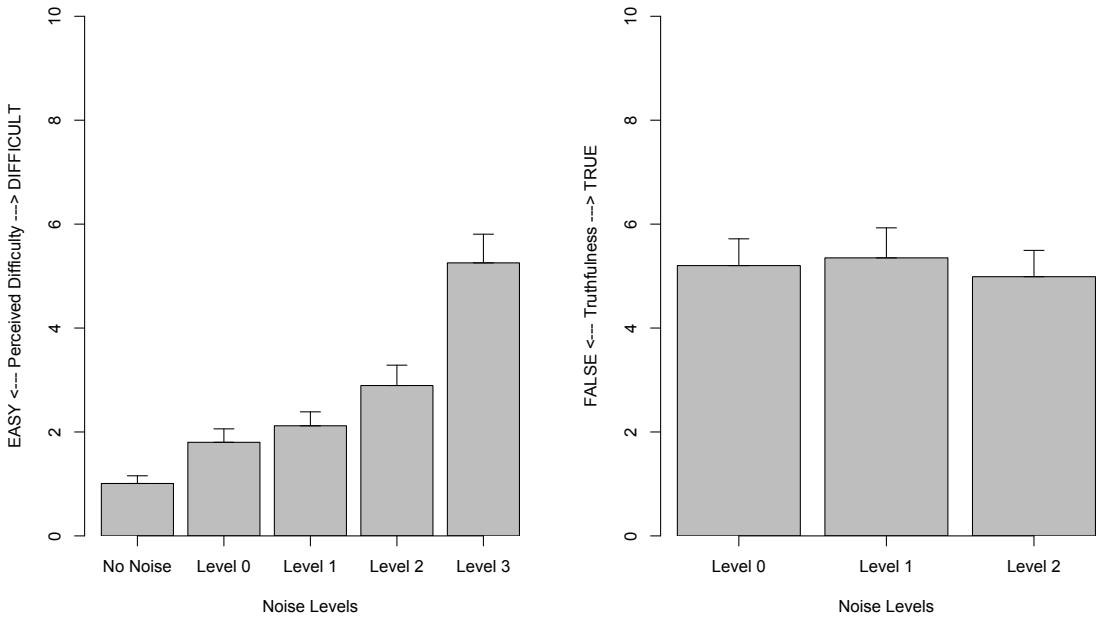


Figure 4: Perceived Difficulty (plot on the left) and Truthfulness Ratings (plot on the right) as a Function of Noise Levels.

Results

Once again, contrary to the main prediction, the results showed that the speech babble noise did not affect the truthfulness judgments of the trivia statements. The mean truthfulness ratings was very similar across all three different levels of noise, $F(2,22) = .14$, $p = .86$ (Figure 4, plot on the right). The next experiment was a direct replication attempt of Lev-Ari and Keysar (2010), that is, it was an attempt to investigate whether accented speech is, in fact, harder to process and influence judgments of truth.

5.3 Accented Speech and Credibility Judgments

Participants

Sixty-five native speakers of English participated in this experiment. Participants were undergraduate students at The University of Texas at Austin and participated for course credit. None of the participants from the previous experiments participated in this one.

Materials

A female native English speaker, two female native speakers of Brazilian-Portuguese and two female native speakers of Korean recorded the same 70 trivia statements used in the previous experiments. A separate pool of participants rated the degree of accentedness of the non-native speakers. Results showed that the non-native speech was significantly perceived as accented as compared to the native speech (Figure 5, plot on the left).

Procedure

To test for the effect of accent on credibility judgments, participants sat in front of a computer and listened to 48 trivia statements in English. Sixteen of these statements were spoken by a native speaker of Brazilian-Portuguese, 16 by a native speaker of Korean and 16 by a native speaker of English. All statements were recited in English. After listening to each statement, participants were asked to (a) indicate how likely they were to believe that the statement was true. indicate whether they knew for a fact the statement is true and (b) indicate whether they knew for a fact the statement was true. For the truthfulness rating, participants used a *Likert* scale ranging from 1 (definitely false) to 10 (definitely true). To reduce suspicion about the main objective of the study and the prominence of foreign-accented speech, each participant heard additional 20 fillers statements read by two additional native speakers of English. Each participant heard a total of 70 trivia statements.

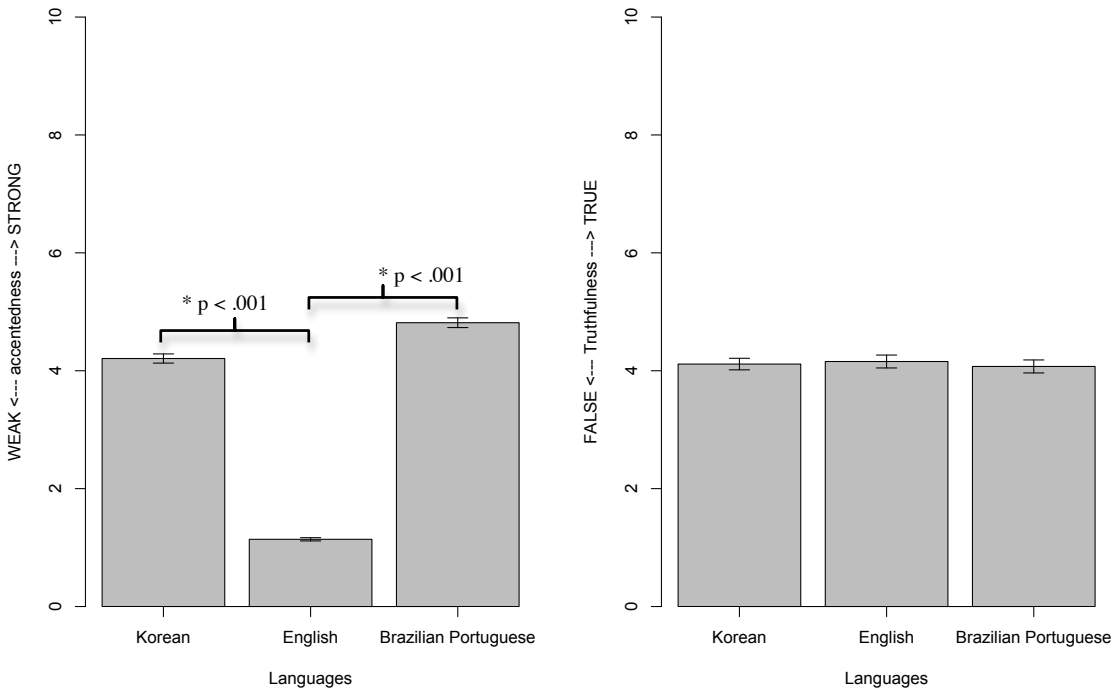


Figure 5: Perceived Accentedness (plot on the left) and Truthfulness Ratings (plot on the right) as a Function of Language.

Results and Discussion

The present experiment failed to replicate the effects of accentedness on credibility judgments reported by Lev-Ari and Keysar (2010). There was no reliable effect of language (foreign accent) on the truthfulness ratings, $F(2,128) = .18$, $p = .83$ (Figure 5, plot on the right). These results along with other three additional studies (see Appendix C for details) suggest that the effects of processing fluency might be modality specific. In a way, the results of these studies conceptually replicate previous findings suggesting that auditory information is less susceptible to the influence of distractors or signal degradation (Gardiner & Gregg, 1979). To this date, there is no study that directly

compares the effects of processing fluency across different modalities. The next set of experiments addresses this comparison.

6. Modality Differences Experiments

I designed three experiments to investigate modality differences associated with the effects of processing fluency on cognitive judgments. The main objective of Experiment 1 was to investigate whether processing fluency has different effects on judgments of truth in the written versus the auditory modality. Participants were asked to either read or hear trivia statements that were either fluent (i.e., easy to read or listen) or disfluent (i.e., difficult to read or listen) and report the degree to which they believed the statement. The hypothesis is that, if fluency of processing has the same effect on judgments of truth in both the written and auditory modality, the truthfulness ratings should be affected by fluency of processing across modality. However, if fluency affects only one modality, an effect of processing fluency should not be observed across both modalities.

6.1 EXPERIMENT 1

Participants

Fifty-six native speakers of English participated in Experiment 1. Participants were undergraduate students at The University of Texas at Austin and participated in the study for course credit.

Materials

The experiment consisted of the same trivia statements used in the studies presented in the previous Section. For the auditory modality, two female speakers – a native speaker of English and a native speaker of Brazilian-Portuguese – recorded 70 trivia statements such as *A rat can last longer without water than a camel* (See Appendix A). The recording took place in a sound-attenuated booth at The University of Texas

Sound Lab in the Department of Linguistics. The speakers read the statements into a microphone and the speech was recorded directly to disk at 24 bit accuracy using an Apogee PSX-100 A/D D/A converter at a sampling rate of 16 kHz. To obtain equivalent overall amplitude levels for all statements across the two speakers, the sound files were equated for RMS amplitude.

There were two different manipulations of processing fluency for the auditory modality. One of them consisted of mixing multi-talker babble speech noise at 0dB SNR. The multi-talker babble speech was constructed out of six different speakers using *Audacity 1.3.13-beta*. To insure that there was no recognizable word or phrase in the multi-talker babble speech, three research assistants (blind to the manipulation) listened to the files and indicated that they could not identify any isolated word or phrases. The other manipulation of processing fluency consisted of presenting the statements spoken with a foreign accent. To ensure that both fluency manipulations did indeed influence processing fluency, I normed the stimuli by asking a different set of participants to rate the degree of difficultness – in a scale ranging from 1 (easy) to 10 (difficult) – of the statements mixed with noise and the statements spoken by a non-native speaker. The statements with noise had a mean difficultness rating of $M = 5.25$ ($SD = 2.52$) and the statements spoken by the non-native speaker had a mean difficultness rating of $M = 5.45$ ($SD = 1.60$).

To manipulate the perceptual fluency associated with the written modality, the statements were presented in black 12-pt Times New Roman font with a white background (for the fluent condition) and in purple 12-pt **Haettenschweiller** font with a blue background (see Figure 6). Several previous studies (Alter & Oppenheimer, 2008; Novemsky, Dhar, Schwarz & Simonson, 2007; Reber & Zupanek, 2007; Reber & Schwarz, 1999) have used this type of font/background manipulation. All of them

consistently showed that the Times New Roman font was perceived as easier to process than the Haettenschweiller variation.

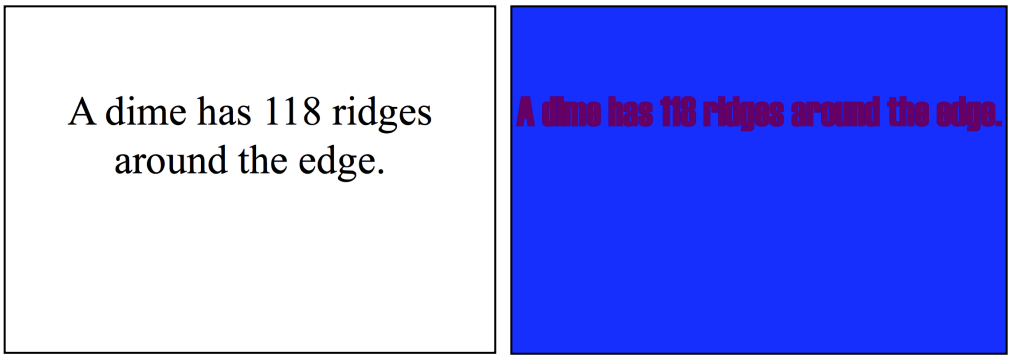


Figure 6: The written modality fluency manipulation.

Procedure

The experiment used a between-subject design. Participants were randomly assigned to one of five conditions: (1) audio-fluent, (2) audio-disfluent-noise, (3) audio-disfluent-accent, (4) written-fluent and (5) written-disfluent. In all conditions, the statements were presented to participants using the software *E-prime 2.0*. Participants were told that the experiment was about knowledge assessment. Each participant sat in front of a computer screen with headphones. The instructions of the experiment read (according to the condition to which the participant was assigned): "*In this experiment, you will listen/read to a series of statements. You need to listen/read to each statement carefully. Your job is to indicate the truthfulness of each statement. You can indicate any number between 0 (definitely true) and 7 (definitely false)*". After listening (or reading) each statement, participants were presented with a screen asking them to rate the degree of truthfulness of the statement.

Results and Discussion

Given the nature of the instructions, in the subsequent analysis, the higher ratings mean less trustworthiness: the higher the bars in the graphs, the less the participants trusted the statements in that condition. As expected, participants in the written-fluent condition (i.e., who read the fluent statements) trusted the statements reliably more (M = 3.76, SD = .49) than participants in the written-disfluent condition (M = 4.31, SD = .50), $t(26) = 2.91$, $p < .01$, Cohen's $d = 1.14$. However, the same effect was not reliable in the auditory modality for the noise manipulation nor for the accent manipulation (see Figure 7). These results suggest that processing fluency in the auditory modality did not influence truthfulness ratings the same way it does in the written modality. Indeed, there was a marginally significant interaction between modality and processing level, $F(1,53) = 3.91$, $p = .053$, $r^2 = .18$.

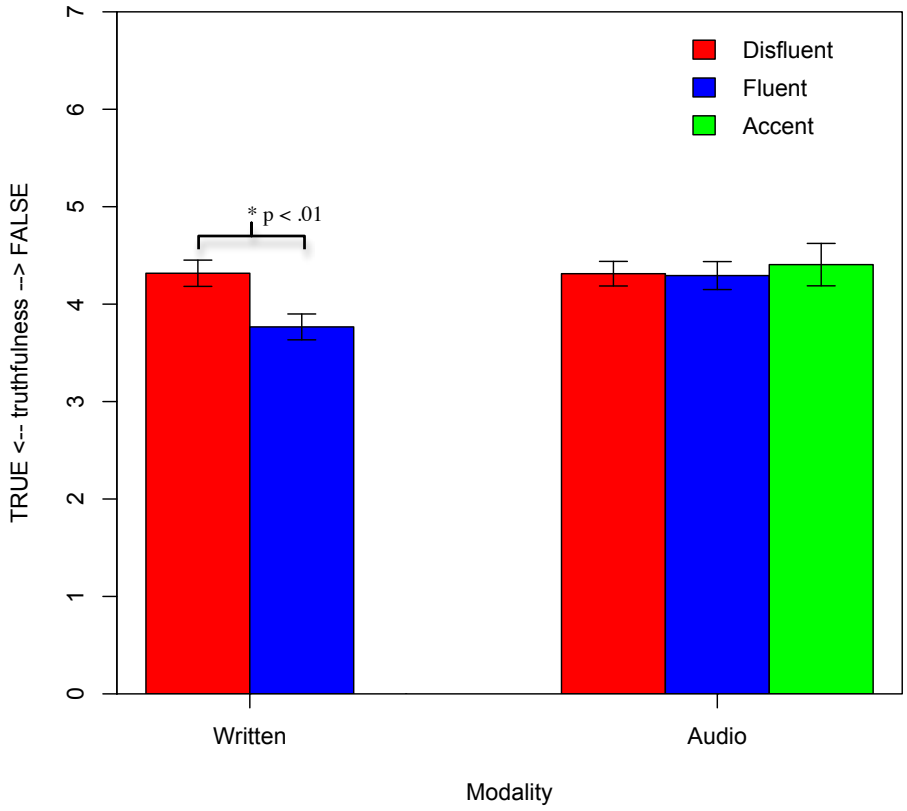


Figure 7: Truthfulness ratings as a function of Modality and Processing Level for the Noise Manipulation.

The results of the direct comparison between the written-fluent and written-disfluent are consonant with several previous studies showing that disfluency associated with written material affects subsequent evaluative judgments of truth, regardless of the declarative information. The absence of the same effect on the auditory modality suggests that the auditory information is being processed differently, so that the presence of signal deterioration is not affecting subsequent cognitive judgments.

6.2 EXPERIMENT 2

The results of Experiment 1 suggested that the effects of processing fluency on evaluative judgments is modality-specific. To further explore this possibility with a different cognitive judgment, Experiment 2 investigated the effects of processing fluency on people's purchase decisions. Shah and Oppenheimer (2007) showed that people use processing fluency as a basis for weighting cues to make particular decisions about product features and price, that is, people place more weight on information that feels easy to process. Following a similar procedure, in Experiment 2, I investigated the possibility that this effect is specific to the written modality. To test this possibility, participants were shown a series of negative consumer's reviews about a variety of products. The reviews were presented in either the written or the auditory modality. The processing level was manipulated by presenting the reviews printed in a disfluent font (for the written condition) or from a non-native speaker (for the auditory condition). The font manipulation was similar to the one used in Experiment 1. Participants were asked to report their intention to purchase the product (Chang & Wildt, 1994). If the effects of processing fluency is modality specific, I expect participants to be less willing to purchase the products when presented with the disfluent font but not with the disfluent (foreign-accented) speech.

Participants

Sixty-five native speakers of English participated in Experiment 2. Participants were undergraduate students at The University of Texas at Austin and participated in the study for course credit. None of the participants from Experiment 1 participated in Experiment 2.

Materials

A female native speaker of English and a female native speaker of Brazilian-Portuguese recorded negative reviews for six different products (see Appendix B). As before, the recording took place in a sound-attenuated booth and the speech was recorded directly to disk at 24 bit accuracy using an Apogee PSX-100 A/D D/A converter at a sampling rate of 16 kHz. Again, to obtain equivalent overall amplitude levels for all recordings across the two speakers, the sound files were equated for RMS amplitude.

To ensure that the non-native speech was indeed perceived as disfluent (i.e., difficult to understand), a different set of participants rated the degree of difficultness of the auditory reviews using a scale ranging from 1 (easy) to 7 (difficult). The non-native speech was perceived as reliably more difficult (M = 4.54, SD = 1.53) than the native counterpart ($M = 1.00, SD = 0$), $t(23) = 11.32, p < .0001$.

The same procedure to manipulate the perceptual fluency associated with the written modality in Experiment 1 was used in Experiment 2.

Procedure

Participants were randomly assigned to one of four conditions: (1) audio-fluent, (2) audio-disfluent, (3) written-fluent and (4) written-disfluent. The experiment consisted of 12 trials (six experimental trials). In each trial, participants were presented with a series of specifications about a product (e.g., *this camera has 14.0 megapixels of resolution*). The specifications were constant across conditions. Following the presentation of the product specifications, participants either read or listened to (depending on the experimental condition) a negative customer review about the product. After listening to the negative review, participants were asked to respond to two questions aimed at assessing participants' intention to purchase the product (Chang & Wildt, 1994). See Figure 8 for the structure of a single trial.

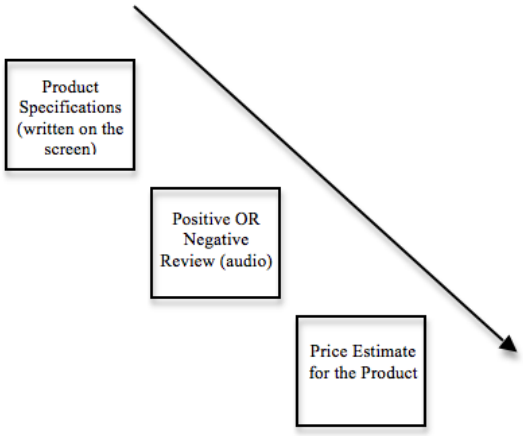


Figure 8: The Structure of a Single Trial in Experiment 2.

Each participant sat in front of a computer screen with headphones on. The instructions of the experiment read (according to the condition to which the participant was assigned): "*In this experiment, you will read a series of product specifications. Read them very carefully. After reading the product specifications, you will listen/read to a consumer review about the product. You need to listen/read to each review very carefully. After listening/reading the review, you will be asked to answer some questions about the product*. After listening (or reading) each review, participants were presented with a screen asking (1) *how probable are you to purchase this product?* And (2) *how possible are you to purchase this product?* They answered the questions using a Likert scale ranging from 1 (improbable/impossible) to 7 (probable/possible). For all the conditions, the specifications and reviews were presented to participants using the software *E-prime 2.0*.

Results and Discussion

Following the procedure used by Chang and Wildt (1994), the intention to purchase score was calculated by averaging the individual scores for the two questions presented to participants (the *probable* and the *possible* questions). As in Experiment 1, participants in the written-fluent condition (i.e., who read the fluent negative reviews) were reliably less willing to purchase the products (M = 3.10, SD = 1.53) than participants in the written-disfluent condition (M = 4.24, SD = 1.81), $t(31) = 1.92$, $p < .05$, one-tailed, Cohen's $d = .68$. On the other hand, the processing fluency manipulation did not affect the intention to purchase when the reviews were presented in the auditory modality (see Figure 9).

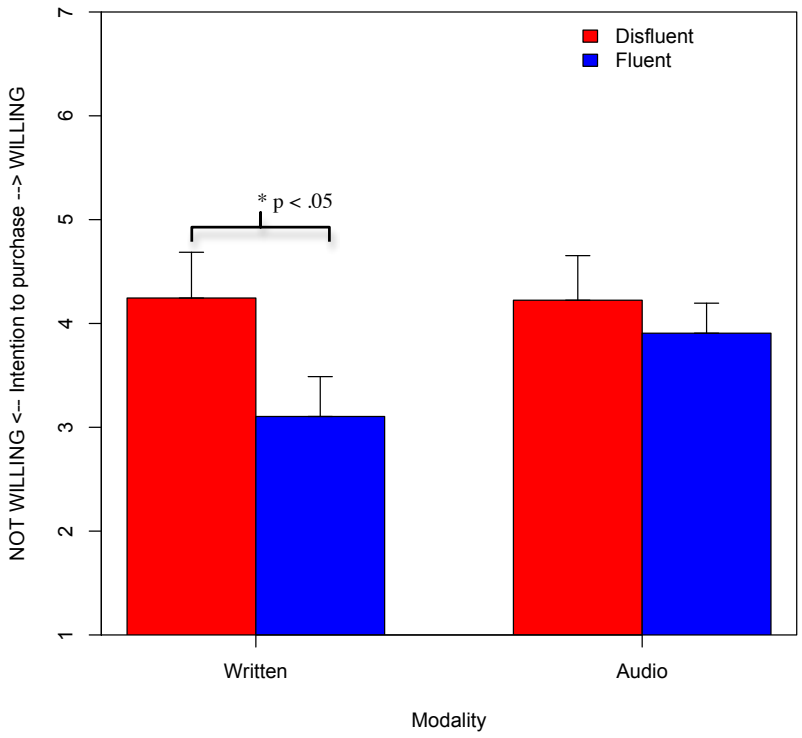


Figure 9: Intention to Purchase as a Function of Modality and Processing Level.

As in Experiment 1, the results suggest that the effects of processing fluency on cognitive judgments is modality-specific.

6.3 EXPERIMENT 3

The results of Experiment 1 and Experiment 2 suggested that the effects of processing fluency on evaluative judgments is modality-specific. In general terms, this finding can be explained by the normalization hypothesis (Lahiri & Marslen-Wilson, 1991). According to this hypothesis, prior to processing conceptual information, the acoustic signal is cleaned of all disturbing noise resulting in a normalized representation of the speech signal. Floccia et al. (2006) showed that accent normalization is typified by an initial temporary perturbation in speech processing which becomes evident after only a certain amount of time. This suggests two possibilities: (1) that people get used to accented speech and noisy signal really fast and therefore any perturbation to the signal is later ignored and (2) this process is automatic so that people just do not pay close attention to perceptual characteristics of speech signal. In the case of accented speech, because people normalize the representation of the foreign sounds they hear, the difficulty associated with producing a foreign sound is not processed. If this is the case, priming people to attend to the acoustic features that make a foreign sound difficult to process will make them "notice" the difficulty associated with the foreign speech and we should, therefore, observe the effects of processing fluency on cognitive judgments. Experiment 3 explores this possibility by priming people to simulate the perceptual difficulty involved in producing a foreign language. The hypothesis is that people will be implicitly more tuned to the superficial characteristics of the speech signal and will, therefore, be affected by the processing fluency.

Participants

Forty-eight native speakers of English participated in Experiment 3. Participants were undergraduate students at The University of Texas at Austin and participated in the study for course credit. None of the participants from Study 1 and Study 2 participated in Study 3.

Materials

The same 70 trivia statements used in Experiment 1 were used in Experiment 3. To manipulate processing fluency, the statements were presented either with a foreign accent or with a native accent mixed with white noise at 0dB SNR. To prime the difficulty associated with producing a foreign language, a list containing 32 words in Brazilian Portuguese was created. All the words in the list contain at least one sound that is not part of the English sound system. Also, the list was carefully created to avoid any sort of semantic priming of the trivia statements. In addition, a list containing the same words in English was created to function as a control (see Appendix E).

Procedure

Experiment 3 was a 2 (prime: foreign words vs. native words) by 3 (processing level: fluent vs. disfluent vs. accent) between-subject design. Participants were randomly assigned to one of six conditions. The overall procedure was similar to Experiment 1, with the exception that, in Experiment 3 participants were asked to read a list of words out loud before starting the experiment. Participants in the foreign-words conditions received a list with 32 words written in Brazilian Portuguese and were asked to read the words out loud so that they could be recorded. Participants in the native-words conditions received a list with 32 words in English and received the same instructions. After the priming procedure, participants listened to each statement and were asked to rate the degree of truthfulness of the statement using a rating scale ranging from 1 (true) to 7

(false). For all the statements were presented to participants using the software *E-prime 2.0*.

Results and Discussion

Experiment 3 explored the possibility that priming people to simulate the perceptual difficulty involved in producing a foreign language would make them implicitly aware of the superficial characteristics of the signal and would, therefore, affect their truthfulness ratings. Participants primed with foreign words rated the accented statements as reliably less true than the fluent statements, $t(8) = 2.29$, $p < .05$, one-tailed, Cohen's $d = 1.62$ (see Table 1). On the other hand, the foreign-word prime did not affect the truthfulness ratings of the statements mixed with noise (see Figure 10).

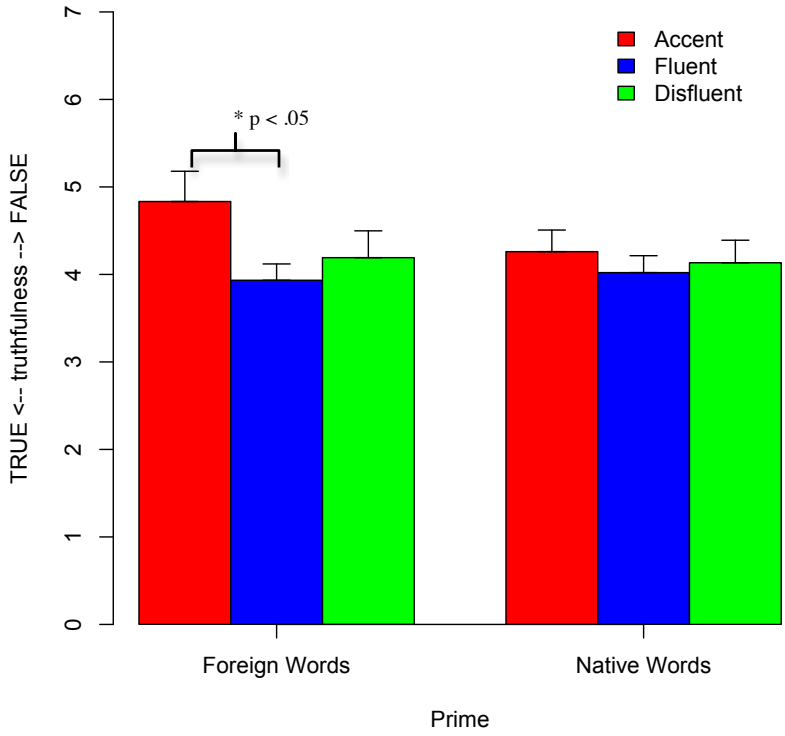


Figure 10: Truthfulness Ratings as a Function of Prime and Processing Level.

	Foreign Words	*Native Words*
Accent	4.83 (.77)	4.26 (.60)
Fluent	3.93 (.41)	4.02 (.43)
Disfuent	4.19 (.68)	4.13 (.57)

Table 1: Mean Truthfulness Ratings (Standard Deviations in Parenthesis).

Results of Experiment 3 showed that when primed to difficulty of producing a foreign accent, people's judgments of truth are affected by processing fluency. Because the priming did not affect the judgments of truth for the speech presented with noise, the results cannot be explained by the idea that having people pronounce foreign words primed them to have an overall processing difficulty bias. The results suggested that the priming tackled on some process that is language-specific.

7. General Discussion

Fluency of processing is defined as the perceived ease with which one extracts information from stimuli, and affects a variety of cognitive processes over and above the influence of declarative content (Alter & Oppenheimer, 2009). This influence has been extensively demonstrated in a variety of different domains (Alter & Oppenheimer, 2008; Jacoby & Whitehouse, 1989; Koriat, 1993; Reber, Winkielman & Schwarz, 1998; Reber & Schwarz, 1999; Whittlesea, Jacoby & Girard, 1990; Unkelbach, 2007; Winkielman & Cacioppo, 2001). However, all these demonstrations used exclusively written or visual stimuli. Except for Lev-Ari and Keysar's (2010) study which investigated attributions of credibility to foreign-accented speakers, no other study has explored effects of processing fluency on cognitive judgments with auditory materials. Because foreign accents – a unique mode of phonetic and phonological realization – cause several changes to the expected native sound pattern, they are harder to understand (Arslan & Hansen, 1996). A similar phenomena occurs when native speech is produced in adverse conditions. There is ample evidence demonstrating that the presence of background noise affects people's recognition of words because it makes speech harder to understand (Pisoni & Koen, 1981). Given this evidence, the goal of the current studies was to investigate the effects of processing fluency on cognitive judgments using auditory stimuli.

To do this, I presented native speakers of English with several trivia statements spoken by (1) native speakers of English in quiet, (2) non-native speakers of English and (3) native speakers of English in adverse conditions (i.e., in the presence of white and babble speech background noise). Following Schwarz's (2004) claim that any mechanism or tool that increases the degree of processing fluency has an effect on later judgments,

the primary prediction was that any type of distortions to the auditory signal (i.e., accent and the presence of background noise) would make the signal harder to process and, consequently, would affect cognitive judgments of truth.

The findings were consonant with the first part of the prediction, that is, the presence of white noise and babble speech noise made the statements significantly harder to understand than the statements spoken in quiet. This finding confirms several studies showing that processing speech in adverse conditions imposes an extra cognitive burden on listeners (Lane, 1963; Munro, 1998). Also, the foreign-accented speech was found to be significantly harder to understand than the native speech counterpart. This is also consistent with previous studies showing that people take longer to process foreign-accented speech than native accented speech (Munro & Derwing, 1995).

However, contrary to the second part of the prediction, the disfluency associated with the noisy speech and the foreign-accented speech did not influence participants judgments of truth. These findings represent a direct failure to replicate the finding of Lev-Ari & Keysar (2010) who showed that people judged trivia statements as less true when spoken by non-native speakers. They suggested that people misattribute the processing difficulty associated with understanding foreign-accented speech to reduced credibility. Because I directly investigated several other ways to manipulate processing fluency (other than just accent) and yet found no effect on cognitive judgments, our findings suggest that Lev-Ari and Keysar's (2010) conclusion might be incorrect.

Interestingly, the pattern of results of the current dissertation can be explained in terms of the kinds of masking (*energetic* versus *informational*) that accent and noise causes to the speech.

7.1 ENERGETIC VERSUS INFORMATIONAL MASKING

The psycholinguistics literature has shown that listeners process intact speech (i.e., noise-free) by relying primarily on lexical-semantic information and paying less attention to sub-lexical, acoustic features of the speech. Adults use sub-lexical cues only when the lexical-semantic information is ambiguous or absent (Gow & Gordon, 1995; Mattys, White & Melhorn, 2005; Norris, McQueen & Cutler, 1995).

The weights attributed to lexical-semantic and to sub-lexical categories change when speech is processed in adverse conditions. Mattys, Brooks and Cooke (2009) coined a useful distinction between adverse situations that lead to *energetic masking* and adverse situations that lead to *informational masking*. Energetic masking (also known as *perceptual masking*) occurs when there is a degradation of the acoustic signal in shared spectro-temporal regions. Because the energy of a speech signal is concentrated in a few spectro-temporal regions of high informational value, if masking takes place in other regions, little impact on speech processing will be observed (Cooke, 2006). On the other hand, informational masking (also known as *conceptual masking*) occurs when there is a reduction of speech intelligibility even after any energetic masking has been accounted for (Cooke, 2006). Generally, informational masking refers to distractions that directly competes with the listener's attentional resources when processing the speech (e.g., the presence of an unrelated task.)

Several studies on speech processing and speech segmentation (Mattys et al., 2005; Mattys et al., 2009; Mattys, Carroll, Li & Chan, 2010) have demonstrated that depending on the type of masking (energetic or informational), people will attend to different cues to process and segment the speech. More specifically, energetic masking (e.g. white noise) tends to favor the listener's reliance on lexical-semantic information

whereas informational masking tends to favor the listener's reliance on sub-lexical, acoustic information. Related to our current findings, it might be that the presence of white noise (i.e., energetic masking) made our participants focus closely on the conceptual aspect of the message other than the acoustic features. Therefore, instead of producing a metacognitive feeling of disfluency, the presence of the white noise made it easier for people to focus on the declarative information of the speech.

According to Mattys et al. (2009), babble speech noise might function as an informational masking (i.e., it might function as a direct competitor for attentional resources). One might argue that if informational masking triggers listeners to focus on the acoustic features of the speech, the current babble speech manipulation should have made people more tuned to the noise itself. However, the speech babble in our study was formed by 6 different speakers. There is evidence that the larger number of speakers in the mask, the less informational masking they cause (Van Engen & Bradlow, 2007). This suggests that in the current study, the babble speech manipulation might have functioned as energetic masking as did the white noise manipulation.

Although foreign-accented speech is harder to process, it does not necessarily mask the speech signal the same way white noise does. Therefore, despite the acoustic differences between native and non-native speech, it might be that people process foreign-accented speech similarly to native speech when it comes to the cues they use to segment the speech, that is, they segment the speech by relying primarily on lexical-semantic information (Mehler, Dommergues & Frauenfelder, 1981). Another alternative is linked to the evidence that listeners normalize accented speech before engaging in any sort of conceptual processing with the content of the speech (Lahiri & Marlsen-Wilson, 1991; Floccia, Goslin, Girard & Konopczynski, 2006). According to this view, the acoustic signal is cleaned of all distortions and deviant information and a "clean" signal is

processed instead. This normalization process happens after short periods of exposure to accented speech. In fact, there is evidence that after sufficient information on the accent is gathered, comprehension strategies return to baseline levels (Floccia, Goslin, Girard & Konopczynski, 2006), making people less tuned to the acoustic properties of the signal. It is possible that the participants in our study normalized the accented speech after a short period of exposure and then neglected to attend to sub-lexical acoustic features of the speech.

7.2 Auditory Versus Written Modalities

The findings of our first set of studies are consistent with research on modality differences. These studies suggest that people process auditory information differently than they process visual or written information (Conway & Gathercole, 1987; Markman, Taylor & Gentner, 2007). Two experiments investigated the possibility that disfluency associated with information processing only affects judgments of truth (Experiment 1) and the intention to purchase a product (Experiment 2) when material is presented in written format. Because the results of our previous studies suggested that disfluency did not affect cognitive judgments with auditory material, the prediction was that the visual signal degradation, but not auditory signal degradation, would affect participants' cognitive judgments of the same declarative content.

Consistent with the main prediction, in the current study participants who read the trivia statements in a more difficult-to-process font judged the statements as less true than participants who read the statements printed in an easy-to-read font. On the other hand, participants who listened to the same trivia statements either spoken by a non-native speaker or mixed with babble speech noise did not judge the statements as less true. The

same overall pattern was observed with a different measure: the intention to purchase. Participants who read a negative consumer review presented in a disfluent font weighted the review less heavily than participants who read the same consumer review in a fluent font.

Together these results support the idea that auditory information is processed differently than visual written information. The findings, along with related evidence from psycholinguistic research (Gow & Gordon, 1995; Mattys, White & Melhorn, 2005; Norris, McQueen & Cutler, 1995), add to the body of research that suggests that auditory presentation promotes greater focus on conceptual information in comparison to the greater focus on perceptual, surface information promoted by written presentation. This is consistent with Markman, Taylor and Gentner (2007) who found that participants attended more to relational information when exposed to auditory material than when exposed to written material.

It is possible that this difference in focus would lead people to discount the presence of distracting information on the auditory signal and process the declarative content regardless of the quality of the signal. One explanation for this phenomenon is that people are more used to extracting conceptual information from spoken discourse than from written discourse (Clark, 1996) which is supported by evidence showing that two people are more likely to arrive at a shared understanding about a topic when communicating with spoken language instead of with written language (Horton & Gerrig, 2005; Markman, Taylor & Gentner, 2007). The current finding is also in line with research showing that distracting information interferes more with reading than with listening tasks (Levy, 1977; Margolin, Griebel & Wolford, 1982).

7.3 PRIMING ACOUSTIC FEATURES

Because people tend to pay less attention to the acoustic features of auditory information before engaging in conceptual processing (Lahiri & Marslen-Wilson, 1991), distortions to the superficial features of the speech signal have limited impact on how people process the conceptual content of the information. As mentioned before, several studies have suggested that listeners are more likely to rely on lexical-semantic than sub-lexical information when processing speech. It is reasonable to speculate that, if people are primed to attend to the difficulty associated with foreign-accented speech, they might focus on the acoustic features of the speech, and not only the content, so will be more affected by the difficulty of processing it. To explore this possibility, in Experiment 3, I primed participants to attend to the superficial features of foreign-accented speech by having them read a list of foreign words. The prediction was that by attending to the perceptual features of foreign-accented speech, participants' subsequent judgments of truth would be affected because they would incorporate the disfluency associated with processing accented speech. However, the priming manipulation should not affect the processing of speech in noise.

In line with the predictions, the results showed that when participants were primed to attend to the acoustic features that made speech harder to process, they judged the statements spoken by non-native speakers as less true than those of native speakers. On the other hand, statements spoken by native speakers in quiet and in noise were judged as equally true. The cause of this effect is not entirely clear. One view with which it is consonant is the view of speech perception in which an acoustic stimulus lead to a covert articulatory response that mimics the way the acoustic signal should be produced (Lieberman & Mattingly, 1985; Lane, 1965). It might be that by priming participants to

"produce" foreign sounds, I primed their motor system to mimic the difficulty associated with producing a foreign sound, and therefore, participants were more tuned to the disfluency associated with the speech. However, it is also possible that asking participants to produce foreign sounds draws their attention to sub-lexical features of the speech, leading them to focus less on the conceptual content of the speech. The current study cannot distinguish between these two possibilities.

7.4 Limitations and Future Directions

The results of the studies in the current dissertation suggest that the effect of processing fluency on cognitive judgments is modality specific. However, the research is preliminary and a great deal of work remains to be done to fully comprehend the effect and the mechanisms underlying it. For instance, I suggested that it might be that the presence of white noise made our participants focus closely on the conceptual aspect of the message other than the acoustic features. An interesting follow-up would to investigate whether manipulations on perceptual and conceptual features together would render any effect on cognitive judgments. Because the presence of energetic noise shifts people's attention to conceptual features, any conceptual fluency manipulation should have a bigger effect on speech in noise than in speech in quiet.

The results also showed that when participants were primed to attend to the acoustic features of the speech, they judged the statements spoken by non-native speakers as less true than the native speakers. On the other hand, statements spoken by native speakers in quiet and in noise were judged as equally true. This was taken as evidence that the prime elicited some sort of mechanism that is used to process foreign accent. To further explore this possibility, it would be interesting to have other tasks that elicit

participants' attention to sub-lexical features of the speech (i.e., English words that are known to be harder to pronounce.) If both primes (foreign words and native words) affect processing fluency equally, we might conclude that what the prime is actually doing is eliciting some sort of general language difficulty and not some sort of foreign-language processor.

It might be interesting to investigate participants experience with foreign accent. McGowan (2012, personal communication) has shown that experienced listeners (i.e., listeners who are used to hearing foreign accents) are better able to identify authentic accented speakers than inexperienced listeners. It might be that experienced listeners are more less likely to focus on sub-lexical features and therefore be less affected by processing fluency manipulations. It would also be interesting to explore how non-native speakers process accented speech. Research by Smiljanic and Bradlow (under review) – showing that high-proficiency non-native listeners benefited considerably from clear speech produced by native speakers – suggests that non-native speakers might process foreign accented-speech differently. If this is the case, they might be affected by processing fluency in a totally different way.

7.5 CONCLUSION

In summary, although processing fluency affects cognitive judgments, the current studies showed that disfluency is modality-specific and that because people tend to focus on conceptual information over low-level acoustic information when processing language, disfluency is likely to have limited impact on how people process the conceptual content. Overall, the studies presented here show that listeners can extract content information from speech, even when it is distorted. They also show that when

attention is directed to low-level acoustic features of speech, processing fluency effect becomes apparent.

Appendix A – Trivia Statements

True Experimental Statements

1) A rat can last longer without water than a camel.
2) Tigers have striped skin not just striped fur.
3) The dot over the letter "i" is called a “tittle”.
4) A raisin dropped in a glass of fresh champagne will bounce up and down continuously.
5) Donald Duck comics were banned from Finland because he doesn't wear pants.
6) Because metal was scarce, the Oscars given out during World War II were made of wood.
7) The name Wendy was made up for the book Peter Pan. There was never a recorded Wendy before.
8) The very first bomb dropped by the Allies on Berlin in World War II killed the only elephant in the Berlin Zoo.
9) The first CD pressed in the US was Bruce Springsteen's "Born in the USA."
10) The original name for butterfly was flutterby.
11) The phrase "rule of thumb" is derived from an old English law which stated that you couldn't beat your wife with anything wider than your thumb.
12) It takes more calories to eat a piece of celery than the celery has in it to begin with.
13) Chewing gum while peeling onions will keep you from crying.
14) Bats always turn left when exiting a cave.
15) A dime has 118 ridges around the edge.
16) A cat has 32 muscles in each ear.
17) A "jiffy" is an actual unit of time for 1/100th of a second.
18) The two hemispheres of a dolphin's brain work independently in alternating "shifts" of 8 hours.
19) An ostrich's eye is bigger than its brain.
20) Cats have over one hundred vocal sounds.
21) Our eyes are always the same size from birth
22) Peanuts are one of the ingredients of dynamite.
23) Rubber bands last longer when refrigerated.
24) There are more chickens than people in the world.

True Filler Statements

25) Women blink nearly twice as much as men.
26) Your stomach has to produce a new layer of mucus every two weeks.
27) The sound heard when holding a seashell to the ear is the echo of the blood pulsing in the ear.
28) At least 300,000 people have been killed by volcanoes in the last 500 years.

29) Three percent of Americans clean their pets by showering with them.
30) Thirty-eight percent of men sleep in a room other than the bedroom at least once a month.
31) The cigarette lighter was invented before the match.
32) The spots on dice are called "pips."
33) It's against the law to catch fish with your bare hands in Kansas.
34) The first VCR, made in 1956, was the size of a piano.

False Experimental Statements (In RED the wrong information. In parenthesis the correct information)

35) Americans eat an average of 86 bananas a year per person. (75)
36) Strawberries contain about 2,000 seeds each. (200)
37) Ants sleep 3 hours a day. (Ants don't sleep)
38) A kangaroo can't jump unless its paws are touching the ground. (tail)
39) Polar bears can swim more than 3 miles without a rest. (60)
40) Owls swallow their prey whole because they have only one teeth. (no teeth)
41) The flea can jump 1,000 times its body length. (350)
42) Camels have four eyelids to protect themselves from blowing sand. (three)
43) A horse can go without water longer than a camel can. (giraffe)
44) A giraffe's heart can pump 25 gallons of blood in one minute. (16)
45) Even though a polar bears fur looks white it is actually green. (colorless)
46) Wolves fur is oily and water repellent. (polar bear)
47) The Sun contains 60 percent of the total mass of the solar system. (99.8)
48) The Sun shrinks three feet every hour. (five)
49) The only animals born with horns are hippos. (giraffes)
50) An chameleon can also change its gender. (oyster)
51) A snail can sleep for six years. (three)
52) The can opener wasn't invented until 10 years after the can. (48)
53) A hippo can run faster than horse. (man)
54) A mosquito has 10 teeth. (47)
55) The first public library in the world was in Paris, France in 1745. (Warsaw, Poland)
56) Earthworms have five brains. (hearts)
57) Sharks attack women ten times more often than they attack men. (men, women)
58) The koala is the only known animal that never gets sick. (shark)

False Filler Statements

59) The only places on the body of a cow that have sweat glands are the ears. (nose)
60) Berlin is the European city with the highest population density. (Monaco)
61) The planet Mars spins opposite to the other planets in the solar system. (Venus)
62) The first city to establish a police force was Austria in 1667. (Paris)
63) The leech has 5 brains. (32)
64) Ireland is the country with the highest number of breweries after the US. (Germany)

65) Ten percent of the water covering the earth is drinkable. (one)
66) Only male polar bears hibernate. (pregnant female)
67) There are approximately 70,000 feathers on an eagle. (7,000)
68) Polar bears are predominately right-handed. (left-handed)

Examples Statements

69) Children grow twice as fast in the spring as they do in the fall.
70) The average adult stands 0.4 inch taller in the morning than in the evening.

Appendix B – Product Review and Specifications

P1 - digital camera

Specifications
14.0 megapixels of resolution
3.0-inch LCD display
YouTube-enabled
6 ounces

Positive Review
The image quality is really good on this camera. The camera is responsive and easy to use. The owner's manual is very clear and instructions are easy to follow. The quality of the videos are really superior and it is super straightforward to upload videos to YouTube. The battery lasts more than 7 hours even with the flash feature turned on all the time.

Negative Review
The image quality is really poor on this camera. The camera is not very responsive and it is difficult to use. The owner's manual is confusing and it doesn't help at all. The videos are not as high-quality as they advertise. I tried to upload videos to YouTube and it didn't work. The battery doesn't last long enough, even with the flash feature turned off.

P2 - athletic watch

Specifications
1.06-inch diameter, display size
Water resistant
8 hours of battery in training mode
2.11 ounces

Positive Review
I have used this watch for 3 months now. It is very easy to use. After only 20 minutes I knew how to access most of its features. The watch utilizes a built-in GPS to track route and speed. The tracking accuracy is reasonable. The heart rate monitor is excellent and the screen is big and clear. All the features are easy to set up and the battery life is really impressive: it lasted more than 8 hours in training mode.

Negative Review
I have used this watch two or three times. It is buggy and complicated to use. After 3

days, I still can't access most of its features. The watch utilizes a built-in GPS to track route and speed, but the tracking accuracy is unreliable. The heart rate monitor freezes all the time. The screen is big but very blurry. Features are difficult to set up and the battery life is not what they say: it only lasted 2 hours in training mode.

P3 - treadmill

Specifications
2.5 horsepower drive motor
2-window LCD display
Tracks speed, time, distance and calories
18 x 45 workout area

Positive Review
I purchased this treadmill as a Christmas present for myself and it arrived promptly on time. The treadmill is not heavy and assembly was a breeze. The controls are extremely easy to use. The equipment is quiet and the display stays pretty stable making it easy to read. When folded, it takes up virtually no space. It folds completely flat.

Negative Review
I purchased this treadmill as a Christmas present for myself and it did not arrive on time. The treadmill is very heavy and assembly was not easy. The controls are extremely difficult to use. The equipment is loud and the display shakes a lot when we exercise, making it difficult to read. Even when folded, it takes up a lot of space. It doesn't fold completely flat.

P4 - microwave

Specifications
Turbo/Fast Defrost
10 power levels
19.4 x 23.9 x 14 inches
40 pounds

Positive Review
This microwave is easy to use and reliable. All the buttons work smoothly. The LCD display is easy to read from all viewing angles. The microwave is quiet with a bright internal light that makes it easier to see food inside. It is a perfect size which makes it fit perfectly everywhere.

Negative Review

This microwave only lasted 2 months. The push-to-open button froze shut. I then sent it back and got another one that lasted 3 months. Same problem. The LCD display is hard to read at all viewing angles. The machine is much noisier than expected. The internal light does not turn on when the door is opened.

P5 - running shoes

Specifications
Anatomically shaped
Long-lasting cushioning
Inner climate control for the foot
7 ounces

Positive Review
I am very happy with my purchase. The shoes are very comfortable. If you are looking for cushioning, this is the softest version I have ever seen. You will feel like you are running on soft earth. You can run many miles and your feet still feel good. They are very durable. I've had them for three years now and it still feels good and comfortable.

Negative Review
I was disappointed because the shoes were not the quality that I expected. After using them for three runs I started feeling a ridiculous pain inside my leg. I went back to my old running shoes and the pain was gone. They are not very comfortable and the cushioning is not soft at all.

P6 - bookcase

Specifications
Cappuccino Display Cabinet
Contemporary style
Staggered shelf design
78 pounds

Positive Review
This bookcase looks great and is quite impressive. It looks sturdy enough to handle bigger and heavier books. Everyone seems to think that it's pretty cool and modern. The assembly instructions were clear. It is easy to dismantle parts and put them back together again without damaging anything.

Negative Review
This bookcase is quite unstable. It doesn't feel sturdy enough to handle bigger and heavier

books. It was supposed to look cool and modern, but it looks tacky. The assembly instructions were confusing. It is difficult to dismantle parts and put them back together again without damaging anything.

F1 - Coffeemaker

Specifications
10.8 x 12.4 x 16.5 inches
Fully automatic
3-Year limited warranty
9 pounds

Review
After purchasing three other coffeemakers, this one is the charm! It makes great tasting coffee. I never knew there was a difference. It has all of the features I was looking for such as: adjustable warming plate, water filter, it is programmable. I have no complaints about this one!

F2 - MP3 Player

Specifications
20 GB
Excellent sound quality
Capacity for 5,000 songs
Built-in camera

Review
I bought this to replace my old one. I like it. It is very light, easy to read and easy to transfer music to. The sound quality is awesome especially with good headphones. It alphabetizes your music as well as the album/artist's names.

F3 - Bluetooth Headset

Specifications
Compatible with any phone
8 hours of conversation
Noise-reduction technology
lightweight

Review
This earpiece is a very, very easy to operate and to wear. It is a perfect choice for a starting earpiece. I've had it for two weeks and had no problems with it whatsoever. The sound quality is very clear on both ends. It has very good battery life as promised. It is super lightweight which makes it very comfortable to wear.

F4 - Road Trip Grill

Specifications
Ideal for tailgating and picnics
Adjustable burners
Detachable side tables
5-year limited warranty

Review
I purchased this Road Trip Grill after having horrible experiences with four previous ones. I like the various griddle, grill and stove top pads. I am able to cook just about anything on it. I used it to reheat and cook just about everything for a Thanksgiving dinner while out camping. The clean up is easy. You can place this on the picnic table to cook on or use the fold down legs.

F5 - LCD TV

Specifications
Plug-and-Play compatibility
Enhanced Picture and Sound Quality
Channel Labeling
Efficient design

Review
I bought this TV and it's one of the best TV's I've ever owned. Picture quality is excellent and there is a multitude of input options. The sound is perfect and it becomes even better if you have a home theater to hook up to the TV. The combination of picture quality and sound is great.

F6 - Road Bike

Specifications
Aluminum fitness frame
21-speed shifters
Linear pull brakes

Quality padded saddle

Review
This is my first road bike. Assembling the bike was easy. The gears and the brakes were easy to use and they needed no adjustments. The bike is very quite when pedaling. It is light weight and nice to ride. It's also a good looking bike.

Teste Item 1 - Wireless Router

Specifications
Microsoft certified
Supports all security methods
Internal Antenna
1.2 pounds

Review
I've dealt with plenty of routers in the past time and most of them are confusing to configure. This one was different. It is easy to configure, light-weight and sleek looking. I logged into the web interface to set up the Wifi security, grabbed my laptop to connect to it and done. It worked beautifully.

Teste Item 2 - Printer

Specifications
Wireless technology
Includes scanning capabilities
Modern design
18 pounds

Review
I got this printer after my old one broke. It is very efficient and reliable. It is not a fast printer, but as I mainly print receipts and short articles, this is not a problem for me. The quality is great. Another good thing about it is that the wireless is really easy to set up. I’m no computer expert, but it took me less than 10 minutes to get the wireless to work.

Appendix C – Additional Studies

Effects of Accent on Cue Weighting

Conventional models of decision-making suggest that people weight information based on a number of cues before making a particular judgment (Payne, Bettman & Johnson, 1993). Shah and Oppenheimer (2007) showed that people use processing fluency as a basis for weighting cues, that is people place more weight on information that feels easy to process. Following a similar procedure as used by Shah and Oppenheimer (2007), Study 4 proposed that, if foreign accented speech is indeed more difficult to process, information provided with a foreign accent should receive less weight from the participant as compared to the same information provided by a native speaker.

Participants
Seventy-five native speakers of English participated in this study. Participants were undergraduate students at The University of Texas at Austin and participated for course credit.

Material
Three female non-native speakers of English (speakers of Brazilian Portuguese, Persian and Korean) and three female native speakers of English recorded a series of positive and negative reviews about six different products (see Appendix B).

Procedure
Participants were presented to a series of product specifications (e.g., *this camera has 14.0 megapixels of resolution*) and then listened to either a positive or negative customer review about the product. After listening to the review, participants were asked to estimate how much they believed the product should cost – a price range was provided for each product. The customer review was spoken by either a native speaker of English or a non-native speaker of English (see Figure 1C).

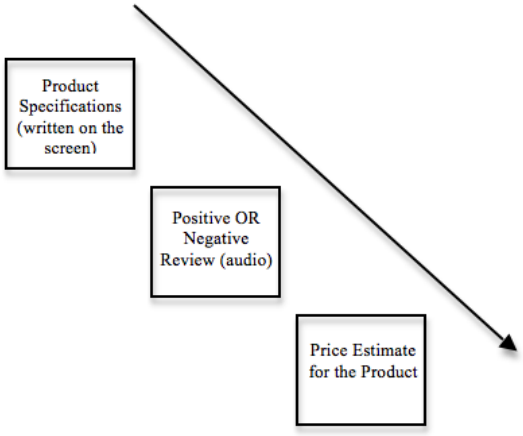


Figure 1C – *Structure of a single trial*.

Participants listened to a total of 12 consumer's reviews (six experimental items and six fillers). The experimental items were: *a digital camera, an athletic watch, a treadmill, a microwave, running shoes and a bookshelf*. The fillers wll be: *a coffeemaker, a mp3 player, a Bluetooth headset, a road trip grill, a LCD TV and a road bike*. The prediction was that participants would weight the consumer review more heavily when spoken by a native speaker (fluent) than when spoken by a non-native speaker (disfluent). More specifically, the price estimates for products with a positive review given by a native speaker should be higher than the price estimates for products with a positive review from a non-native speaker. Similarly, the price estimates for products with a negative review from a non-native speaker should be higher than the price estimates for products with a negative review from a native speaker. This pattern of results would suggest that participants attribute different weights to the same information based on the processing level of the review.

Results

As each product had a different price range, the estimates provided by the participants were standardized. This way an estimate that is closer to 0 means that the estimate provided by the participant was closer to the minimum. Estimates closer to 1 mean that the price provided by the participant is closer to the maximum price in the range. Overall, the results revealed a main effect of valence, $F(1,356) = 112.66$, $p < .001$, but no other reliable main effect or interaction. In other words, accented speech did not influence the price estimates participants provided for the products (Figure 2C).

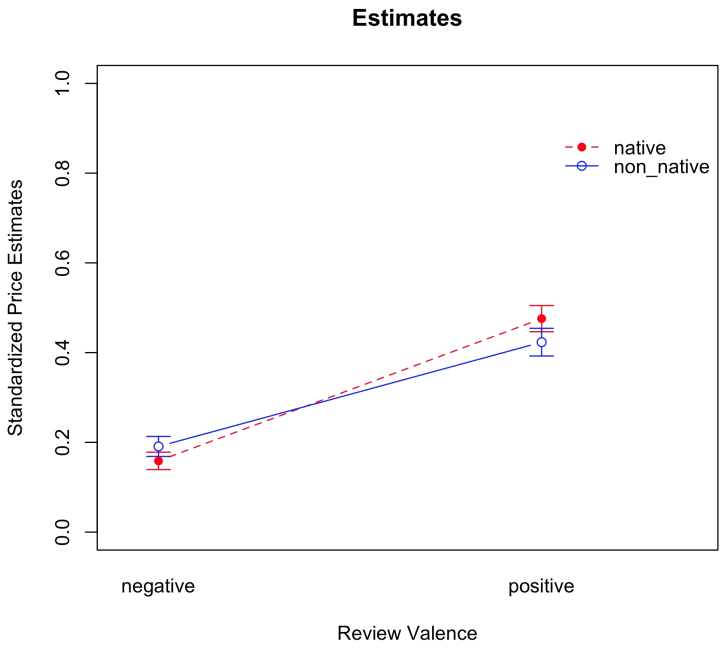


Figure 2C – *Standardized Price Estimates as a Function of Language and the Valence of the Review*

Effects of Accent on Intention to Purchase

Study 5 utilized the very same procedure as in Study 4, but instead, it used as dependent variable the construct known as intention to purchase (Chang & Wildt, 1994).

Participants
Seventy-five native speakers of English participated in this study. Participants were undergraduate students at The University of Texas at Austin and participated for course credit.

Material
The same material used in the previous study.

Procedure
Same procedure used in the previous study. However, after listening to the review, participants were asked to rate, in a Likert scale raging from 1 (probable/possible) to 7 (improbable/impossible):

(1) how probable they were to purchase the product
(2) how possible was it for them to actually buy the product

The combination of both scores gives how willing a person is to purchase the product.

Results
Results revealed a main effect of valence, $F(1,169) = 67.49$, $p < .001$). But no other reliable interaction or main effect was found. Overall, for the positive review, there was an marginal effect accent, $t(81) = 1.90$, $p < .06$.

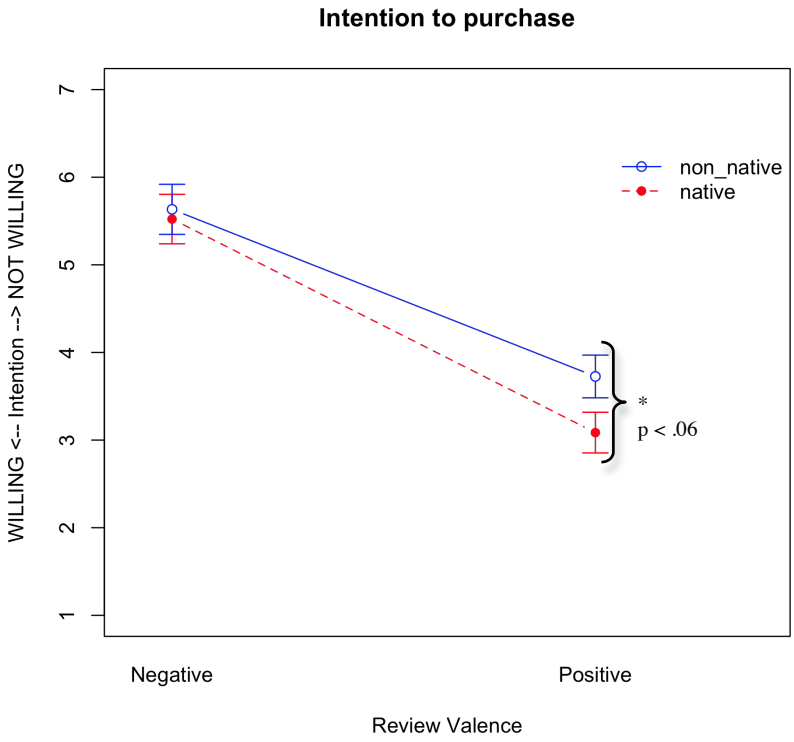


Figure 3C – *Intention to Purchase as a Function of Language and the Valence of the Review*

Appendix E – Prime Words

Foreign Words	English Words
começar	start
pesquisadores	research
nível	level
medida	measure
perguntaram	ask
alguma	some
duas	two
executar	execute
tela	monitor
punhado	bit
letras	letters
minúsculo	small
número	number
febre	fever
querer	want
cabeça	head
derpessão	depression
crença	belief
verdade	true
completo	complete
combatida	defeated
pessoas	people
pequeninas	tiny
neurotransmissores	neurotransmitter
moléculas	molecule
tijolo	brick
culpa	guilt
mulher	woman
burro	donkey
maluco	crazy
interessa	interest
jovem	young

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