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Inferring Character Emotions During Text Comprehension: A Divided Visual Field Study

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Abstract

During reading, individuals often need to activate mental representations of a character's emotional state. Currently, little is known about how readers infer positive and negative character emotional states. Furthermore, the selective involvement of the two cerebral hemispheres in generating emotional inferences is unclear. In the current study, participants read texts that primed either a positive (Experiment 1) or negative (Experiment 2) emotion of a character in a text. Using a divided visual-field paradigm, participants performed a lexical decision task for target words congruent with the character's emotional state, which were presented to either the left visual field-right hemisphere or right visual field-left hemisphere. Results showed significant priming in both hemispheres for negative emotion inferences. The pattern from the current study suggests a negativity bias, in which readers are faster to infer negative character emotions from a text than positive character emotions. Furthermore, these results suggest that both the right and left hemisphere are highly involved in generating negative emotion inferences from a text

Introduction

Prior research has demonstrated that readers activate mental representations of a character's emotional state while reading (Gernsbacher, Hill Goldsmith & Robertson, 1992; Gernsbacher & Robertson, 1992). This effect has been shown by requiring participants to infer the emotional state of a character based on the description of the text (i.e., emotion inferences). Although it has been shown that readers generate emotion inferences during reading, there are still many unanswered questions regarding how the brain processes these inferences. Are there differences depending on whether the emotion is positive (e.g., happy) or negative (e.g., sad)? Are the two hemispheres of the brain equally involved in generating emotion inferences, and does this depend on the valence of the emotion? This present study attempts to address these questions.

Hemispheric differences in the processing of emotion have been shown in a variety of tasks. For example, numerous studies have shown asymmetries in the cerebral hemispheres for recognition of emotion in faces (Adolphs, Damasio, Tranel & Damasio, 1996; Mandal, Tandon & Asthana, 1991; Ley & Bryden, 1979; Christman & Hackworth, 1993; Lane, Kivley, Du Bois, Shamasundara & Schwartz, 1995; Asthana & Mandal, 2001; Kilgore & Yurgelon-Todd, 2007; Alves, Aznar-Casanova & Fukusima, 2009; Bourne, 2010; Nijboer & Jellema, 2012; Thomas, Wignall, Loetscher & Nicholls, 2014). In addition, findings have shown hemispheric differences for processing positively- and negatively-valenced music (Altnemüller, Schürmann, Lim & Parlitz, 2002; Gagnon & Peretz, 2000; Schimdt & Trainor, 2001). Collectively, these findings have not shown a

consistent pattern. Some studies have found a selective right hemisphere advantage for processing emotion (Bourne, 2010; Adolphs et al., 1996) while other studies have found that the two hemispheres processes emotion differently based on emotional valence (Mandal et al., 1991; Nijboer & Jellema, 2012). Valence refers to position of a stimulus along an affective dimension ranging from positive (e.g., happy) to negative (e.g., sad). This mix of findings has, in turn, produced two prominent theories regarding hemispheric asymmetry for the processing of emotion. The Right Hemisphere Hypothesis (RHH) proposes that the right hemisphere has a specialized role in the processing of emotion (Schwartz, Davidson & Maer, 1975). In contrast, the Valence Hypothesis (Hellige, 1993) proposes that the right hemisphere is specialized for the processing of negative emotional information whereas the left hemisphere has an advantage for processing positive emotional information. At present, it is uncertain which theory is correct.

Recently, researchers have begun to examine emotion processing in the context of language. In a pioneering study (Graves, Landis & Goodglass, 1980), researchers found that accuracy for emotional words in a lexical decision task (e.g., happy, sad, mad) was higher relative to neutral words (e.g., hat, foot, book) when presented to the left visual field-right hemisphere (lvf/RH). These results are consistent with the Right Hemisphere Hypothesis. Other studies further support this theory in showing a right hemisphere advantage for processing emotion words regardless of valence (Nagae & Moscovitch, 2002; Dimberg & Petterson, 2000). However, other research has shown patterns of results that

support the Valence Hypothesis (Holtgraves & Felton, 2011; Ali & Cimino, 1997; Cohen & Shaver, 2004; Alfano & Cimino, 2008). In the context of language processing, The Valence Hypothesis would predict a right hemisphere advantage for processing negative emotional words and a left hemisphere advantage for processing positive emotional words. In addition to differing patterns of results observed between the Right Hemisphere and Valence Hypotheses, some studies have found a left hemisphere advantage for emotional verbal stimuli (Strauss, 1983) or no lateralization effects (Eviatar & Zaidel, 1991). Currently, the processing of emotional text between the two brain hemispheres is unclear

One factor that may account for the discrepancies in the previous findings is the general physiological effect of stimuli (i.e., the arousal) (Alfano & Cimino, 2008). Combining behavioral and EEG/ERP measurements during a lexical decision task, Hofmann, Kuchinke, Tamm, Võ and Jacobs (2009) found subjects had faster response times for high-arousal negative words (e.g., earthquake) than low-arousal negative words (e.g., apathy). The ERP results showed that positive words elicited a larger negativity than neutral words, and high-arousal negative words showed a larger negativity relative to low-arousal and neutral words at early time windows following presentation (80-120 ms). These results demonstrate physiological differences in response to low-arousal and high-arousal words that may affect the ease with which high and low arousal words are recognized.

A second factor that may help explain the discrepancy in findings is the interaction of valence and arousal. Studies have found that arousal and valence

interact in tasks measuring attentional control (Jefferies, Smilek, Eich & Enns, 2008). Abbassi, Kahlaoui, Wilson and Joanette (2011) propose a dual-process model for processing emotional words in which the left hemisphere processes emotion words early and automatically, whereas the right hemisphere processes emotion words later in a more controlled manner relying on attention. Other researchers suggest that arousal is the primary factor responsible for hemispheric asymmetry rather than valence (Zhang, Zhou & Oei, 2011).

In addition to hemispheric differences for processing emotion, there are also prominent hemispheric differences for the processing of language in general. The left hemisphere of the brain has long been considered specialized for language. However, in the past few decades, it has been shown that language may not be as lateralized as previously thought, and the question of how the brain processes language has become far more complex. For example, patients with damage to the right hemisphere of the brain have shown impairments in language comprehension, such as difficulty generating inferences (Tompkins, Scharp, Meigh, Lehman Blake & Wambaugh, 2012; Blake, Tompkins, Scharp, Meigh & Wambaugh, 2015) and with discourse comprehension (Blake, Frymark & Venedictov, 2013). Such observations have pressured language researchers to modify theoretical models of language processing in the brain.

It is possible that emotional verbal stimuli may be processed differently in the right hemisphere and left hemisphere under certain conditions. Studies utilizing a divided visual field paradigm to examine hemispheric differences for the processing of positively- and negatively-valenced words have offered partial

support for the Valence Hypothesis. For instance, Ali and Cimino (1997) found that participants had better recall for negative words presented to the right hemisphere, and better recall for positive words presented to left hemisphere. In lexical decision tasks, participants have shown faster response times for positive words presented to the left hemisphere (Holtgraves & Felton, 2011) relative to the right hemisphere. In addition, Alfano and Cimino (2008) found that participants showed better recognition accuracy for a stimulus presented to the left hemisphere when primed with a positive word, and better recognition accuracy for a stimulus presented to the right hemisphere when primed with a negative word. Taken together, these results suggest that emotion processing for verbal stimuli is not exclusive to the right hemisphere as proposed by the Right Hemisphere Hypothesis. Instead, emotional information may be processed differently between the hemispheres when the emotional valence of the stimuli differs. The left hemisphere may be more involved when the valence of a stimulus is positive, whereas the right hemisphere may be more involved when the valence is negative.

In the context of generating emotion inferences from text, it is also possible that the right and left hemisphere have differing contributions. For instance, previous research (Tapiero & Fillon, 2007) has shown that readers more quickly infer negative emotional inferences relative to positive emotional inferences in the right hemisphere. This result partially supports the Valence Hypothesis, showing a right hemisphere advantage for negatively-valenced information. However, prior studies have not matched positive and negative target words for arousal. In addition, previous researchers have reported relatively long

participant response times. Lastly, previous research has not compared responses between emotion-priming texts and texts with no emotion priming (e.g., neutral texts). Instead, prior experiments have tended to only compare responses between positive emotion-priming texts and negative emotion-priming texts. Without a baseline measure, it cannot be determined to what extent readers actually infer the emotional state of the character. The present study addressed these limitations.

Rationale

Although previous findings have shown that readers infer the emotional state of characters, it is unclear whether this effect is modulated by the valence of the character emotion. In addition, it is not clear whether there are hemispheric differences for the generation of emotional inferences. In this study, short texts were constructed (see Table 1) to prime readers with either a positive, negative, or neutral character emotion. After reading each text, participants performed a lexical decision task for either related positive-valence or negative-valence target words. To measure the processing in each hemisphere, a divided visual-field procedure was used wherein target words were randomly presented to either the right visual field-left hemisphere (rvf/LH) or the left visual field-right hemisphere (lvf/RH). Congruent with the predictions of the Valence Hypothesis, it was expected that the right hemisphere would show a processing advantage for negative emotional inferences, whereas the left hemisphere would show a processing advantage for positive emotional inferences. The present study may provide a better understanding of how readers process both positive and negative

information during text comprehension. Furthermore, the results of the study will show whether the two hemispheres process emotional content differently.

Experiment 1

The first experiment examined hemispheric differences for positive emotional inferences. Participants read a text in one of two conditions: (1) text priming a positive emotion, or (2) a neutral text. Next, participants made a lexical decision for positive-valence target words that were either presented to the right visual field-left hemisphere or to the left visual field-right hemisphere.

Statement of Hypotheses

Hypothesis I**.** A main effect for text condition was expected, in which participants would respond to targets faster following a positive emotion-priming text relative to a neutral text.

Hypothesis II. A text condition x hemisphere interaction was also expected. When presented to the right visual field-left hemisphere, it was predicted that participants would respond faster to positive targets than when presented to the left visual field-right hemisphere following positive emotional priming.

Method

Participants 136 undergraduate students (74 female, 29 male) participated in Experiment 1. Students received course credit for their participation. Prescreening was conducted to ensure that all participants were right-handed, native English speakers, had normal or corrected-to-normal vision, and had no history of brain damage.

Materials

Texts. 96 texts (24 positive emotional inference, 24 neutral, 48 fillers), each consisting of three sentences, were created for this experiment (see Table 1). The first two sentences of each text were identical between conditions (i.e., introductory text). The final sentence (i.e., the inference text) differed by condition, priming either a positive emotional inference or no inference (i.e., the neutral). A pilot study was conducted to ensure that the inference sentences reliably generated the appropriate emotional inference. Participants (n = 46) were given the following instructions: "The word in the left column describes the emotion or feeling felt by the character in the following text." Participants rated each target word on a 7-point Likert scale (ranging from 1 = strongly disagree to 7 = strongly agree). Paired *t*-tests were conducted comparing the average rating for each target word between the two conditions: (1) paired with a positive inference text, (2) paired with a neutral text. The pilot materials were split into two versions to ensure that no participant rated the same target word for both conditions. Only the positive inference texts that produce a significantly higher score for a target word ($M = 5.96$, $SE = .06$) compared to the neutral texts ($M = 3.8$, $SE = .09$) were included in the study, $t(47) = 18.72$, $p < .001$. Of the 60 texts that were pilot tested, 24 were retained and used for Experiment 1 (Appendix A).

Table 1.

Example Text and Experimental Conditions

Introductory Text

Shane's high school prom was scheduled for this Saturday.
The theme was "Walking in a Winter Wonderland".

Emotion Inference Text

Positive: Shane approached the girl he liked to see if she would be his date and she said, 'yes'. (Experiment 1)
Negative: Shane approached the girl he liked to see if she would be his date and she said 'no'. (Experiment 2)

Neutral Text

The dance was being planned by the teen council members.

Target Words

ecstasy (Experiment 1)
anguished (Experiment 2)

Target words. 48 words taken from the Affective Norms for English Words (ANEW) (Bradley & Lang, 1999) were selected as target words. Only words with a mean valence rating greater than 7 (on a scale of 1-9) were included in the positive valence condition. The ANEW has been shown to correlate strongly with factors of pleasure and arousal of the verbal Semantic Differential Scale (Russell & Mehrabian, 1977) as well as the Dictionary of Affect and Language (DAL) (Whissell, 2008), and the measure has been replicated in additional studies (Montefinese, Ambrosini, Fairfield & Mammarella, 2014; Redondo, Fraga, Padrón & Comesaña, 2007; Soares, Comesaña, Pinheiro, Simões & Frade, 2012). Forty-eight nonwords matched for number of letters, number of syllables, and neighborhood frequency were used as fillers.

Comprehension questions. To ensure that participants read the texts for comprehension, six comprehension questions were included at various points in the experiment. These questions asked participants to answer a true/false question about the previous text they had just read.

Procedure All participant testing was done on a computer using *E-Prime 2.0* testing software. Participants were seated in front of a computer screen, placing their chin on a chin rest, positioning their head 50 cm away from the screen, creating a 3.5° visual angle. In each trial, participants were first presented with the introductory texts (see Table 1) one sentence at a time. Next, participants were presented with either the positive inference text or the neutral text. Participants read the text at their own pace, and indicated by button press when they had finished. The final sentence was replaced by a fixation point "+" in the center of the screen for a duration of 750 ms, immediately followed by the presentation of a string of letters located at either the right or left visual field for 176 ms. Using a button box, participants were instructed to respond as quickly and accurately as possible to the string of letters, pressing one button to identify the letter string as a word and another button to identify the letter string as a nonword. Participants were randomly assigned to either make their responses with their right hand or their left hand.

Results and Analysis

Prior to analysis, 19 participants with accuracies for the lexical decision task below 70% were removed. In addition, 9 participants who answered less than four of the six comprehension questions correctly were removed. Since stimuli in

the divided visual-field paradigm are initially processed by the contralateral hemisphere, it is crucial that responses be made before information can be shared with the ipsilateral hemisphere. To minimize this risk, 5 participants with average response times for correct trials falling above or below 2 standard deviations from the grand mean were removed per condition. In total, 103 participants were included in the analyses for Experiment 1.

Table 2

Mean response time (in ms) and accuracy (in percent correct) for targets following emotion priming and neutral texts for Experiment 1 and Experiment 2

	rvf-LH		lvf-RH	
Condition	RT	AC	RT	AC
Positive				
Priming	694.28 (15.08)	0.86 (0.01)	698.35 (14.7)	0.86 (0.01)
Neutral	683.86 (14.3)	0.88 (0.01)	710.96 (16.9)	0.85 (0.01)
Negative				
Priming	659.66 (14.7)	0.87 (0.01)	680.84 (14)	0.87 (0.01)
Neutral	696.8 (16.6)	0.86 (0.01)	719.49 (15.7)	0.84 (0.01)

Note. rvf-LH refers to the right visual field-left hemisphere and lvf-RH refers to the left visual field-right hemisphere. RT refers to response time and AC refers to accuracy. Values in parentheses represent standard errors.

Response Times

A two-way repeated measures ANOVA was conducted to compare average response times to targets between the positive inference texts and neutral texts. The independent variables were visual field-hemisphere (rvf-LH or lvf-RH) and text condition (emotion-priming or neutral). For both tests, only the means for correct trials were included. The results of the ANOVA revealed no significant differences in response times to targets between the two text conditions (Hypothesis I), $F(1, 102) = .018$, *ns*. In addition, no significant main effect for visual field-hemisphere was found, $F(1, 102) = 2.61$, *ns*. Lastly, no interaction effect (Hypothesis II) between text condition x hemisphere was found, $F(1, 102) = 2.07$, *ns*. No significant differences based on sex or response hand were found for accuracy or response times.

Discussion – Experiment 1

The results of Experiment 1 show that the text priming a positive character emotion did not cause readers to infer the target words faster than the neutral sentences. In addition, the results did not support the expected priming x hemisphere interaction effect. These results are consistent with previous studies showing a select processing advantage for negative emotions words, but not positive words in a lexical decision task (Jonczyk, 2014). Interestingly, these null findings do not support the Right Hemisphere Hypothesis or the Valence Hypothesis accounts. The Right Hemisphere Hypothesis would have predicted that the right hemisphere would be faster to generate a positive emotional inference. In contrast, the Valence Hypothesis would predict shorter response

times to positive stimuli selectively in the left hemisphere. Potential explanations for the current set of results are addressed in the general discussion.

Experiment 2

Using the same procedure as Experiment 1, the second experiment examined hemispheric differences for negative emotional inferences. Participants read texts in one of two conditions: (1) text priming a negative emotion, or (2) a neutral text. Next, participants performed a lexical decision task for negative target words presented to either the right visual field-left hemisphere or the left visual field-right hemisphere.

Statement of Hypotheses

Hypothesis I. A main effect for text condition was expected, in which participants would respond to negative targets faster following an emotion-priming text than when following a neutral text.

Hypothesis II. A text condition x hemisphere interaction was also hypothesized. Following negative emotion priming, participants were expected to respond faster to negative targets when presented to the left visual field-right hemisphere compared to the right visual field-left hemisphere.

Method

Participants 117 undergraduate students (90 females, 27 males) participated in Experiment 2. Students received course credit for their participation. Prescreening was conducted to ensure that all participants were right-handed, native English speakers, had normal or corrected-to-normal vision, and had no history of brain damage.

Materials

Texts. 96 texts (24 negative emotional inference, 24 neutral, 48 fillers) each consisting of three sentences, were constructed (see Figure 1). As in Experiment 1, the texts were pilot tested by participants (n = 19) to ensure that the inference sentences reliably generated the appropriate negative emotional inference. Only the negative inference texts that produced a significantly higher score for a target (M = 5.88, SE = .09) compared to the neutral texts (M = 2.4, SE = .09) were included in the study, $t(47) = 27.56$, $p < .001$. Of the 60 texts that were pilot tested, 24 were retained and used for Experiment 2 (Appendix B).

Target words. 48 words taken from Bradley and Lang (1999) were selected as target words. Only words with a mean valence rating less than 3 (on a scale of 1-9) were included in the negative valence condition. These forty-eight negative-valence words were matched for arousal, word frequency, number of letters, and number of syllables to the forty-eight positive-valence words included in Experiment 1.

Comprehension questions. Comprehension questions were identical to Experiment 1.

Procedure The procedure was identical to Experiment 1. However, participants were first presented with the introductory texts, and then presented with either the negative inference text or the neutral text in Experiment 2.

Results and Analysis

Prior to analysis, 12 participants with accuracies for the lexical decision task below 70% were removed. In addition, 5 participants who answered less than four

of the six comprehension questions correctly were also removed. As in Experiment 1, 7 participants with average response times for correct trials falling above and below 2 standard deviations from the grand mean were removed. In total, 93 participants were included in the analyses for Experiment 2.

Response Times

A two-way repeated measures ANOVA was conducted to compare average response times to targets following the negative inference texts and neutral texts. The independent variables were visual field-hemisphere (rvf-LH or lvf-RH) and text condition (emotion-priming or neutral). For both tests, only the means for correct trials were included. The results showed a main effect for text condition, $F(1,92) = 20.08$, $p < .001$, $\eta_\rho^2 = .179$. A follow up *t*-test showed a significant priming effect, $t(185) = 4.68$, $p < .0001$, wherein targets were responded to significantly faster following the negative emotion-priming text ($M = 670$, $SE = 10.18$) relative to the neutral text ($M = 708$, $SE = 11.46$). There was also a main effect for hemisphere, $F(1,92) = 5.33$, $p < .05$, $\eta_\rho^2 = .055$. A *t*-test showed that average response times were significantly faster when target words were presented to the rvf-LH ($M = 678$, $SE = 12.06$), than when presented to the lvf-RH ($M = 700$, $SE = 10.61$), $t(185) = -2.53$, $p = .012$. Follow up *t*-tests also revealed that, in the right hemisphere, average response times to targets words were significantly faster following the negative emotion priming text compared to the neutral text, $t(92) = 3.95$, $p < .001$. Average response times in the left hemisphere were also faster following negative emotion-priming text compared to

the neutral text, $t(92) = 2.87$, $p = .005$. No significant differences in response times or accuracy based on sex or response hand were observed.

Discussion – Experiment 2

The results of Experiment 2 show that participants responded to target words faster following texts priming a negative emotion compared to a neutral text, supporting Hypothesis I. However, the expected emotion priming x hemisphere interaction was not shown. Instead, faster response times to targets following negative emotion priming texts were found in both hemispheres. These results differ from previous findings (Tapiero & Fillon, 2007), in which negative emotional inferences were generated faster than positive emotional inferences only in the right hemisphere. The previous results could be due to methodological issues that influenced how quickly target words are recognized. For example, previous studies have used neutral texts as fillers, but have not compared responses between neutral texts and emotion-priming texts. In the current study, neutral texts were used and systematically matched with the emotion-priming texts. Only the final sentence differed by condition (see Table 1). Therefore, the structure of the current set of texts enable greater control among the text conditions, and more clearly demonstrate the extent to which readers infer the positive, or negative, emotional state of the character. Also, prior studies examining emotion inferences using a lexical decision task have reported long average response times. However, response times in divided visual field – lexical decision tasks must be short enough to prevent information from being shared across the hemispheres (Bourne, 2006). In contrast to previous studies, in the

current study response times longer than 2000 milliseconds were removed prior to analysis to reduce the likelihood of inter-hemispheric noise. In addition, participants with average response times two standard deviations below or above the grand mean were also removed to avoid the potential use of both hemispheres in making responses. By controlling for these two methodological issues in the current study, the results from Experiment 2 suggest that negative emotional inferences seem to be processed similarly in both hemispheres.

Facilitation

Facilitation effects for response times in Experiment 1 and Experiment 2 were entered into a 2 (visual field-hemisphere: rvf-LH or lvf-RH) by 2 (emotion: positive or negative) ANOVA. Facilitation effects were calculated by subtracting the mean response times for targets in the experimental conditions from the mean response times for targets in the neutral conditions. A main effect for emotion was found, $F(1, 346) = 6.61$, $p = .01$, $\eta_\rho^2 = .019$. A follow-up *t*-test revealed that facilitation effects (Figure 1) were significantly larger in the negative condition ($M = 37.89$, $SE = 8$) relative to the positive condition ($M = 1.09$, $SE = 8.1$), $t(390) = 3.2$, $p = .001$. No significant interactions were observed. No significant differences based on sex or response hand were found for facilitation in either emotion condition.

Figure 1. Facilitation Effects for Positive and Negative Emotion Inferences for Experiment 1 and Experiment 2

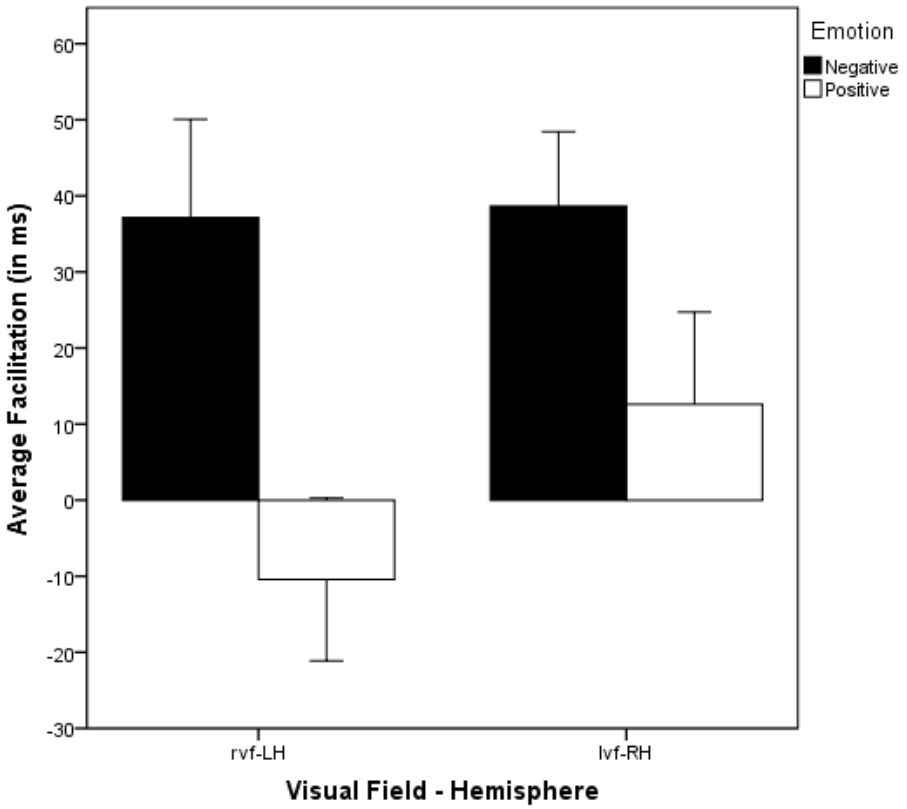

Figure 1. Results showing facilitation (measured by subtracting the mean response time for target words in the emotion inference conditions from the mean response time for targeting words in the neutral condition) for the right visual field-left hemisphere (rvf-LH) and left visual field- right hemisphere (lvf-RH). Positive valence targets were used in Experiment 1, whereas negative valence targets were used in Experiment 2.

In order to determine if response times differed between Experiments 1 and 2, positive and negative inferences, respectively, a post hoc analysis was conducted comparing average response times to target words following positive inference texts (Experiment 1) and negative inference texts (Experiment 2).

Interestingly, there were no significant differences in response times between the two emotion priming conditions. In addition, no significant hemisphere x valence interactions were found for response times. Lastly, there were no significant differences in response times to positive and negative targets in the neutral conditions. The implications are discussed below.

General Discussion

Overall, the results from Experiments 1 and 2 suggest that readers more quickly infer negative character emotional states than positive emotional states in a text. Furthermore, this effect occurred bilaterally, suggesting that both the left and right hemisphere are involved in the processing of negative emotional inferences. This is in contrast to the predictions of both the Right Hemisphere Hypothesis and Valence Hypothesis. Specifically, the right hemisphere did not show selective facilitation for the negative inference condition, and the left hemisphere did not show selective facilitation for the positive inference condition. In addition, the results did not support the Right Hemisphere Hypothesis. By this account, facilitation effects should have been observed selectively in the right hemisphere for both positive and negative inferences.

The null results of the post hoc analysis, combined with the significant facilitation effects for negative targets, suggest that the observed differences between positive and negative emotional inferences were due to textual priming and not simply the targets. If response times to target words had significantly differed between Experiment 1 and Experiment 2 – positive and negative target words, respectively – this might suggest that response time differences in the

current study were caused by the differing valence of the target words. In previous studies, significant response time differences were found between positively- and negatively-valenced words. For example, Smith and Bulman-Fleming (2005) found a right hemisphere advantage for processing negative, but not positive emotion words in a divided visual field lexical decision task. However, this effect was not found in the present study. Participant response times did not significantly differ between negative texts and positive texts in either hemisphere. It is possible that in higher-level language tasks, such as generating negative emotional inferences for characters in a text, both hemispheres are similarly recruited.

The finding that facilitation effects were shown only for negatively-valenced emotional inferences suggests a negativity bias for emotional inferences in a text. Negativity biases have been shown in similar tasks. For example, Osgood and Hoosain (1983) found that participants were significantly faster to identify a negative adjective (e.g., hostile) as negative than to identify a positive adjective as positive (e.g. friendly), suggesting that negatively-valenced information may receive activation faster than positively-valenced information. There is also evidence to suggest that negative stimuli are more likely to attract an individual's attention compared to positive stimuli. For example, Pratto and John (1991) had participants complete a Stroop task using emotional adjectives as targets (e.g., sadistic, honest). Participants took significantly longer to name the color of ink when the word was negatively-valenced than when the word was positively-valenced, suggesting that automatic attentional resources are biased to

process negative adjectives compared to positive adjectives. Negative biases have been observed in numerous psychological domains, including attentional, memory, and language tasks (see Rozin & Royzman, 2001 for a review). Based on a variety of evidence across these domains, some researchers have argued that negative information generally receives more processing than positive information (Baumeister, Bratslavsky, Finkenauer & Vohs, 2001). Emotion theorists have also claimed that positive emotions are fewer in number and more diffuse relative to negative emotions (Fredrickson, 1998). Together, the differences both in the characteristics and processing between negative and positive emotions may explain why facilitation effects were found for negative texts but not positive texts.

The current results suggest that negativity biases found in emotion processing tasks in general extend to language tasks. Based on a review of several languages, Jing-Schmidt (2007) proposes a cognitive-affective model underlying negativity biases in language, in which negative emotions have a greater neurophysiological influence on cognition and linguistic behavior. Furthermore, this negative/positive asymmetry is proposed to be universal across languages. The results of the current study extend the incidence of negativity bias in language tasks to textual inferences of character emotional states.

Negativity biases have been shown to occur in several ways. Rozin and Royzman (2001) propose four ways in which negativity biases are expressed: (1) negative potency, (2) steeper negative gradients, (3) negativity dominance, and (4) negative differentiation. The current study is best explained as an example of

negative potency. Negative potency describes an instance in which a "negative event is subjectively more potent and of higher salience than its positive counterpart...negative events are more potent with respect to their objective magnitude than are positive events" (p. 298). In the present study, the negative emotional state primed by the negative texts may have resulted in higher salience relative to the positive texts. Therefore, the higher salience of the negative emotion-priming texts relative to the positive emotion-priming texts may have caused stronger priming in the former. This effect could have then resulted in faster inferences for negative target words compared to positive target words.

Studies using physiological measures have provided further support for differential activation between negative and positive text. For example, EEG studies have shown larger late positivity effects for negative words relative to positive words following neutral texts (Holt, Lynn & Kuperberg, 2008). In addition, P300 amplitudes have been shown to be significantly larger when participants read about a person performing bad behaviors compared to good behaviors (Bartholow, Fabiani, Gratton & Bettencourt, 1999). Holt, Lynn and Kuperberg (2008) propose that determining the emotional meaning of words occurs in two stages: an early semantic analysis receptive to emotional salience and a later attention-modulated evaluation where the specific valence of a word is determined. Other authors have proposed similar accounts (Recio, Conrad, Hansen & Jacobs, 2014). The current results cannot be explained by arousal caused by the targets. As stated in the methods, positive and negative targets were matched for arousal, and the same targets were used for both the neutral and

emotion-inference conditions. However, it is possible that the negative inference texts caused greater arousal compared to the positive inference texts. For example, N400 components have been shown to be modulated by a reader's mood, the valence of targets, and depending on whether emotional information is explicit or must be inferred from a text (Egidi & Nusbaum, 2012). Future studies need to account for the arousal effects of both priming texts and targets. It is also possible that the negative inference texts were more highly constrained to negative interpretations than the positive inference texts were to positive interpretations. For example, the phrase "her attention was drawn to her little sister's loud chewing nearby" (Appendix B, text 17) could be more constrained to a negative evaluation than the phrase "her attention was drawn to the complexities of the circulatory system" (Appendix A, text 17) is constrained to a positive evaluation. Particular texts may lend themselves more easily to one valence relative to the other, which may make for quicker inferences. In sum, the findings from this study show that readers are faster to infer negative character emotions from text than positive character emotions, which occurs similarly in both hemispheres.

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Appendix A

Texts for Experiment 1 – Positive Inferences

1. Derek was driving to work.
   He decided to stop at the bakery.
   Positive: As he walked in the door, he saw his favorite dessert.
   Neutral: The bakery was across the street from the gas station.
   Target: delight

2. Maya has a role in the school play.
   She spent a good part of the day rehearsing her lines.
   Positive: During rehearsal, the theatre group took notice of Maya's ability to remember all her lines.
   Neutral: The play was "Much Ado About Nothing."
   Target: admired

3. Matthew and Ryan were at a baseball game.
   It was the 9th inning.
   Positive: They watched closely as a player on their team hit a homerun, ending the game.
   Neutral: Matthew sat down after returning from the restroom.
   Target: cheer

4. Kate and Ross went out to dinner.
   They decided to go to a Chinese restaurant.
   Positive: After taking a bite, Kate told Ross it was the tastiest rice she had ever eaten.
   Neutral: The couple gave the hostess their names.
   Target: enjoyment

5. Catherine was at the park.
   She saw a young, attractive man and went to go talk to him.
   Positive: As they were talking, she noticed his lean, muscular abs.
   Neutral: The park was relatively busy that day.
   Target: aroused

6. David was a volunteer for the new mayor's campaign.
   David listened closely as the mayor gave a speech.
   Positive: The mayor's words made David stand and applaud.
   Neutral: It was very windy in the city that day.
   Target: inspired

7. Brook was at the zoo.
   After seeing the reptiles, she was now looking at the lions.
   Positive: Walking alongside their pen, she saw that the glass barrier was very thick.
   Neutral: Earlier, Brook had seen the birds.
   Target: safe

8. Katie's mom was in town for the weekend.
   Her mom arrived at her apartment around noon.
   Positive: On the second day of her visit, Katie's mom gave Katie a big hug.
   Neutral: Katie lived on the third floor of her building.
   Target: comfort

9. The young child was running around the playground.
   After going down the slide, he ran to the swing set.
   Positive: When he got off the swing, his mother picked him up and kissed the top of his head.
   Neutral: The young child then climbed onto the swing.
   Target: warmth

10. David went over to his girlfriend's house.
    She wanted to watch a movie.
    Positive: David liked action movies, but he agreed to watch a romance film.
    Neutral: They tried to decide whether to watch an action movie or a comedy.
    Target: devoted

11. Sally was laying in bed.
    Turning over, she looked at the clock on the nightstand.
    Positive: Sally had not left the bed because the sheets were so warm.
    Neutral: Next to the nightstand lied Sally's books for school.
    Target: cozy

12. Aaron had not checked his garden in several days.
    In the morning, he walked outside to look at his plants.
    Positive: His face lit up when he saw that his plants were thriving.
    Neutral: Aaron grew vegetables, but also some flowers.
    Target: surprised

13. Shane's high school prom was scheduled for this Saturday.
    The theme was "Walking in a Winter Wonderland".
    Positive: Shane approached the girl he liked to see if she would be his date, and she said "yes".
    Neutral: The dance was being planned by the teen council members.

Target: ecstasy

14. Patty and Wayne went to Las Vegas.
    When they entered the casino they decided to play cards.
    Positive: They put $500 on a hand of blackjack and doubled their money.
    Neutral: But first, they dropped off their luggage to their hotel room.
    Target: joyful

15. Gina looked at herself in the mirror as she got ready.
    While she waited for her hair to dry, she reached into the nearby drawer.
    Positive: When she began putting on makeup, she felt the makeup made her eyes glow.
    Neutral: After searching awhile, she found the hairdryer.
    Target: pretty

16. Andy walked into class on his first day of school.
    He was a new student who had just transferred from another high school.
    Positive: Though he was new, the students included him in all their conversations.
    Neutral: Andy was tall and had brown hair.
    Target: acceptance

17. Helen was sitting on the couch reading from her anatomy textbook.
    She was studying to become a nurse.
    Positive: While Helen looked through the diagrams, her attention was drawn to the complexities of the circulatory system.
    Neutral: But, she had to complete her clinical training first.
    Target: fascinate

18. William's school was hosting a spelling bee.
    After school, William went to sign up.
    Positive: During the final round, the judge informed William that he had correctly spelled the final word.
    Neutral: The information sheet stated that the event would be held in the winter.
    Target: triumph

19. Sonny was a senior on the wrestling team.
    He had competed in the 160-pound weight class.
    Positive: It had been a tough season, but Sonny had trained for days in order to win the gold medal.
    Neutral: Last year, Sonny competed in the 152-pound weight class.
    Target: ambition

20. Robin Hood and Little John were walking through the forest.
    As the trail ended, they came upon a large hill.

Positive: When the king's soldiers drew near, the pair drew their swords and raised their shields.
Neutral: The pair then crossed a stream before arriving at their destination.
Target: brave

21. Margaret was out on a hiking trip in the mountains.
After trekking through the woods for awhile, she came to a large clearing.
Positive: Looking upward, she saw a bright sunny sky and a beautiful mountain.
Neutral: Looking down, she noticed that her shoe had become untied.
Target: bliss

22. Betty was at home watching the political debate.
It was not common for her to watch political talks.
Positive: Listening to the senator made Betty think that she too might one day be a member of Congress.
Neutral: However, Betty's teacher had assigned her students to write a short paper for the debate.
Target: inspire

23. Amy was having Thanksgiving dinner at her grandparent's house.
It was her family's holiday custom.
Positive: When Amy was getting ready to leave, her grandma gave her a big kiss on the cheek.
Neutral: This year, Amy thought she would try yams for the first time.
Target: loved

24. Billy sat in English class while his teacher passed back their graded essays.
Eventually, the teacher passed Billy's back to him.
Positive: When Billy received his exam, the grade brought a smile to his face.
Neutral: Billy packed up his bag and went to his next class.
Target: pride

Appendix B

Texts for Experiment 2 – Negative Inferences

1. Aldo was sitting in class.
   His professor started handing back an assignment.
   Negative: When he got his paper back, he realized he scored much lower than he'd hoped.
   Neutral: The paper was for an English assignment.
   Target: troubled

2. Isabel was at the movie theatre.
   During the previews, she went to buy a snack.
   Negative: When she returned, someone had taken her seat.
   Neutral: The movie was playing in two theatres.
   Target: anger

3. Emma is the captain of her rugby team.
   She put on her gear and headed out onto the field.
   Negative: Emma blamed herself for not practicing enough when her team lost.
   Neutral: Emma's team wore yellow jerseys.
   Target: defeated

4. Catherine was at the park.
   She saw a young, attractive man and went to go talk to him.
   Negative: As they were talking, she noticed a wedding ring on his finger.
   Neutral: The park was relatively busy that day.
   Target: crushed

5. Timmy was playing checkers with his sister.
   They played checkers every Friday night.
   Negative: As he was about to jump her final piece, Timmy stood up and admitted to cheating.
   Neutral: Timmy had the black pieces and his sister had the red pieces.
   Target: guilty

6. Jacob decided to enter the science fair.
   He made a volcano that spewed red lava.
   Negative: Jacob frowned as the first place medal was awarded to his friend.
   Neutral: The science fair was usually held after school.
   Target: jealousy

7. Sarah was getting ready to go to work.
   After taking a shower, she began to get dressed.
   Negative: Sarah looked down and spotted a big stain on her shirt.
   Neutral: Sarah had a routine for getting ready for work.
   Target: mad

8. Tyler was sitting on the sofa.
   He turned on the T.V. and searched for a movie to watch.
   Negative: Within a few minutes, he found a horror movie and turned off the T.V.
   Neutral: Tyler used a remote control to switch through the channels.
   Target: scared

9. Jenna decided to get a makeover.
   When she was finished, the beautician handed Jenna a mirror.
   Negative: When Jenna saw herself, she felt she looked like a clown.
   Neutral: The salon tended to have more business on the weekends.
   Target: enraged

10. Evan had the day off from work.
    He decided to read a book to pass the time.
    Negative: After reading the first half of the book, Evan could not follow the complicated storyline.
    Neutral: But he soon closed the book, and decided to do something else instead.
    Target: lost

11. Margaret went for a morning jog.
    She took her usual route.
    Negative: Halfway through her run, she felt a pain in her leg and couldn't run anymore.
    Neutral: Halfway through her run, Margaret stopped to re-tie her shoe.
    Target: agony

12. Sally was laying in bed.
    Turning over, she looked at the clock on the nightstand.
    Negative: Sally had not left the bed or eaten in three days.
    Neutral: Next to the nightstand lied Sally's books for school.
    Target: depression

13. Shane's high school prom was scheduled for this Saturday.
    The theme was "Walking in a Winter Wonderland".
    Negative: Shane approached the girl he liked to see if she would be his date, and she said "no".

Neutral: The dance was being planned by the teen council members.
Target: anguished

14. Kelly had one week before school started.
This would be her 3rd year at the university.
Negative: She spent the entire week in bed puking.
Neutral: Kelly's school was located in Denver.
Target: sick

15. Pete decided to help repaint his roommate's bedroom.
Pete bought paint to re-color the walls.
Negative: While redecorating, he saw that he spilled paint on his roommate's laptop.
Neutral: He also bought several paint brushes.
Target: fearful

16. Andy walked into class on his first day of school.
He was a new student who had just transferred from another high school.
Negative: Though he was new, the students did not include him in any of their conversations.
Neutral: Andy was tall and had brown hair.
Target: neglect

17. Helen was sitting on the couch reading from her anatomy textbook.
She was studying to become a nurse.
Negative: While Helen looked through the diagrams, her attention was drawn to her little sister's loud chewing nearby.
Neutral: But, she had to complete her clinical training first.
Target: annoy

18. Jordan was getting ready to have breakfast.
He opened the cupboards and looked inside.
Negative: He saw that there were no boxes of his favorite cereal.
Neutral: Jordan then got ready and left for work.
Target: upset

19. Kayla was preparing for the fall semester.
She had already signed up for her classes.
Negative: When Kayla asked her parents for a small loan, they refused to help.
Neutral: Kayla was studying to become a psychologist.
Target: hurt

20. Jamie was out at the carnival.
When she got to the front of the line, she sat down on the ride.

Negative: Looking down, she noted that the seatbelt was not tightly fixed to her seat.
Neutral: Jamie remembered coming to the same carnival when she was younger.
Target: terrified

21. Carl worked as a consultant for an insurance company.
He was a Claims Specialist.
Negative: By the end of the day on Friday, he had a lot of work to do over the weekend.
Neutral: Carl received his training in Houston.
Target: burdened

22. Robin Hood and Little John were walking through the forest.
As the trail ended, they came upon a large hill.
Negative: When the king's soldiers drew near, the pair dropped their swords and quickly ran away.
Neutral: The pair then crossed a stream before arriving at their destination.
Target: fear

23. Jennifer worked as a barista at the local coffeehouse.
She was cleaning the oven with her co-worker, Craig.
Negative: She never looked forward to working with Craig.
Neutral: Afterword, the two discussed who would take their break first.
Target: detest

24. Keith walked into school the day after getting his hair cut.
All the students were at their lockers, getting ready for their first class.
Negative: Since getting his haircut, he noticed that he got less attention from the girls in his class.
Neutral: Keith's high school was located in the heart of downtown.
Target: displeased