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Language and the Perception of Emotion

Kristen A. Lindquist, Lisa Feldman Barrett, Eliza Bliss-Moreau, and James A. Russell
Boston College

Three studies assessed the relationship between language and the perception of emotion. The authors predicted and found that the accessibility of emotion words influenced participants' speed or accuracy in perceiving facial behaviors depicting emotion. Specifically, emotion words were either primed or temporarily made less accessible using a semantic satiation procedure. In Studies 1 and 2, participants were slower to categorize facial behaviors depicting emotion (i.e., a face depicting *anger*) after an emotion word (e.g., "anger") was satiated. In Study 3, participants were less accurate to categorize facial behaviors depicting emotion after an emotion word was satiated. The implications of these findings for a linguistically relative view of emotion perception are discussed.

Keywords: perception, emotion, language, linguistic relativity

People believe that they can read emotions in other people. Both as scientists and as social beings, we make the commonsense assumption that a person automatically expresses his or her internal emotional state in behavior. In fact, the entire field of nonverbal behaviors is built upon the supposition that we can detect emotions in others with some degree of accuracy (see DePaulo & Friedman, 1998). This is most clearly seen in research on nonverbal communication. Researchers talk about "genuine" and "false" smiles with the idea that a person's internal emotional state gives authenticity to the facial behavior (e.g., Ekman, Davidson & Friesen, 1990). This stands in contrast to the view that facial behaviors can be related to internal states that are not strictly emotional in nature, such as smiling to invite a social interaction. Psychologists who conduct research on what has been termed "emotion recognition" assume that a perceiver is able to decode or extract emotional information from the real world, such as an emoter's observable behaviors (e.g., the facial movements), to learn something about the emoter (such as his or her internal emotional state). This decoding is thought to take place automatically, be innate (Buck, 1999; Izard, 1994), reflexive (Ekman, 1993), pan-cultural (Ekman, 1994) and correspond to natural categories of emotion (Ekman, 1997; Ekman & Friesen, 1975; Izard, 1994; Tomkins, 1962). In this view, language is not necessary for the perception of emotion to occur.

An alternate view is that language intrinsically shapes how one person perceives emotion in another person's behavior. The idea that language intrinsically shapes how people perceive, categorize, and experience reality is known as the Linguistic Relativity Hypothesis (LRH; Whorf, 1956). The LRH has been the subject of much debate over the past several decades. Initial experiments in color perception showed evidence of relativity, such that lexical differences in color words predicted the accuracy with which English speakers perceived certain colors (Brown & Lenneberg, 1954). The LRH then lost popularity, largely as a result of findings that seemed to suggest universality in color perception (e.g., Berlin & Kay, 1969; Heider, 1972). This research assessed differences in color perception across cultures and demonstrated that people could more accurately identify focal colors (i.e., the perceptual "best examples" of basic level color categories; Berlin & Kay, 1969) as compared with nonfocal colors, irrespective of the language they spoke. Specifically, when English speakers and the preliterate Dani were shown a color chip and were then asked to locate it 30 seconds later within a color spectrum (consisting of 160 different colors), both English and Dani more accurately identified focal color chips (Heider, 1972). Similarly, when Dani participants were asked to learn new words and associate them with a color chip, they remembered new words better in subsequent recall when words had been associated with focal color chips, as compared with nonfocal color chips (Heider, 1972). These findings were taken as evidence that the experience of focal colors is the same for all people, regardless of the language different social groups speak. As a consequence of this research, the LRH was largely dismissed.

Recent research has breathed new life into the idea that language impacts perception (see Gentner & Goldin-Meadow, 2003, for a review). Experiments claiming evidence for the universality of color perception have been criticized for their experimental design and for their interpretations of findings (see Lucy 1997; Lucy & Shweder, 1979; Ratner, 1989; Saunders & van Brakel, 1997; van Brakel, 1993). Furthermore, new studies of color perception have provided some of the clearest evidence for the LRH. For example, the words that people use to identify colors influence how people divide the visible range of the light spectrum into basic level categories (i.e., categories that are learned early in childhood and represent the modal level of categorization; Rosch et al., 1976), as well as how people categorize specific

Kristen A. Lindquist, Lisa Feldman Barrett, Eliza Bliss-Moreau, and James A. Russell, Department of Psychology, Boston College.

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Correspondence concerning this article should be addressed to Kristen Lindquist, Department of Psychology, Boston College, Chestnut Hill, MA, 02467. E-mail: lindqukr@bc.edu

instances of color (Davidoff, 2001; Davies & Corbett, 1997; Davies & Davidoff, 2000; Roberson, Davies & Davidoff, 2000). Participants who speak English (a language with 11 basic color terms), Russian (with 12 basic color terms) and Setswana (with 5 basic color terms) parse regions of the light spectrum differently (e.g., they make different categorizations of the blue-green region), create different numbers of color groups, and differ in the number of tiles they place in each color group (Davies & Corbett, 1997). The way that people parse the visible light spectrum has also been shown to change as people learn new color categories. When participants are trained to distinguish between two subordinate categories for the English basic level color category "blue," they are subsequently better at discriminating between different "blue" wavelengths (Özgen & Davies, 2002).

Language also influences how people use points of reference to visualize spatial locations (Levinson, 1996; Levinson, Kita, Huan, & Rasch, 2002; Pederson, Danziger, Wilkins, Levinson, Kita, & Senft, 1998). Participants' conceptions of spatial relationships were compared across five different languages (i.e., languages spoken by Dutch, Japanese, Arandic, Tetzel, and Longgu people). The Dutch and Japanese languages describe spatial relationships in a relative sense (i.e., objects are described in reference to the perceiver's point of view, e.g., the ball is to the left of the chair relative to where the perceiver stands) whereas the Arandic, Tetzel, and Longgu languages describe spatial relations in an absolute sense (i.e., objects are described in reference to a particular object, e.g., the ball is to the north of the chair). When participants were shown an array of objects, turned 180° in the opposite direction and asked to rearrange the objects on a different table, Dutch and Japanese speaking participants arranged the objects in a relative fashion and Arandic-, Tetzel-, and Longgu-speaking participants arranged the objects in an absolute fashion (Pederson, et al., 1998).

Recent empirical research also demonstrates that language may facilitate the acquisition of perceptual categories (Steels & Belpaeme, 2005). Language guides how people communicate about a shared set of categories. Without language, a social group cannot share the meaning of perceptual categories and thereby cannot use the same set of "rules" to identify aspects of the environment. Recent experiments using artificial intelligence simulations suggest that language plays an important causal role in the development of color categories (Steels & Belpaeme, 2005). Findings from this research suggest that neither biological constraints (i.e., the way that the visual system takes in and processes sensory information), nor the statistical structure of the world (i.e., the way that wavelengths are distributed in the physical world) are sufficient to allow a social group to acquire a shared set of color categories. Findings are more consistent with the notion that language drives the acquisition of color categories. This view is consistent with newer evidence showing that emotion language influences acquisition of emotion concepts (Pons, Lawson, Harris, & de Rosnay, 2003; Widen & Russell, 2003).

Language also influences the process of categorization itself. The impact of language on categorization was compared in a task where English speakers and Chinese speakers viewed a series of triplet word sequences (e.g., seagull-squirrel-tree) and grouped together the two most associated words. English emphasizes hierarchy, such that English speakers made more taxonomic word categorizations (e.g., seagull-squirrel). In contrast, Chinese emphasizes relationships between objects, such that Chinese speakers made more thematic word categorizations (e.g., squirrel-tree; Ji, Zhang, & Nisbett, 2004).

Although far from conclusive, the existing empirical evidence is consistent with the idea that there is linguistic relativity in the perception of emotion in others. People of different cultures divide the affective world into different basic emotion categories (Russell, 1991), such that emotion concepts differ across cultures. Culture also influences emotion perception in others (Elfenbein & Ambady, 2002). Furthermore, there is some evidence from the neuroscience literature that is consistent with the view that language influences the perception of emotion. Perception of emotional faces is generally associated with increased activation in a distributed face perception network (including inferior occipital gyri, the superior temporal sulcus, and lateral fusiform gyrus; Haxby, Hoffman, & Gobbini, 2000), but several studies also report increased activation in left (Gorno-Tempini, et al., 2001) and right (Nakamura, et al., 1999) inferior frontal cortex. The inferior frontal cortex regions are associated with language processing, and more specifically semantic processing (e.g., Gitelman, Nobre, Sonty, Parrish, & Mesulam, 2005) and controlled retrieval of semantic knowledge (e.g., Poldrack & Wagner, 2004; Wagner, Pare-Blagoev, Clark & Poldrack, 2001; Wiggs, Weisberg, & Martin, 1999; although some have argued that left inferior frontal cortex in involved in a more general process of information selection during conceptual processing, see, Thompson-Schill, D'Esposito, Aguirre, & Farah, 1997; Thompson-Schill, 2003). The left inferior frontal cortex, known as Broca's area, is associated with language production (Kandell, Schwartz, & Jessell, 2000). The right inferior frontal cortex is associated with emotional prosody comprehension (Ross, 2000). Taken together, these findings suggest that language and semantic knowledge may play a fundamental role in the perception of emotion on another person's face. No study to date has experimentally examined the extent to which emotion language directly influences the perception of emotion in others, however. Such is the purpose of the present report.

Semantic Satiation and the Language-Perception Link

In this article, we used a technique known as semantic satiation to manipulate language accessibility and subsequently measured its effects on emotion perception. In the typical semantic satiation experiment (e.g., Lewis & Ellis, 2000; Smith, 1984; Smith & Klein, 1990), participants repeat a category word out loud 3 or 30 times, following which they judge an exemplar (i.e., a word or perceptual object) that is either a member (i.e., matches) or nonmember (i.e., does not match) of the repeated category. Repeating a word 30 times leads to a temporary decrease in the accessibility of the word's meaning, producing semantic satiation.

The effects of semantic satiation were first documented in the early 1900s (Severance & Washburn, 1907). In recent years, semantic satiation has been shown to slow word associations (Balota & Black, 1997; Black, 2001), judgments of category membership (Smith, 1984; Smith & Klein, 1990), and identity recognition (Lewis & Ellis, 2000). Researchers propose that semantic satiation works via spreading activation, which is the same cognitive mechanism that has been offered to explain some forms of priming. In accordance with spreading activation models (e.g., Collins & Loftus, 1975), words are thought to be represented by nodes that are connected via associative pathways. Manipulating the semantic activation between associative pathways (i.e., temporarily encumbering the connection between the word and its semantic meaning, as well as its connections to other semantically related words) temporarily impedes judgments involving the word (Balota & Black, 1997). As a consequence, semantic satiation is a paradigm that is well suited to testing whether emotion perception is dependent on emotion language.

Language-Perception Hypotheses

If perception of emotion in others is in part driven by language, then people will have more difficulty identifying emotion in others when relevant emotion words have been temporarily satiated. Language may impact the perception of emotion in one of two ways. First, repeating an emotion word (e.g., "anger") might influence the perception of only those faces specifically related to the repeated word (e.g., judgments of faces depicting *anger*). We refer to this as the *category-based hypothesis*. Second, repeating an emotion word might also have a more general effect on emotion perception, such that it influences the perception of any emotional face (e.g., repeating "anger" would influence judgments of faces depicting *fear, sad, disgust,* and *anger*). This effect would be consistent with the mechanism of spreading activation that is thought to underlie semantic satiation. If emotion representations are highly associated in the semantic network, then the effects of temporarily rendering one emotion concept inaccessible might spread to other closely associated concepts, thereby rendering these concepts temporarily inaccessible as well. In this account, temporarily rendering one emotion category word (e.g., "anger") less accessible might cause another semantically related category word (e.g., "sad") to become temporarily less accessible as well. We refer to this as the *spreading activation hypothesis*. If language is epiphenomenal to perception, then semantic satiation will not impact the perception of emotion. We refer to this as the *epiphenomenon hypothesis.*

Evidence for a Language-Perception Link

Evidence of semantic satiation, and therefore a link between language and perception, could appear in either the speed or accuracy of perceptual judgments following word repetition. Experiments using semantic satiation typically yield increases in response latency for cognitive judgments following 30 repetitions of a word (e.g., Lewis & Ellis, 2000; Smith, 1984; Smith & Klein, 1990). In fact, it is standard in cognitive research to use response latency as an index of processing ease or efficiency (for a discussion, see Bargh & Chartrand, 2000; e.g., Stroop, 1935). Under normal processing circumstances, individuals favor accuracy over speed when making judgments (i.e., a speed–accuracy trade-off; e.g., Draine & Greenwald, 1998; McElree, Murphy, & Ochoa, 2005; Wickelgren, 1977). If the semantic satiation of an emotion word renders a perceptual judgment more difficult, then participants will be slower to make perceptual judgments of faces depicting emotion after repeating an emotion word 30 times.

When people are forced to favor speed over accuracy, evidence for semantic satiation, and therefore a language–perception link, would be seen as a decrement in judgment accuracy. There is little evidence in the published literature that satiation significantly reduces the accuracy of judgments because few semantic satiation studies have forced participants to favor speed over accuracy (e.g., Balota & Black, 1997; Black, 2001; Lewis & Ellis, 2000; Smith, 1984; Smith & Klein, 1990). Any procedure that would force participants to favor speed over accuracy will allow an experimental test of semantic satiation effects on judgment accuracy rates. A response window is one means of manipulating speed–accuracy trade-offs because it forces participants to make quicker judgments (e.g., Draine & Greenwald, 1998; McElree et al., 2005). We would expect, therefore, that the accuracy of perceptual judgments about emotion would become less accurate following 30 repetitions of a word when participants are asked to render their judgments quickly within a speeded response window.

In past satiation studies, the clearest evidence for semantic satiation has been found in comparing performance on word-relevant trials, where a word relevant to the judgment is repeated 30 times (satiation condition) versus 3 times (priming condition, such that the priming condition is used as a control condition) (Lewis & Ellis, 2000; Smith, 1984; Smith & Klein, 1990). In the present report, we will refer to this comparison as the *satiation comparison* (the comparison between word-relevant priming conditions, such as repeating the word "anger" 3 times followed by a judgment of a face depicting *anger*, and word-relevant satiation conditions, such as repeating the word "anger" 30 times followed by a judgment a face depicting *anger*). If participants are significantly slower or less accurate in their emotion perception judgments following emotion word satiation (30 repetitions) versus priming (3 repetitions) within in the satiation comparison, then this will constitute evidence that satiating an emotion word interfered with emotion perception.

The Present Studies

To test the language–perception link, we conducted three studies where we temporarily primed or satiated words representing basic level emotion categories (e.g., "anger," "fear") and asked participants to make subsequent judgments of facial behaviors depicting emotion. Participants repeated a word (e.g., "anger") and were then asked to judge whether a facial behavior (e.g., a facial behavior depicting *anger*) matched the repeated word. In Study 1, we predicted that the satiation of emotion category words would slow the speed with which participants categorized facial behaviors in the satiation comparison. In Study 2, we attempted to replicate and extend the results of Study 1 by implementing a perceptual matching task. Following the satiation or priming manipulation, participants saw two facial behaviors depicting emotion and judged whether the facial behaviors matched one another or not. This perceptual matching task did not involve language because it did not require participants to explicitly reference the repeated word in the subsequent judgment. The perceptual matching task ruled out the possibility that increased response latency following semantic satiation is merely caused by participants' inability to access the appropriate verbal label during the judgment stage. Finally, Study 3 was designed to demonstrate that satiation also impacts judgment accuracy. A response window caused participants to favor speed over accuracy, such that judgment accuracy was rendered the dependent variable of interest.

Study 1

Study 1 was designed to test whether satiating basic level emotion category words would slow participants' categorizations of facial behaviors prototypical of basic level emotion categories. Participants repeated an emotion category word out loud either 3 or 30 times. Next, participants were presented with a facial behavior depicting emotion and were asked to judge whether the facial behavior did or did not match the word repeated. We tested basic level emotion categories in the present studies because they represent the abstract categories that are learned early in childhood and represent the modal level of categorization (Rosch et al., 1976).

According to the spreading activation hypothesis, participants will be slower to categorize any facial behavior depicting an emotion following emotion word satiation. Repeating a basic emotion category word (e.g., "fear") 30 times would cause the meanings of the repeated word to become temporarily less accessible. To the extent that emotion category words are distributed in a semantic network, other semantically related emotion category words might become temporarily less accessible as well. In this account, participants would be slower to categorize any facial behaviors depicting emotion (e.g., categorizations of faces depicting *sad*) following emotion word satiation (e.g., "fear").

According to the category-based hypothesis, individuals would be slower to categorize facial behaviors that matched the word they repeated 30 times (vs. 3 times). Repeating a basic emotion category word (e.g., "fear") 30 times would cause the meaning of the word to become less accessible for a brief amount of time, thereby causing participants to be slower in subsequent categorizations involving the word's meaning (e.g., in categorizations of faces depicting *fear*).

According to the *epiphenomenon hypothesis*, the semantic satiation of an emotion word would not affect the speed with which participants categorize facial behaviors of emotion. In this account, the speed with which participants categorize facial behaviors following satiation would not differ from the speed of categorizations following priming.

Method

Participants

Participants were 53 undergraduate psychology students (28 women and 25 men; M_{age} = 19, SD_{age} = 0.75, 82% Caucasian; 11% Asian/Pacific Islander; 4% African American; 5% Hispanic). Data from 2 participants were removed from analysis due to computer errors during the experiment. English was the first language of all participants. Participants were compensated with 1 credit toward their research requirement.

Procedure

Participants were tested individually during one laboratory session. Participants were told the cover story that the study was designed to examine speech processing in those who spoke English as their first language versus those who did not. In reality, only English speaking participants were recruited.

After completing preliminary measures (not relevant to this study), participants completed the emotion judgment task modeled after Lewis and Ellis (2000). Participants sat 60 cm from the computer screen and were asked to place the left index finger on the "1" key and the right index finger on the "9" key. They were then presented with a series of 96 trials (plus 4 practice trials). On a given trial, participants were presented with one of six emotion words (i.e., "happy," "sad," "fear," "anger," "surprise," or "disgust") and asked to pronounce the word out loud as it appeared on the screen. The word appeared on screen for 500 ms, either 3 times (prime condition) or 30 times (satiation condition) with a 200 ms interval between repetitions. After repeating the emotion word, participants viewed a blank screen for 200 ms, followed immediately by a fixation cross for 500 ms. Next, participants viewed a photograph depicting facial muscle configurations that were prototypic of an English emotion category (*happy, sad, surprise, disgust, anger* and *fear*; taken from Ekman & Friesen, 1976). On a given trial, facial configurations either matched or did not match the emotion word participants repeated. The face remained on screen until the participant either pressed the "9" key (indicating a match) or the "1" key (indicating a mismatch). The computer recorded the latency of response (in ms) and the accuracy of the category judgment. Facial stimuli of four identities (two male and two female) were used for each emotion category (*happy, sad, surprise, disgust, anger,* or *fear*), resulting in 24 stimuli. On average, *anger* was represented in 15% of the trials, *disgust* in 14.5%, *fear* in 14.9%, *happy* in 26.6%, *sad* in 15.1%, *surprise* in 13.9%. Because participants were not exposed to an equal number of trials of each emotion category, we used weighted mean reaction times for correct responses and percentage of accurate responses in data analyses. Weighted mean latency and accuracy rates were calculated per each participant for each of the four trial types. Data for reaction times below 200 ms or above 3,000 ms (7% of the total trials) were not included for analysis (as per Balota & Black, 1997).

Results

A 2 (Repetition: 3 v. 30 repetitions) × 2 (Word Relevance: word-face match vs. word-face mismatch) repeated measures analysis of variance (ANOVA) was performed on the response latency data and on the accuracy data. Weighted mean response latencies and average percentage correct for each trial type are presented in Tables 1 and 2, respectively. A significant main effect of repetition would constitute evidence for the spreading-activation hypothesis (because repeating any emotion word 30 times would cause participants to take longer to render a perceptual judgment). A Repetition × Word Relevance interaction would constitute evidence for the category-based hypothesis (because repeating an emotion word 30 times would cause participants to take longer to render a perceptual judgment only when the word and face stimulus belonged to the same emotion category). In particular, the strongest evidence for the category-based hypothesis would be a significant difference in response latencies in the satiation comparison trials (i.e., on trials where an emotion word that matches a subsequent face stimulus is repeated 30 vs. 3 times). Absence of significant

Table 1
Weighted Mean Response Latencies: Study 1

Repetition condition	Judgment type		Marginal means
	Match	Mismatch	
3 (Priming)	1306.41 (35.93)	1334.32 (43.05)	1320.37 (36.29)
30 (Satiation)	1362.04 (40.19)	1367.35 (46.12)	1364.70 (41.61)
Marginal means	1334.23 (36.83)	1350.84 (42.74)	

Note. Response latencies are presented in ms. Standard errors are presented in parentheses.

Table 2
Mean Accuracy Rates: Study 1

Repetition condition	Judgment type		Marginal means
	Match	Mismatch	
3 (Priming)	.94 (.01)	.88 (.01)	.91 (.01)
30 (Satiation)	.94 (.01)	.92 (.01)	.93 (.01)
Marginal means	.94 (.01)	.90 (.01)	

Note. Mean accuracy is reported in percentages. Standard errors are presented in parentheses.

satiation effects in the response latency data would constitute support for the epiphenomenon hypothesis.

There was some evidence for the spreading activation hypothesis, as evidenced by a main effect of repetition in the response latency data. Participants were slower to categorize facial stimuli after repeating an emotion word 30 times (M = 1364.70) as compared with repeating it 3 times (M = 1320.37), $F(1, 52) = 8.09$, $p < .01$, ($\eta^2 = .14$). There was also a main effect of repetition for accuracy, such that participants were more accurate in their categorizations of facial stimuli following the satiation manipulation (M = 0.93) as opposed to priming (M = 0.91), $F(1, 52) = 11.18$, $p < .002$, ($\eta^2 = .18$). In combination, these findings are consistent with the presence of a speed–accuracy trade-off. Participants seem to have been favoring accuracy over speed, thereby slowing the speed of judgments down to increase their accuracy. The presence of a speed–accuracy trade-off is consistent with the hypothesis that satiation of emotion language makes subsequent perceptions of emotion more difficult. Participants may have found it more difficult to categorize facial behaviors following satiation because they could not access the meaning of an emotion category word implicated in the categorization task. Participants compensated for this difficulty by taking more time to correctly categorize facial behaviors.

In addition to finding evidence for the spreading activation hypothesis, we also found evidence consistent with the category-based hypothesis. The Repetition × Word Relevance interaction did not reach statistical significance in the response latency analysis, $F(1, 52) = 0.46$, $p < .50$, ($\eta^2 = .01$), but a closer inspection of the mean response latency for each condition suggests that participants' judgments were significantly different in the satiation comparison trials. Participants were slower to categorize face stimuli (e.g., a face depicting *fear*) when a judgment relevant word (e.g., "fear") was satiated (M = 1362.04) versus primed (M = 1306.41), $t(52) = -2.83$, $p < .007$. Participants performed equally slowly when they repeated an irrelevant emotion word (e.g., repeated "fear" but judged a face depicting *anger*) 30 times (M = 1367.35) versus 3 times (M = 1334.32), $t(52) = -1.29$, $p < .203$.

Although there was evidence for the category-based hypothesis in the satiation comparison trials (i.e., participants were slower following 30 vs. 3 repetitions of a word, when the emotion word matched the emotion depiction to be judged), participants did not differ in their accuracy for this comparison (satiation trials, M = 0.94, priming trials M = 0.94), $t(52) = 0.74$, $p < .47$). Instead, participants were the least accurate on trials where they repeated a word 3 times but the word did not match the subsequent facial stimulus to be categorized (e.g., trials where participants repeated "sad" 3 times and were asked to categorize a facial behavior depicting *anger*). This resulted in a Repetition × Word Relevance interaction, $F(1, 52) = 5.87$, $p < .02$, ($\eta^2 = .10$). The pattern of means was most consistent with what we know of priming effects. Repeating a word 3 times served to increase accessibility of a word's meaning, such that participants expected that they would see an exemplar of the primed category. When the primed word was irrelevant to the facial stimulus presented, participants had to inhibit their prepotent response expectancy in order to render an accurate judgment.

Finally, the main effect for word relevance was also significant in accuracy rate analyses, such that participants were more accurate on judgments where the face they saw matched the repeated word (e.g., they repeated "anger" 3 or 30 times and saw a face depicting *anger*), $F(1, 52) = 17.54$, $p < .001$, ($\eta^2 = .25$). The main effect for word relevance in response latency analyses did not reach statistical significance, $F(1, 52) = 0.54$, $p < .47$, ($\eta^2 = .01$).

Discussion

Study 1 provided initial evidence that emotion language influences emotion perception. We saw evidence that interfering with the accessibility of basic level emotion category words encumbered emotion perception. Analysis of the response latency data provided evidence of a speed–accuracy trade-off, such that participants were slower, but more accurate, to categorize faces depicting emotion following a satiation manipulation. The fact that participants slowed responses to make correct emotion categorizations is consistent with the idea that language influences perception, because it suggests that emotion categorization was more difficult to perform after the meaning of an emotion word was made temporarily less accessible. This pattern of findings is consistent with the spreading activation hypothesis, because it suggests that participants were slower to make a perceptual judgment of any emotional facial behavior (e.g., a facial behavior depicting *sad*) following 30 repetitions of an emotion word (e.g., "anger").

Closer examination of the means provided some support for the category-based hypothesis. Participants were significantly slower to make a perceptual judgment of an emotional facial behavior (e.g., a face depicting *sad*) following 30 versus 3 repetitions of a judgment relevant emotion word (e.g., "sad"). Participants were not significantly slower to make a perceptual judgment of an emotional facial behavior (e.g., a face depicting *sad*) following 30 versus 3 repetitions of a judgment irrelevant emotion word (e.g., "anger"), however. This finding is largely consistent with the category-based hypothesis because repeating relevant emotion words 30 times (as compared with 3 times) caused participants to make slower categorizations of facial behaviors. Repeating irrelevant emotion words 30 times (as compared with 3 times) did not significantly impair participants' ability to categorize facial behaviors. Instead, participants performed equally as slowly on all trial types where the word repeated was irrelevant, regardless of whether the word was repeated 3 or 30 times.

Although Study 1 provided preliminary evidence that language supports emotion perception, other interpretations are possible. For example, these findings might indicate that emotion word satiation (e.g., repeating "fear" 30 times) merely impeded participants' ability to label the emotion they saw (e.g., the ability to label a face as "fearful"). This alternate hypothesis would imply that people could perceive emotion after repeating an emotion word 30 times, but that their ability to produce a verbal label was slowed. Study 2 addressed the issue more directly.

Study 2

Study 2 was designed to test the impact of emotion word satiation on emotion perception more directly. Specifically, Study 2 included a perceptual judgment task that did not directly depend on the use of emotion words. After repeating a word (such that the word's meaning was primed or satiated), participants were presented with two pictures of facial behaviors depicting emotion and were asked to judge whether they matched each other or not. To produce a correct response, participants had to categorize each stimulus and then decide whether or not they matched one another. If emotion words supported perception, then satiating emotion words would interfere with the judgment process. Thus, the perceptual matching task allowed us to examine how language influenced perception even though the participants were not required to verbally label the face stimuli.

As in Study 1, a significant main effect of repetition would constitute evidence for the spreading-activation hypothesis (because repeating any emotion word 30 times would cause participants to take longer in rendering perceptual judgments about emotion). A Repetition × Word Relevance interaction would constitute evidence for the category-based hypothesis (because repeating a relevant emotion word 30 times vs. 3 times would cause participants to take longer in rendering perceptual judgments about emotion, but repeating an irrelevant word 30 times vs. 3 times would not impact the speed with which participants rendered perceptual judgments). In particular, evidence for the category-specific hypothesis would be a significant difference in response latencies in the satiation comparison trials (i.e., on trials where an emotion word that matched a subsequent face pair was repeated 30 vs. 3 times). In Study 2, the satiation comparison trials of interest were trials in which participants repeated a word either 30 times (satiation) versus 3 times (priming) (e.g., "anger" was repeated 3 or 30 times), following which the participant judged a face pair depicting the same emotion (e.g., two faces depicting *anger*). As in Study 1, then, the *satiation comparison* consisted of performance on word-relevant trials, but in Study 2, both face stimuli matched the repeated word. Finally, absence of significant satiation effects in the response latency data would constitute support for the epiphenomenon hypothesis.

Study 2, unlike Study 1, involved complex trial types, where the repeated emotion word (e.g., "anger") was irrelevant to either both face stimuli presented (e.g., a face depicting *fear* and a face depicting *disgust*) or one of the face stimuli presented (e.g., a face depicting *fear* and a face depicting *anger*) on a given trial. Previously published satiation studies have not focused on participants' performance in complex trial types where the word repeated did not match the stimuli to be judged (e.g., where participants repeated the word "piano" but were asked to judge whether the word pair "organ–kidney" was associated with the repeated word; Black, 2001). A close look at the literature suggests, however, that performance is worst on these trial types, as compared with satiation comparison trials (where the word repeated 3 or 30 times is relevant to judgments). We suspect that participants' poor performance on complex trial types is due to a more general verbal interference effect (e.g., Hermer-Vasquez, Spelke, & Katsnelson, 1999; Roberson & Davidoff, 2000). Verbal interference occurs when participants repeat words out loud prior to making cross-category judgments, such that category judgments become more difficult (Roberson & Davidoff, 2000). Verbal interference works as a kind of "linguistic load" that prevents judgment-necessary language from being accessed, therefore interfering with judgment performance (e.g., repeating any word interferes with any perceptual judgment that requires language). In Study 2, then, we also expected that participants would perform particularly poorly on trials where the emotion word (e.g., "sad") did not match face pairs to be judged (e.g., a pair of faces depicting *fear* and *disgust*). Evidence of verbal interference would occur if performance was equally impeded on more complex trial types, regardless of whether an emotion word was repeated 30 or 3 times.

Method

Participants

Participants were 40 undergraduate psychology students (19 women, 21 men, $M_{age} = 19$, $SD_{age} = 1.10$; 75% Caucasian; 10% Asian/Pacific Islander; 5% African American; 5% Hispanic; 5% Other). English was the first language of all participants. Participants were compensated with 1 credit toward their research requirement. One participant was excluded from analysis because of failure to comply with experimental procedure.

Procedure

Participants were tested individually during one laboratory session. As in Study 1, participants were presented with a cover story that the study was designed to examine speech processing in those who spoke English as their first language versus those who did not. In reality, only English-speaking participants were recruited.

Participants completed an emotion judgment task similar in many respects to that used in Study 1 (modeled after Lewis & Ellis, 2000). Study 2 differed from Study 1 in two important ways. First, the task was modified such that participants completed a perceptual matching task following emotion word satiation or priming. In the perceptual matching task participants were presented with two facial behaviors (taken from Ekman & Friesen, 1976) that were prototypic of English emotion categories (i.e., *sad, fear, anger,* and *disgust*) and were asked to judge whether the facial behaviors matched one another or not. Trial types used in Study 2 are presented in Table 3. Facial stimuli of 4 identities (2 male and 2 female) were used for each emotion category (*sad, fear, anger*, and *disgust*), resulting in 16 stimuli. Facial identities were randomly paired, such that participants saw two different identities on any given perceptual matching task (i.e., the identities of faces never "matched," e.g., participants never

Table 3
Study 2 Trial Types

Condition	Word repeated	Face stimuli	Example
1	Relevant	Match	"fear" repeated, judge two *fear* faces
2	Relevant	Mismatch	"fear" repeated, judge a *fear* face and a *disgust* face
3	Irrelevant	Mismatch	"fear" repeated, judge a *sad* face and an *anger* face

Table 4
Mean Response Latencies: Study 2

Repetition condition	Judgment type: Repeated word and both face stimuli match	Repeated word and one face stimulus match	Repeated word and both face stimuli mismatched	Marginal means
3 (Priming)	917.62 (15.78)	993.99 (14.47)	989.89 (17.00)	967.17 (14.37)
30 (Satiation)	953.02 (16.46)	1023.06 (15.63)	1007.11 (15.91)	994.40 (14.71)
Marginal means	935.32 (15.46)	1008.53 (13.89)	998.50 (15.10)	

Note. Response latencies are presented in ms. Standard errors are presented in parentheses.

saw two Male identity #1 faces presented side by side).[1] Second, participants were primed or satiated with only four basic level emotion category words (i.e., "sad," "anger," "fear," and "disgust") instead of the six used in Study 1. In Study 1, we found that participants showed near ceiling accuracy rates for judgments involving the category *happy.* This effect may have occurred because *happy* was the only positive emotion represented in Study 1, and participants used valence to distinguish facial stimuli prototypic of *happy* from the five other negatively valenced facial stimuli that were presented.

Participants were presented with a series of 128 trials (plus four practice trials) broken into two blocks of trials. On a given trial, participants were presented with one of four negatively valenced emotion words (i.e., "sad," "fear," "anger," or "disgust") and asked to pronounce the word out loud either 3 times (prime condition) or 30 times (satiation condition) with a 200 ms span between repetitions. After repeating the emotion word, participants viewed a blank screen for 200 ms, followed immediately by a fixation cross for 500 ms. Next, participants completed a perceptual matching task. Participants had to respond by pressing the "9" key (indicating that the facial behaviors matched) or the "1" key (indicating that the facial behaviors did not match). In the second block of trails, the responses associated with the "1" and the "9" keys were switched to control for the effect of handedness on the speed of participants' responses. The computer recorded the latency of response (in ms) and the accuracy of the category judgment. If participants did not register a judgment within the response window, the computer coded the response latency as zero and moved on to the next trial.

Results

A 2 (Repetition: 3 vs. 30) × 3 (Word Relevance: word repeated is relevant to both vs. one vs. neither facial stimuli) repeated measures ANOVA was performed on the latency data and on the accuracy data. Mean response latencies and average percentage correct for each trial type is presented in Tables 4 and 5, respectively. As in Study 1, absence of significant satiation effects in the response latency data would constitute support for the epiphenomenon hypothesis. A significant main effect of repetition would constitute evidence for the spreading-activation hypothesis (because repeating any emotion word 30 times would cause participants to take longer in rendering a perceptual judgment). A Repetition × Word Relevance interaction would constitute evidence for the category-based hypothesis (because repeating only a judgment-relevant emotion word 30 times would interfere with a participant's emotion perception judgments).

As in Study 1, analysis of the response latency data yielded some support for the spreading activation hypothesis. There was a main effect of repetition, such that participants were slower to perceptually match the faces depicting emotion following the satiation manipulation ($M = 994.40$) when compared with the priming manipulation ($M = 967.17$), $F(1, 38) = 12.57$, $p < .001$, ($\eta^2 = .25$). The effect of repetition on accuracy rates did not reach statistical significance, $F(1, 38) = 0.129$, $p < .721$, ($\eta^2 = .003$). This finding suggests that participants were not enlisting in a speed–accuracy trade-off in Study 2.

Analysis of the latency data was also consistent with the category-based hypothesis. Although the Repetition × Word Relevance interaction did not reach statistical significance in the response latency analysis, $F(2, 76) = 0.79$, $p < .46$, ($\eta^2 = .02$), a closer inspection of the latency means showed evidence that emotion language influenced emotion perception in the satiation comparison trials. Participants were slower to perceptually match two faces depicting the same emotion (e.g., *anger*) when a relevant emotion word (e.g., "anger") was repeated 30 ($M = 953.02$) as compared with 3 times ($M = 917.62$), $t(38) = -3.86$, $p < .001$. A similar pattern of findings was observed in the analysis of mean accuracy rates. Although the Repetition × Word Relevance interaction did not reach statistical significance in accuracy rate analysis, $F(2, 76) = 0.972$, $p < .383$, ($\eta^2 = .025$), a closer analysis of mean accuracy rates demonstrated that participants were marginally less accurate in perceptual matching judgments when a relevant emotion word was repeated 30 ($M = 0.68$) versus 3 times ($M = 0.72$), $t(38) = 1.72$, $p < .09$. The perception of emotion was specifically encumbered after satiating (vs. priming) a relevant emotion word, but repeating an irrelevant emotion word on complex trial types (e.g., trials where the word repeated was irrelevant to one or both of the facial behaviors in the perceptual matching task) interfered with emotion perception under any circumstance. Participants were equally slow to judge faces depicting emotion (e.g., *disgust* and *anger*) after repeating a judgment-irrelevant word (e.g., "fear") either 3 ($M = 989.88$) or 30 times ($M = 1007.11$) $t(38) = -1.31$, $p < .20$. Participants were also equally inaccurate to judge facial stimuli following 30 repetitions ($M =$

[1] We also instituted a response window (as per Draine & Greenwald, 1998) to attempt to force participants to favor speed over accuracy as they rendered a perceptual judgment. A 1,400 ms response window was chosen because it was the median response latency in data from Study 1 (i.e., it was the median within the range of meaningful responses, defined as 200 ms–3,000 ms, following Baltota & Black, 1997). The window was too large to shift people from favoring accuracy to favoring speed, however, rendering latency, rather than accuracy, the main variable of interest.

Table 5
Mean Accuracy Rates: Study 2

Repetition condition	Judgment type: Repeated word and both face stimuli match	Repeated word and one face stimulus match	Repeated word and both face stimuli mismatched	Marginal means
3 (Priming)	.72 (.03)	.47 (.03)	.58 (.03)	.59 (.02)
30 (Satiation)	.68 (.03)	.48 (.03)	.59 (.04)	.59 (.03)
Marginal means	.70 (.03)	.47 (.02)	.59 (.03)	

Note. Mean accuracy is reported in percentages. Standard errors are presented in parentheses.

0.59) versus 3 repetitions ($M = 0.58$), of an emotion word when the word was irrelevant to both facial stimuli (e.g., when "anger" was repeated and participants saw a face depicting *sad* and a face depicting *fear*), $t(39) = -0.32$ $p < .75$. Mean latency and accuracy rates were similar when participants repeated judgment-irrelevant words prior to making a perceptual judgment, regardless of whether the emotion word was repeated 3 (priming) or 30 times (satiation). These findings can be interpreted as evidence of verbal interference.

This verbal interference effect is best exemplified by the significant main effect for word relevance in both the latency and accuracy data, such that participants were slower and less accurate when the face stimuli depicted different emotion categories and the repeated emotion word failed to match at least one of the faces, $F(2, 76) = 45.08$, $p < .001$, ($\eta^2 = .54$), and $F(2, 76) = 42.95$, $p < .001$, ($\eta^2 = .53$), respectively.

Discussion

As in Study 1, findings from Study 2 were consistent with the hypothesis that it is possible to interfere with the perception of emotion by rendering emotion words less accessible. Study 2 clearly demonstrated that semantic satiation did not merely make it more difficult to apply a verbal label to a perceived emotional face, but rather made it more difficult to perceive emotion on another person's face.

As in Study 1, we found evidence for both the spreading activation and category-based hypotheses. Participants were slowest to perceptually match emotion faces after an emotion word was satiated. This pattern of findings is consistent with the spreading activation hypothesis, because it suggests that making any emotion word less accessible interfered with the perceptual matching of faces depicting emotion. A closer analysis of mean response latencies and accuracy rates yielded evidence consistent with the category-based hypothesis as well. Participants were significantly slower to make perceptual judgments of faces depicting emotion (e.g., two faces depicting *fear*) after a judgment-relevant emotion word (e.g., "fear") was satiated. Participants were also marginally less accurate in their emotion perceptions under these conditions. Although the pattern of findings from Studies 1 and 2 are consistent with the hypothesis that emotion language supports emotion perception, an alternative hypothesis for satiation effects remains. Participants may have been slower and less accurate on the perceptual matching task following emotion word satiation because they were fatigued from repeating a word 30 times. This explanation is unlikely, however. If decrements in performance were due to fatigue, then participants would have been slower or less accurate after repeating an emotion word 30 times (as compared with 3 times) on complex trial types (e.g., they would have performed worse on their judgment of faces depicting *fear* and *sad* after repeating "anger" 30 times as compared with repeating it 3 times). Instead, we observed a pattern that was more consistent with a verbal interference effect, where participants were slower and less accurate to perceive emotion when they repeated an irrelevant word either 3 or 30 times.

Study 3

Study 3 was designed to replicate and extend the findings from Studies 1 and 2 by assessing the impact of semantic satiation on judgment accuracy. It is difficult to significantly impair the accuracy of perceptual judgments under normal conditions. For example, the Stroop interference effect is one of the most reliable and robust effects in cognitive science and it is always evidenced in response latency (see MacLeod, 1991, for a review). Stroop interference does not often appear in response accuracy (e.g., Kane & Engle, 2003), because people tend to favor accuracy over speed. To force participants to favor speed over accuracy, we instituted a short response window in the experimental paradigm (e.g., Draine & Greenwald, 1998; McElree, et al., 2004). A response window forces participants to produce quicker responses, thereby rendering accuracy the dependent variable of interest (e.g., Drain & Greenwald, 1998; Schouten & Bekker, 1967; Wickelgren, 1977). If small enough, a response window would have the effect of clarifying the impact of emotion word satiation on emotion perception.

In Study 3, as in Study 2, evidence for the spreading activation hypothesis would be seen as a main effect of repetition, because individuals would make less accurate perceptual matching judgments of all faces after repeating an emotion word 30 versus 3 times. Evidence for the category-based hypothesis would be seen as a Repetition × Word Relevance interaction in the accuracy rate data, followed by differential perceptual accuracy in the satiation comparison conditions. In Study 3, as in Study 2, the satiation comparison involved comparing performance on 30 repetition (satiation) and 3 repetition (priming) trials where the repeated word belonged to the same emotion category as the facial stimuli to be judged (e.g., trials where participants repeated "anger" 30 vs. 3 times and judged face pair depicting *anger*). Specifically, we would expect individuals to be less accurate to perceptually match facial behaviors (e.g., a face pair depicting *disgust*) following 30 versus 3 repetitions of a relevant emotion category word (e.g., "disgust"). Evidence for the epiphenomenon hypothesis would be seen if the satiation manipulation did not significantly decrease the accuracy with which individuals perceive emotion on another person's face.

Method

Participants

Participants were 37 undergraduate psychology students (19 women, 18 men, M_{age} = 19, SD_{age} = 0.89. 86.5% Caucasian; 5.4% Asian/Pacific Islander; 2.7% African American; 2.7% Hispanic; 2.7% Other). English was the first language of all participants. Participants were compensated with 1 credit toward their research requirement.

Procedure

The procedure for Study 3 was similar to Study 2, except for the addition of a fourth trial type. Trial types used in Study 3 are presented in Table 6. In Study 3, trial types were the three conditions used in Study 2: where a repeated emotion word matched the emotional content of both of the face stimuli (e.g., "fear" was repeated followed by a face pair depicting *fear*), where a repeated emotion word matched the emotional content of one face stimulus (e.g., "fear" was repeated followed by a face pair depicting *fear* and *sad*), or where a repeated emotion word matched the emotion content of neither of the face stimuli (e.g., "fear" was repeated followed by a face pair depicting *disgust* and *sad*); plus, a fourth condition where the repeated emotion word was irrelevant to the perceptual judgments, but the facial stimuli to be judged matched one another (e.g., "fear" was repeated followed by a face pair depicting *disgust*). Therefore, in Study 3, participants repeated an emotion category word either 3 or 30 times (repetition conditions) following which they judged the similarity of facial stimuli in 1 of 4 perceptual matching conditions. Specifically, participants were asked to judge whether two faces matched one another or not (face-matching conditions) after repeating a word that was relevant or irrelevant to the judgment or not (word-relevance conditions).

In addition, the response window was shortened to 854 ms to ensure that we could assess the early effects of language on the accuracy of participants' perceptual judgments. Accuracy rates were calculated for each participant for each trial type. Latency rates were not analyzed in Study 3 because the response window forced participants to hold latency constant.

Results and Discussion

A 2 (Repetition: 3 vs. 30) × 2 (Word-Relevance: relevant vs. irrelevant) × 2 (Face-Matching: match vs. mismatch) repeated measures ANOVA was performed on the accuracy data. Average percentage correct for each condition is presented in Table 7.

Table 6
Study 3 Trial Types

Condition	Word repeated	Face stimuli	Example
1	Relevant	Match	"fear" repeated, see two *fear* faces
2	Relevant	Mismatch	"fear" repeated, see a *fear* face and a *disgust* face
3	Irrelevant	Mismatch	"fear" repeated, see a *sad* face and an *anger* face
4	Irrelevant	Match	"fear" repeated, see two *sad* faces

Table 7
Mean Accuracy Rates: Study 3

Repetition condition	Relevant		Irrelevant		Marginal means
	Match	Mismatch	Match	Mismatch	
3 (Priming)	.42 (.04)	.31 (.03)	.21 (.03)	.28 (.04)	.31 (.03)
30 (Satiation)	.36 (.04)	.23 (.03)	.23 (.04)	.25 (.03)	.27 (.03)
Marginal means	.39 (.04)	.27 (.03)	.22 (.03)	.26 (.03)	

Note. Mean Accuracy is reported in percentages. Standard errors are presented in parentheses.

As in Studies 1 and 2, we saw evidence for the spreading activation hypothesis. The ANOVA yielded a main effect of repetition, such that participants were less accurate to perceptually judge facial behaviors following the satiation manipulation (M = 0.27) as opposed to priming (M = 0.30), $F(1, 35) = 5.12$, $p < .03$, ($\eta^2 = .13$). Thus, participants were less accurate in perceptual judgments of any emotional face (e.g., a face depicting *sad*) following 30 repetitions of an emotion word (e.g., "anger").

We also found evidence for the category-based hypothesis. Findings yielded a Repetition × Word Relevance interaction $F(1, 35) = 5.77$, $p < .02$, ($\eta^2 = .14$), and a closer analysis of the mean accuracy for trials in the satiation comparison indicated that participants were marginally less accurate to judge two faces matching in emotion content (two faces depicting *anger*) following 30 repetitions of a relevant emotion word (e.g., repeating "anger") (M = 0.36), as compared with 3 repetitions (M = 0.41), $t(35)$ = 1.71, $p < .10$.

As in Study 2, we also found evidence of verbal interference. As expected, participants were less accurate overall on complex trial types for which the word repeated was irrelevant to the judgment task. There was a significant a main effect of word relevance, $F(1, 35) = 36.78$, $p < .001$, ($\eta^2 = .51$), such that participants were less accurate to perceptually judge a face pair after repeating a judgment-irrelevant word, regardless of whether the word was repeated 3 or 30 times. The Word Relevance × Face-Matching interaction was also statistically significant, $F(1, 35) = 36.32$, $p < .001$, ($\eta^2 = .51$), such that participants were less accurate when all three stimuli did not match (e.g., when "anger" was repeated, and participants viewed a face pair depicting *fear* and *sad*), regardless of whether an emotion word was primed or satiated. Specifically, the mean accuracy of participants' perceptual judgments was not significantly different following 30 repetitions (M = 0.23) as compared with 3 repetitions (M = 0.21) of a judgment irrelevant word, $t(35) = -0.624$, $p < .54$. Furthermore, this pattern of results indicates that judgment accuracy rates did not reflect participant fatigue, where we would expect to see a significant decrement in 30- versus 3-repetition trials for complex trial types. The main effect of face-matching did not reach statistical significance, $F(1, 35) = 1.81$, $p < .19$, ($\eta^2 = .05$), nor did the repetition × face-matching interaction, $F(1, 35) = 1.29$, $p < .26$, ($\eta^2 = .04$), nor the Repetition × Word Relevance × Face-Matching interaction, $F(1, 35) = .592$, $p < .45$, ($\eta^2 = .02$).

General Discussion

Our findings provide initial support for the hypothesis that language influences the perception of emotion. In all three studies, participants found it more difficult to render perceptual judgments about faces depicting emotion when emotion language was made less accessible via a standard semantic satiation procedure. In Study 1, participants were slower to perceive emotion in others after the meaning of an emotion word implicated in the perception task was made temporarily less accessible. Studies 2 and 3 again demonstrated the language-perception link. Study 2 replicated the finding from Study 1 that participants were slower to perceive emotion in others when the meaning of a relevant emotion word was made less accessible. In Study 2, this effect occurred even when the perception task did not explicitly require the use of emotion words. In Study 3, forcing participants to favor speed over accuracy made them less accurate to perceive emotion in others when the meaning of a relevant emotion word was made less accessible. Furthermore the pattern of findings from Studies 2 and 3 together were not consistent with the view that participants were slower to perceive emotion or made more perceptual errors following emotion word satiation merely because they were fatigued after repeating a word 30 times. Taken together, these findings provide initial experimental evidence that emotion language can be satiated, and doing so interferes with the perception of emotion in others. Most importantly, our findings demonstrate that language influences people's ability to perceive emotion, even when a perceptual task does not require the explicit use of language.

The present studies provided some information regarding the structure of the semantic satiation effects. There was some evidence for the spreading activation hypothesis, in that satiating any emotion word made emotion perception more difficult (compared with when emotion words were primed). Findings across the three studies also produced evidence for the category-based hypothesis, in that semantic satiation interfered with emotion perception in a category-specific manner.

As in prior published studies (Black, 2001; Smith & Klein, 1990), participants were slower and less accurate to make judgments on complex trial types where the emotion word repeated did not match the exemplars (face pairs) to be judged. For example, in Black (2001), participants had more difficulty with word association judgments (e.g., after repeating a judgment irrelevant word such as "piano" 3 or 30 times, and judging whether a word pair such as "organ-flower" matched the repeated word). We believe that participants' performances on this trial type are evidence of a more general verbal interference effect (e.g., Hermer-Vasquez et al. (1999); Roberson & Davidoff, 2000). Verbal interference occurs when participants repeat irrelevant words prior to perceptual judgments, such that judgments become more difficult (Hermer-Vasquez et al., 1999; Roberson & Davidoff, 2000). This interpretation was reinforced by the observation that participants generally made more errors on trials in which the repeated word was irrelevant to the perceptual matching judgments, regardless of how many times that word was repeated. Verbal interference has been shown to impede spatial perception (Hermer-Vasquez et al., 1999) and the categorical perception of color and emotions (Roberson & Davidoff, 2000). For example, participants were generally better at distinguishing between cross-category pairs of colors (e.g., blue and green tiles) than within-category pairs (e.g., two different blue tiles) when asked to indicate if colors were the same or different. Repeating a series of different words out loud (e.g., "beige," "tan," "navy," etc. in Experiment 1; "beech," "pegs," "mice," etc. in Experiment 3) prior to color category judgments made it more difficult for participants to determine if two colors were the same or different (Roberson & Davidoff, 2000). Verbal interference removed this cross-category advantage, presumably because participants could not use color words to facilitate their judgments (Roberson & Davidoff, 2000). Similarly, repeating a series of different emotion words removed the cross-category advantage for judgments of emotion face pairs (e.g., participants could not distinguish between a *happy* and *sad* face better than between two *sad* faces; Roberson & Davidoff, 2000).

At first blush, an alternate explanation for our findings, then, may be that semantic satiation is merely an instance of a more general verbal interference effect. The pattern of findings does not support the alternate hypothesis, however. Individuals' ability to perceive emotion in others was significantly impaired following 30 repetitions of a relevant emotion word, as compared with 3 repetitions. This finding was consistent across all three studies. If our findings were due to verbal interference alone, then we would not expect individuals to demonstrate a relative decrement in performance following 30 versus 3 repetitions of a relevant word. Verbal interference would cause a decrement in performance regardless of whether a word was repeated 3 or 30 times.

Evidence from the field of neuroscience also does not support the view that semantic satiation is an instance of verbal interference. Repeated exposure to a stimulus (such as occurs in semantic satiation) causes neural habituation at both the cellular (e.g., Desimone, 1996) and regional (e.g., Fischer, Wright, Whalen, McInerney, Shin, & Rauch, 2003; Wright, Fischer, Whalen, McInerney, Shin, & Rauch, 2001) levels of the brain. This effect, known as repetition suppression, allows an organism to be more behaviorally efficient, because it impedes the processing of a nonpredictive stimulus (Desimone, 1996; Fisher et al., 2003). Semantic satiation may depend on this neural process because massive repetition of a word that does not predict anything may cause temporary habituation to the word's semantic meaning. In contrast, verbal interference effects do not result from a habituation process, because participants read a number of different words out loud, rather than repeating the same word. Verbal interference may interfere with perception because it loads or occupies language-processing faculties of the brain. Therefore, language may interfere with perception via two different mechanisms in the present studies: satiation (the decrease in accessibility of a word's meaning) or interference (linguistic load).

Future Research

These studies provided first evidence that the semantic satiation of emotion language influences emotion perception. While the present findings hint at mechanism, more research is needed to clarify the mechanisms underlying the semantic satiation of emotion language. More detailed research might reveal stronger spreading activation effects. To the extent that spreading activation is the mechanism that underlies satiation, it would first be useful to vary the types of category words that are satiated. Specifically, future studies should include control trials where category-irrelevant words (i.e., "car") are satiated and primed prior to emotion perception. If spreading activation underlies satiation, then we would not expect to see a decrement in performance on perceptual judgments of faces depicting *fear* following 30 repetitions of the word "car." This finding would also more definitely determine whether decrements in emotion perception following 30 repetitions of a word are merely due to participant fatigue at having repeated any word 30 times.

Second, it would be important to systematically vary the semantic relation between the satiated emotion category words and the emotion exemplars to be perceived. Doing so would allow us to assess the magnitude of spreading activation on the perception of emotion. For example, we might expect that the satiation of positively valenced, low arousal words (e.g., "calm") would be more likely to interfere with the perception of faces depicting positively valenced, high arousal behaviors (e.g., *happy*), than perception of a face depicting a negatively valenced, high arousal behavior (e.g., *fear*).

A more detailed understanding of mechanisms is also necessary for semantic satiation to be a useful tool for the study of the LRH. Determining the neural correlates of semantic satiation might give insight into the precise mechanism by which semantic satiation exerts its effects on emotion perception. For example, if semantic satiation effects are a result of neural habituation, then we would expect to see decreases in activation to the inferior frontal cortex following the satiation manipulation. This hypothesis and others regarding the neural mechanisms underlying semantic satiation clearly await further empirical investigation.

It is also important to understand how language and conceptual knowledge about emotion are represented. To date, researchers have suggested that satiation works via spreading activation which is the mechanism common to models of semantic memory. Semantic knowledge is traditionally thought to be a system of representations that are abstracted from sensory-motor events and stored amodally (i.e., as prototypes or summary representations) in some sort of propositional form (see, Markman & Dietrich, 2000 for a review). According to this view, semantic satiation temporarily decreases the accessibility of the node for a repeated word (e.g., "anger") and this deactivation spreads to other related concepts. More recently, the semantic view of conceptual knowledge has been challenged, and it has been argued that the conceptual system relies more intrinsically on embodied (i.e., sensory-motor) representations (Barsalou, 1999; Barsalou et al., 2003). In this view, conceptual knowledge about a category (such as *anger*) is represented by a large number of specific instances that are represented in sensory-motor cortex. Conceptualizing an instance of a category (e.g., perceiving *anger* in another person) requires a partial reenactment or simulation of sensory-motor events associated with a similar instance of the category. Perhaps then, satiation causes repetition suppression of the neural pathways between the sensory modalities, which constitute an embodied conceptualization. Repetition suppression of certain neural regions might temporarily prevent a person from using the conceptualization of a word to guide perceptual judgments. In this view, satiation would occur (i.e., the meaning of *anger* would become temporarily less accessible) when a person was unable to access sensory information about how an emotion looks on another person's face, or could not embody the facial movements themselves. This hypothesis, and others that stem from an embodied view of the conceptual system, await further investigation.

Implications

The findings of this report have several important implications for the study of language and emotion. First, the results add to a growing body of research revealing the relativity of emotion perception. Context influences the emotions that are perceived in ambiguous (Carroll & Russell, 1996; Fernandez-Dols, Wallbott & Sanchez, 1991) and in nonambiguous circumstances (Trope, 1986). People of non-Western cultures have a more difficult time categorizing facial behaviors into Western categories (Elfenbein & Ambady, 2002). Although people categorize facial behaviors effortlessly and often without awareness, this does not constitute evidence that categorization is given solely by information on the face. Our findings add to this literature by being the first to experimentally demonstrate that language influences the emotion that one person sees in the face of another.

More broadly, the results of our studies are consistent with the view that language influences experience, in this case, a person's experience of seeing emotion in another person's face. Different languages contain different emotion words or define the same words in different ways (Russell, 1991; Wierzbicka, 1992a, 1992b). As such, our findings support a weak version of the LRH, which suggests that language shapes how we perceive and categorize an already existing reality (Whorf, 1956). In the case of emotion, words might shape the way that people see affective reality.

We would argue, however, that our results open the door for investigation into the strong version of the LRH, that is, that language forms the emotional reality that we experience. Accumulating evidence has called into question the assumption that emotions such as anger, sadness, and fear actually exist in reality (i.e., as real or natural categories in nature) (for discussions, see Barrett, in press-a; Russell, 2003). Instrument-based measures of emotional response in humans (such as peripheral nervous system, facial EMG, and behavioral measurements) do not reliably differentiate emotion categories like fear, anger, sadness, and so on. Meta-analytic summaries generally fail to find distinct patterns of peripheral nervous system responses (Cacioppo et al., 2000). Nor do facial electromyography measurements give evidence of discrete emotion categories (Cacioppo et al., 2000). Rather than revealing emotion categories, objective measurements correspond to positive and negative affect (for a discussion, see Barrett, in press-b, in press-c; Cacioppo et al., 2000; Russell, 2003; Russell & Barrett, 1999). There is good evidence from behavioral neuroscience that specific behaviors (e.g., freezing) may depend upon specific brainstem and subcortical nuclei (e.g., Panksepp, 1998), but there is little evidence to suggest that each behavior can be uniquely associated with any single emotion category in animals (such as *fear*, e.g., Bouton, 2005). People can effortlessly assign behaviors to such categories, however. People report that they see instances of fear, anger, and so forth, in others and also characterize their own feelings in these terms. One way of reconciling the disparity between what is produced (affect) and what is perceived (emotion) is to hypothesize that emotion language functions to bring emotion into existence as affect is categorized during perception. Empirical evidence may not demonstrate the existence of specific kinds of emotion, say for example, anger, but people can experience anger in themselves and see it in the behaviors of others, because they categorize instances of affect (whether in their own internal state or in other people's behavior) as anger by using the word "anger" to shape their perception (Barrett, in press-b). Of course, this idea awaits experimental investigation.

The findings of the present report not only shed light on the link between language and emotion, but they represent a necessary step toward future empirical investigations of the LRH. Semantic satiation may be a useful scientific method for experimental studies of linguistic relativity. Experimental demonstrations of linguistic relativity are an important compliment to the careful quasi-experimental studies that have revived the LRH. For example, cross-cultural research has shown that different languages demark different color categories, which in turn affect how speakers experience the wavelengths that make up the visible light spectrum. Western English speakers have a perceptual boundary between blue-green, but the Berinmo of Papua New Guinea distinguish between *nol-wor* (which is roughly translated as green-brown, respectively). When presented with blue color tiles, the Berinmo experience them as *nol* (Roberson, Davies & Davidoff, 2000). Quasi-experimental research is inherently correlational because it explores preexisting language differences and assesses perceptual differences. Although the results of quasi-experimental research show an important link between language and experience, they are open to alternate explanations. The findings are consistent with the view that language caused experience, but they are also consistent with the alternative view, that experience caused the language categories used. Prior experience with particular wavelengths (or the association of particular wavelengths with objects of special function) may have influenced the language concepts that were most easily acquired by its speakers. For example, Lindsey and Brown (2002) proposed an intriguing hypothesis that some languages fail to distinguish between green and blue categories because of the amount of UV-B radiation from sunlight that strikes the earth's surface where these languages are spoken (but for a critique of this lens brunescence hypothesis, see Regier & Kay, 2004). These sorts of alternative explanations make experimental tests of the LRH crucial. As an example of such experimental research, recent studies of color perception have demonstrated that perceivers' ability to discriminate between different blue wavelengths is enhanced after they have been taught to acquire two distinct categories subordinate categories for the basic level English color category blue (Özgen, 2004; Özgen & Davies, 2002). By experimentally manipulating the color categories that perceivers have available, these studies more clearly support the hypothesis that language influenced experience. The studies reported in this article are the first to successfully test the LRH for emotion perception by directly manipulating language accessibility and testing its impact upon what emotion is seen, thereby allowing stronger causal claims to be made for the impact of language on the experience of another's emotion. More generally, semantic satiation may be a viable and important tool for test of the LRH in other perceptual domains.

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