Linguistic Markers of Emotional Elaboration in the Past and the Present in Online Blogs

by

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Abstract

Online blog data provide numerous benefits over clinical and laboratory studies, including increased sample size and more genuine responses. By investigating the number of feeling words that a blogger uses in a blog sentence, we can characterize the degree to which individuals elaborate on their emotional experiences. In this study, data were obtained from the website, wefeelfine.org, which collects sentences from English language blogs containing the phrases, “I feel”, “I felt”, and other tenses of the verb “feel”. The number of emotion words in each sentence was counted and used as a metric of emotional elaboration. The results show that sentences containing the phrase “felt” included a significantly smaller proportion of emotion adjectives than those sentences that use the words “feel,” “feeling,” or “feels,” but a significantly larger raw number of emotion adjectives than those sentences. This suggests that people write more words generally in the past tense, but the proportion of emotional words is higher in the present.

Keywords: blogs, computerized text analysis, emotion, language, memory

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Online behavior has been significantly and unexpectedly revealing in the recent past. For instance, twitter feeds have regularly predicted fluctuations in the stock market (Bollen, Mao, & Zeng, 2011), and keywords typed into the Google search engine predicted influenza outbreaks before medical professionals could (Ginsberg et al., 2009). Use of the internet overall is becoming increasingly widespread, with an estimated 1.97 billion internet users around the globe today (Pingdom, 2011). Around 19% of this worldwide online time is spent on social networking sites (Clayton, 2011).

While large-scale data-mining of online sources has been a common practice in the information industry, it has only recently emerged as a venue for psychological research. Blog content, specifically, has newly become a valuable source of data for psychology, as over 152 million blogs can be found on the internet today (Pingdom, 2011). These blogs comprise varying purposes and goals. Yet through these differences in intent, a common factor has developed among many of these blogs: a desire to share past, present, and predicted emotions. Although their emergence as a form of communication is only relatively recent, blogs have already become a common way to share one's feelings.

As a source of data for psychological research, blogs provide numerous advantages over clinical settings. First, the sample size has the possibility to be exponentially larger when drawing from blogs. Data from millions of participants can easily be aggregated, allowing for greater power. Second, the data provided by bloggers is more naturally produced than data collected in an experimental lab setting. The likelihood of genuine responses from participants is therefore much greater. Third, diversity of samples is increased by using blogs as a source of

data, since people in countries around the world blog in English. Increased diversity inherently leads to increased representativeness of results. And finally, detailed information about blog time can be related to circadian rhythms (Golder & Macy, 2011), weather, and other historic events (Cohn, Mehl, & Pennebaker, 2004).

The work of James Pennebaker has been particularly influential in this new realm of computerized text analysis. Pennebaker's Linguistic Inquiry and Word Count (LIWC) functions by counting words in over 75 categories, including language composition, psychological processes, relativity, and current concerns (Cohn et al., 2004; Pennebaker & Graybeal, 2001; Schler, Koppel, Argamon, & Pennebaker, 2005). Most relevant to the present investigation is the category of relativity, which includes a count of present tense vs. past tense verbs. The current study explores differences in the discussion of emotional experiences in the past vs. the present, by looking at the effect of verb tense on the number of emotion words used (i.e. I felt XXX vs. I am feeling YYY).

A variety of hypotheses can be tested through LIWC-like analyses of blogs. For instance, differences between genders can be observed in blog writing in terms of both style and content (Schler et al., 2005). Males have a characteristic style involving more discussion of politics, technology, and money, and use fewer pronouns and assent/negation words. Females, conversely, have their own approach to writing, based on a more personal style. Interestingly, all writing tends to become more "male" as age increases (Schler et al., 2005). LIWC can also be used when examining topics like mood changes in a population across a traumatic event, such as September 11, 2001. A sharp drop in emotional positivity, an overall decrease in cognitive processing, and increases in social processing and psychological distancing were found across 9/11, through the use of LIWC (Cohn et al., 2004).

In one of the most monumental studies of LIWC, language use has been shown to be a method of observing individual differences (Pennebaker & King, 1999). The number of words that fall in each LIWC category type remains stable over both time and writing topic, suggesting that language use can be a reliable individual difference. Further, language use relates to personality characteristics: language use was found to be related to such measures of personality as self-reports, ratings of observers, and meaningful behaviors. Additionally, language use correlated with illness as consistently as the older and more established concept of Big Five Personality traits. As LIWC data correlate only moderately with Big Five Personality traits, these findings introduce the possibility that writing style could be the new "gold standard" of personality measurement (Pennebaker & King, 1999).

Through multiple studies, computerized text analyses like LIWC have been validated in making inferences about various psychological categories based on written word. In the current study, data from English-language blogs were collected and analyzed in a manner comparable to LIWC. Sentences containing past and present tense verbs were collected and analyzed for a count of the number of emotion words contained in the same sentence. Due to their similarities in methodology, validation of LIWC-analyses provides some support for the types of analyses in the current study.

In order to engage in the current analysis, though, sources of data discussing individuals' emotions are necessary. This process of writing about emotions is complex. At any given moment, there is a large amount of information available to us, which we strive to understand and form thoughts about. In order to do so, we must select portions of this information, and then group similar entities. Concepts, or "mental representations for categories," are used to determine how something fits into a category, and thereby make it meaningful (Barrett, 2006b, p.

27). Once an entity has been made meaningful through conceptual knowledge and then categorized, we are finally able to use individual words to describe our specific emotions toward it (Barrett, 2006b). However, although we may use the same word to describe two emotional experiences, we intuitively understand that we never experience two identical emotions. For instance, we use the word happy to suggest that we are calmly content while listening to an orchestra, and when describing our wild excitement after riding a roller coaster. Similarly, we can be silently seething during a tense conversation, or loudly furious while watching an unfair call by a referee during a game; and we might use the word angry to describe both of these emotional experiences.

Shame and guilt work as a specific example of categorical grouping, and demonstrate effects that may be overlooked due to erroneous grouping. Even by psychologists, shame and guilt are often classified as a single emotional experience. In fact, validated scales like the Buss-Durkee Guilt scale and the Mosher Morality-Conscience Scale group shame and guilt items. However, most people can distinguish between these two emotions, at least intuitively. Guilt is a targeted feeling in relation to a specific action, while shame is applied to the entire self (Leith & Baumeister, 1998; Tangney, Wagner, Fletcher, & Gramzow, 1992). The differences between the two emotions involve more than superficial definitions, though. The two experiences have surprisingly different psychological and mood effects. Shame has links to anger, while guilt involves an acceptance of responsibility, and may be more adaptive (Tangney et al., 1992). Guilt may even be positively correlated with increased perspective-taking in individuals, while shame-proneness is not (Leith & Baumeister, 1998). Shame and guilt provide an excellent example of limitations that have been encountered by grouping emotions, as it was not until they were separated that their diverse effects could be realized. By grouping emotions together with a

single descriptive word, as we do with happy and angry, we may be unable to understand the effects of certain more basic processes on the physical, mental, and emotional self.

The current debate involving natural kinds delves into this idea of categorization. A natural kind can be defined as a category of items that have something deep and underlying in common, such as a causal mechanism or superficial features (Barrett, 2006a). For over a hundred years, emotions such as happy and sad have been considered natural kinds by various fields, from anthropology to economics to psychology. One side of the debate maintains that this may not be the most accurate way to study emotions, and cites recent research that supports this. First, the attempt to record and inventory the superficial features of each emotion has been unsuccessful, with only weak to moderate correlations found between facial expression and subjective emotional experience (Barrett, 2006a). Second, investigations into causal mechanisms have not been more revealing. In fact, two meta-analyses of comparable methodology (Murphy, Nimmo-Smith, & Lawrence, 2003; Phan, Wager, Taylor, & Liberzon, 2002) found very different areas of activation for anger, sadness, disgust, fear, and happiness (Barrett, 2006a). Despite the length of time that this perspective has dominated emotion research, natural kinds may not be the most accurate way to study emotions.

If this is indeed the case, then our words for happy, sad, angry, etc. are no longer descriptive enough, and these emotional experiences must be broken down into more basic components. Evidence suggests that a circumplex structure of subjective emotional experiences is most valid. This inherently implies a plurality of factors, as opposed to the single factor perspective that has been taken (Barrett, 2006a). While multiple hypotheses have been put forward as to what these factors could be, one of the most convincing proposes that they could be valence and arousal. As discussed above, only moderate correlations were shown to exist

between facial expression and subjective experience reports, but valence and arousal showed a high correlation with both subjective experience reports and facial expression (Barrett, 2006a). Recent emotional memory research complements this idea with the finding that both arousing words and negative nonarousing words are better remembered than neutral words (Kensinger & Corkin, 2004). Further, remembering these two types of words requires the use of different processes: negative non-arousing words are remembered via the PFC-hippocampal network, and are associated with controlled encoding; while arousing words are remembered through the amygdalar-hippocampal network and involve automatic effects of emotion on subsequent remembering (Kensinger & Corkin, 2004). The fact that these operate through separate pathways suggests that valence and arousal are likely more basic factors in emotional experiences.

The long-standing assumption that emotion categories are the most basic entities has impeded the progress of research into neural specificity. Much of previous research has assumed emotions like happy, angry, and sad to be basic entities, and proceed with research from that assumption. Using this idea, researchers look for consistent activation areas from a given emotion. Unsurprisingly, this tactic has thus far produced contradictory results. By ignoring these constructed affective labels, though, a data-driven meta-analysis of neuroimaging emotion studies advances theories of emotional experience significantly. A review of 162 neuroimaging emotion studies looks at the areas that are consistently activated by emotional experiences, and creates “functional groups” out of these (Kober et al., 2006). These functional groups are presented as a potentially new way to organize emotional experiences into networks. The six groups found are the lateral occipital/visual association group, the medial posterior group, the cognitive/motor group, the lateral paralimbic group, the medial prefrontal cortex (PFC) group, and the core limbic group. These groups function as basic psychological processes, rather than

areas specific for emotion; the interaction between these basic functions results in the experience of emotion for an individual (Kober et al., 2006).

These six functional groups have differing functions in an emotional experience. The first two groups, the lateral occipital/visual association group (composed of cortical areas in the right and left lateral occipital gyrus and the right occipital/temporal cortex) and the medial posterior group (composed of primary visual cortex and posterior cingulate cortex) have potentially cooperative roles and similarities in structure and function, and so can be discussed simultaneously (Kober et al., 2006). The consistent activation of visual areas throughout the studies reviewed suggests that visual processing increases during emotion, compared to neutral conditions. Since the reviewed studies matched emotional and neutral stimuli on perceptual characteristics, it is unlikely that differences in perceptual characteristics could be causing this increase. Rather, this is more likely caused by projections from the limbic circuitry during observations of emotional stimuli. The posterior cingulate cortex (PCC) forms a direct connection with the medial PFC group and the lateral paralimbic group (Kober et al, 2006).

The cognitive/motor group is made up of pre-supplementary motor area (pre-SMA)/left middle gyrus, bilateral inferior frontal gyrus (IFG), and right frontal operculum (frOP), and each of these regions plays a slightly different role. The pre-SMA is involved in representation of intentional action, while the IFG and frOP are involved in response inhibition and selection, task switching, and working memory. Overall, this group handles cognitive control operations, and most likely plays a role in selection of actions based on context. In relation to emotions, these functions may assist with information selection that occurs when analyzing emotional input, and in the following behavioral and physiological responses (Kober et al., 2006).

The lateral paralimbic group is made up of the ventral striatum (vStr), ventral posterior insula (vpIns), dorsal anterior insula (daIns), ventral anterior insula (vaIns)/posterior orbital gyrus, and temporal pole. This functional group is thought to be important in motivation since both the posterior orbital gyrus and the ventral striatum have been implicated in aspects of rewards (Kober et al., 2006). The insula has been proposed by other previous studies to have a direct connection with emotion, through a continuum from the vIns to the dIns. The vIns is theorized to be involved in emotional and affective sensory experience, while the dIns and frOP are thought to be involved with cognitive and motor systems. Kober and colleagues' (2006) review finds structural support for this, finding the daIns to connect the pre-SMA to the vaIns, which then connects to the core limbic regions.

The medial PFC group is made up of the rostral-dorsal and pregenual subsection of the anterior cingulate cortex, and the dorsal medial prefrontal cortex (dmPFC). This group overall is involved in both generating and regulating affective states, and in mental state attributions in others or oneself. The medial PFC group connects directly with both the lateral paralimbic group and core limbic group, but does not have a connection to the cognitive/motor group. These relationships suggest that the medial PFC group is more involved in core affect responses than with cognitive/motor activity (Kober et al., 2006).

The final functional group, the core limbic group, is made up of the amygdala/left hippocampus (HCMP), thalamus extending into periaqueductal gray (PAG), additional areas of ventral striatum, and lateral hypothalamus (Hy). The PAG receives direct cortical inputs, integrates this information, and forms connections to both the lower brainstem nuclei and the hypothalamus. The amygdala, while often activated in neuroimaging studies of emotion, has not consistently been implicated for a specific function. These variations may suggest that the

amygdala is important in setting the stage for emotion, but not in the actual experience. One further reasonable explanation for these discrepancies is that the several subsections of the amygdala, which differ substantially in structure and function, are not separated in many analyses (Kober et al., 2006).

This review supports the idea that basic emotions, such as happy and angry, do not have specific localizations in the brain (Kober et al., 2006). Yet although there may not be a specific "happy" region of the brain, specific emotional experiences do have neural correlates. These correlates involve basic processes that are not specific to emotion; their interactions produce the infinitely varying emotions we experience.

In order to more fully understand these allegedly universal concepts, a representative and wide-spread sample is necessary. In current psychological research, diversity is noticeably absent: 96% of subjects in behavioral science studies come from Western industrialized countries, which make up only 12% of the world's population (Henrich, Heine, & Norenzayan, 2010). Evidence has shown that basic established psychological concepts become less straightforward when comparing results from industrialized countries with small-scale societies. Differences in previously considered universal concepts like visual perception and spatial cognition, for instance, have been discovered in cross-cultural studies. Moreover, those studies conducted in Western industrialized America often use undergraduates as subjects, who are not necessarily even representative of their own Western industrialized country. Differences in rationalizing choices, individualism, conformity motivations, structure of social networks, and moral reasoning have been found in comparisons of American undergraduate subjects with other American adults (Henrich et al., 2010). Especially in research of potentially universal findings, representative samples are indispensable. Blogs are advantageous as a source of data, for this

reason, because they are naturally diverse data sets. They allow a method for easily obtaining a large data set, while not limiting the research to a specific subset of a population, such as undergraduate students. Research conducted through the use of blogs has the potential to obtain more representative and universal data than that done in a clinical setting.

As discussed above, numerous emotional experiences are represented with a single emotion word. In order to work with this, we can look towards the pattern of emotion adjectives. In daily dialogue, a single word can have multiple meanings, depending on the words that precede or follow it. In the same way, the combination of emotion words in a sentence is important in the overall description of the emotional experience. A sentence using the word happy paired with the word excited, for instance, is likely to have a much different meaning than a sentence using the word happy with the word peaceful (Mogilner, Kamvar, & Aaker, 2011). The current study investigates differences in patterns of emotion adjectives through the concepts of memory, valence, and arousal. Discussing the past requires different descriptive mechanisms than the present, and both of these sentence types use different mechanisms for describing positive vs. negative experiences, and high arousal vs. low arousal experiences. Through collaboration with Sepandar Kamvar, one of the founders of the website wefeelfine.org, we were able to access the data behind the wefeelfine.org website (Kamvar & Harris, 2011). Through these data, we were able to investigate differences in descriptive mechanisms for describing different types of emotional experiences. Wefeelfine.org functions by collecting all sentences from English-language blogs that contain the phrases “I feel,” “I felt,” or other tenses of the verb “feel.” The number of emotion words in sentences using different tenses of the verb “feel” was recorded. In separate analyses, the count of these emotion words was broken down into negative, positive, and neutral valence emotion words, and into high and low arousal emotion words.

Method

The website wefeelfine.org was integral to this investigation. This website, a creation by Sepandar Kamvar and Jonathon Harris, works as a data search engine (Kamvar & Harris, 2011). Every ten minutes, the search engine collects all sentences from English-language blog posts around the internet that contain the phrases "I feel," "I am feeling," "It feels," and "I felt." These phrases, along with the sentences that contain them, are recorded (example screenshots are shown in Figure 1). The emotion used in each sentence is identified from a hand-constructed bank of over 5000 emotion words (angry, sad, happy, etc.). Information beyond emotion words can be extracted, as well. For instance, many of these blogs self-report information about gender, age, country, state, and city. This information is collected, when available, and combined with weather reports for the given location. The process occurs continuously and autonomously, and collects between 15,000 and 20,000 sentences per day.

Participants

Through collaboration with Sepandar Kamvar, one of the founders of wefeelfine.org, we were able to access the data collected by wefeelfine.org from the month of September, 2010. Each sentence using one of four tenses of the verb "to feel" in the given month was collected (*n*=64901sentences, from 28103 unique blogs). As 71% of these blogs did not provide information about gender, we chose not to separate our analyses by gender. 23% of the total number of blogs reported as female and 6% reported as male. 73.4% of blogs did not provide information about the country of writing; the ones that did provide this information were from 167 unique countries. Locations of bloggers are shown on the map below (Figure 2). Although some reports of location are unlikely, such as the 11 bloggers who reported writing from Antarctica or the one who writes from Hogsmeade (a fictional town from the world of Harry

Potter), these self-reports are not irrelevant. Although beyond the scope of the current investigation, they can provide insight into the current social subcultures around the world.

Procedure

From these 64901 collected sentences, four categories were constructed. The categories were based on the tense of the verb in each sentence: feel (*n*=41413), feeling (*n*=21058), feels (*n*=1379), and felt (*n*=1051). Emotion words contained in these sentences were determined using affective norms for English words (ANEW; Bradley & Lang, 1999), and are shown in the chart below (See Appendix A). All ANEW emotion words that could follow the phrase "I feel…" were included. The number of emotion words in each sentence was counted and used as a metric of emotional elaboration. These emotion words were then separated by valence and arousal in the following way, using valence and arousal ratings obtained from ANEW (Bradley & Lang, 1999): negative valence (valence rating of 1 to 3.6; *n*=24125), positive valence (valence rating of 6.3 to 9; *n*=35747), and neutral valence (valence rating 3.6 to 6.3; *n*=5029); high arousal (arousal rating above 5; *n*=46290) and low arousal (arousal rating below 5; *n*=18611). The number of negative, positive, and neutral valence emotion words in sentences of each tense category was counted, as was the number of high and low arousal emotion words in each tense category.

In order to control for the possibility that people may write more in general in either the past or the present, and for the possibility that certain categories of emotion words (i.e., negative high arousal) may contain more words than other categories, data were weighted. These weighted data were obtained by dividing the number of emotion words in a sentence by both the total number of words in the sentence, and by the total number of emotion words in the given category. For instance, if a sentence contained 3 positive valence, high arousal emotion words and 15 total words, 3 would be divided by 15 (the total number of words in the sentence) and 42

(the total number of positive valence, high arousal ANEW words [Bradley & Lang, 1999]), resulting in a weighted value of .00476. The weighted data provide a measure of the proportion of words that are emotion adjectives, while the unweighted data provide a raw number of emotion words used.

For further analysis, the present tense verb categories (those of feel, feeling, and feels) were combined to produce one category of present tense. The proportion of emotion words in present tense sentences was compared to the proportion of emotion words in past tense sentences. Again, the emotion words were broken down by valence and arousal, and the number of negative, positive, and neutral emotion words, and emotion words of high and low arousal, were recorded and weighted for each sentence category.

Analysis

The number of emotion words in each of these sentences was counted and weighted. Comparisons were made between sentences containing three present tense forms and one past tense form of the verb "feel": feel, feeling, feels, and felt. The dependent variable of emotion words used was broken down further into three valence categories (negative, positive, and neutral) and two arousal categories (high and low), to further investigate differences in the number of emotion words used of varying valence and arousal. The weighted number of negative, positive, and neutral valence emotion words of both high and low arousal was determined for sentences of each verb tense.

A three-way analysis of variance (ANOVA) was performed to demonstrate that differences exist between the mean proportion of emotion words contained in each category of sentence, and to reveal main effects and interactions of tense, valence, and arousal on the

proportion of emotion words used. The ANOVA was followed by specific t-tests between tenses to determine significance of differences in mean proportion of emotion words.

The procedure was repeated with the present tense verbs (feel, feels, feeling) combined into one variable of present tense. The mean proportion of emotion words in present tense vs. past tense sentences was compared using a t-test, and these emotion words were again broken down further into valence and arousal. The number of negative, positive, and neutral valence emotion words, and the number of high and low arousal emotion words in sentences of each tense of the verb "feel" were counted and weighted.

Each of the above analyses was conducted on the unweighted data as well. Findings were compared between these two sets of data.

Results

A three-way analysis of variance (ANOVA) of the data yielded significant main effects of tense, valence, and arousal, indicating that these three variables have a significant effect on the proportion of emotion words used in an online written sentence discussing emotional states. The main effect of tense suggests that there is a difference in the proportion of emotion words used in a sentence describing an emotional experience due to the tense of the concurrently used feeling verb, ($F(3, 64898)=112.939$, $p < .001$). The mean proportion of emotion words in each type of sentence demonstrates that sentences that contained the word "felt" used a smaller proportion of emotion words than the present tense sentences that used "feel," "feeling," or "feels" (Table 1). The main effect of valence suggests that people use different numbers of emotion words to describe emotions of different valences in online blogs ($F(2, 64899)=36.745$, $p < .001$) These means suggest that people use more neutral emotion words than either negative or positive emotion words when writing about emotions online (Table 2). Finally, the main effect of arousal

suggests that people use different numbers of emotion words to describe high or low arousal emotions ($F(1, 64900)=94.649$, $p < .001$). These means suggest that people use proportionally more low arousal emotion words than high arousal emotion words in online blogs (Table 3).

The ANOVA yielded several significant interactions as well. The interaction between tense and valence was significant ($F(6, 64895)=10.872$, $p < .001$), suggesting that the differences in weighted number of emotion words used between tenses of the verb "feel" are strongest for neutral emotion adjectives (Table 4). The interaction between tense and arousal also was significant ($F(3, 64898)=8.924$, $p < .001$), which suggests that the differences in weighted number of emotion words used between tenses of the verb "feel" are strongest for low arousal emotion words (Table 5).

Additionally, the three-way interaction between tense, valence, and arousal was significant ($F(6,64895)=7.618$, $p < .001$), suggesting that the effects of tense, valence, and arousal on the number of emotion words used are moderated by the other variables. Specifically, the difference in proportion of emotion words in sentences containing "felt" vs. sentences containing "feel," "feeling," or "feels" was strongest for neutral emotion words of low arousal (Table 6; Figure 3).

The main effect of tense reported above was further analyzed by conducting t-tests between specific tenses. When emotion words of all valences and arousal levels were counted, sentences containing the word "felt" used a significantly smaller proportion of emotion words than sentences containing the word "feel" ($p < .001$), "feeling," ($p < .001$), or "feels" ($p < .001$; Figure 4). Additionally, sentences containing the word "feel" contained a greater proportion of emotion words than sentences containing the word "feeling" ($p < .001$), and sentences containing

the word “feels” ($p < .001$). Sentences containing the word “feeling” used significantly more emotion words than sentences containing the word “feels” ($p < .001$).

Held constant throughout the above results is a significant difference with “felt.” In order to further investigate this significance, the present tense verbs (feel, feeling, feels) were grouped, and the average proportion of emotion words in these sentences was compared to that of sentences using “felt.” Sentences containing present tense verbs used a significantly greater proportion of emotion words than those sentences containing the past tense verb “felt” ($p < .001$; Figure 5). These results were again separated by valence and arousal, and the same result was found for both negative and positive emotion words, and for high and low arousal words. In present tense sentences, a significantly smaller proportion of negative emotion words ($p < .001$), positive emotion words ($p < .001$), and neutral emotion words ($p < .001$) were used, when compared to past tense sentences (Figure 6). Additionally, in present tense sentences, a significantly greater proportion of high and low arousal words were used in the present when compared with the past (high arousal: $p < .001$; low arousal: $p < .001$; Figure 7).

Further analyses were conducted on the unweighted data as well. These data were a straight count of the number of emotion words in a sentence, and were broken down by valence and arousal as the weighted data were. Significant findings were different than those found for the weighted data. In fact, the results tended to be opposite: present tense sentences used fewer emotion words than past tense sentences. These findings were consistent for negative and positive valence emotion words, and for high and low arousal words (Figure 8). These differences suggest that people tend to use a greater number of emotion words in the past, but a greater proportion of emotion words in the present.

For both weighted and unweighted data, each individual tense was additionally analyzed for differences in the mean number of emotion words based on the valence and arousal of these emotion words. Results are reported by verb tense.

Feel

The weighted data showed that, for sentences that contained the word "feel," people used proportionally more neutral emotion words than negative emotion words ($p < .001$), which in turn were used proportionally more than positive emotion words ($p < .001$; Figure 9). The unweighted data showed similarly that all three of the valence categories had significantly different means. However, these results showed that sentences using "feel" contained significantly more positive emotion words than negative emotion words ($p < .001$). In turn, these sentences used a greater number of negative emotion words than neutral emotion words ($p < .001$; Figure 10). These results illustrate the difference between the proportion of emotion words that people use in online blogs and the raw number of emotion words used.

In relation to arousal, the weighted data showed that sentences containing "feel" used a significantly greater proportion of low arousal emotion adjectives than high arousal adjectives ($p < .001$; Figure 11). The unweighted data showed that these sentences used a greater number of high arousal emotion adjectives compared to low arousal emotion adjectives ($p < .001$; Figure 12).

Feeling

In sentences that used the word "feeling", the results found were similar to those from sentences using the word "feel" (Figure 13). Sentences using "feeling" used proportionally more neutral emotion words than negative emotion words ($p < .001$), which were used proportionally more than positive emotion words ($p < .001$). For raw emotion words, a greater number of

positive emotion words were used than negative emotion words ($p < .001$), which were used significantly more than neutral emotion words ($p < .001$; Figure 14).

As with valence, the arousal results for "feeling" sentences were similar to those from "feel" sentences. Proportionally more low arousal emotion words were used in "feeling" sentences ($p < .001$; Figure 15), while these sentences used a greater raw number of high arousal emotion words ($p < .001$; Figure 16).

Feels

Sentences that used the word "feels" had fewer significant results in terms of valence than those that used "feel" or "feeling." Those sentences that used "feels" contained a significantly greater proportion of neutral emotion words when compared to both negative and positive emotion adjectives ($p < .001$; Figure 17). However, the difference between the proportion of negative and positive emotion adjectives used was not significant. For the unweighted data, only the difference between positive emotion adjectives and neutral emotion adjectives was significant; positive emotion adjectives were used significantly more than neutral emotion words ($p = .04$; Figure 18).

In relation to arousal, the proportion of low arousal words was significantly greater than the proportion of high arousal words in "feels" sentences ($p < .001$; Figure 19). These sentences also used a significantly greater number of high arousal words than low arousal words ($p = .013$; Figure 20).

Felt

The results found for sentences using the word "felt" were similar to those discussed above for sentences that used the word "feels." Those sentences using "felt" used a significantly greater proportion of neutral emotion words when compared to the proportion of positive or

negative emotion words used (positive, $p < .001$; negative, $p < .001$; Figure 21). Again, as with sentences using the word "feels," sentences that contained the word "felt" did not use a significantly different proportion of positive and negative emotion words. Differences in raw usage of differently valenced emotion words was insignificant for these "felt" sentences (Figure 22).

In relation to arousal, sentences that contained "felt" used a significantly greater proportion of low arousal words than high arousal words ($p < .001$; Figure 23). Additionally, these sentences used a greater raw number of high arousal emotion words than low arousal emotion words ($p < .001$; Figure 24).

Discussion

The current study is the first to look at the interaction and main effects of tense, valence, and arousal on the number of emotion words used in online blog sentences containing a tense of the verb "feel." The investigation demonstrates that the tense of the verb "feel" has an effect on the number and proportion of emotion words used in online blog post sentences that contain this verb. Sentences using the past tense form, "felt," used a significantly smaller proportion of emotion words than sentences that use one of the three present tense forms, "feel," "feeling," or "feels." Additionally, the valence and arousal of the emotion words used in these online blog sentences has an effect on the number and proportion of emotion words used. In this study, people used a greater proportion of neutral emotion words than either negative or positive emotion words. People also used a greater proportion of low arousal words compared to high arousal words. Unweighted data resulted in a finding of a greater raw number of emotion words used in the present than the past, more positive and negative emotion words used than neutral

emotion words, and more high arousal emotion words used than low arousal emotion words in online blog sentences containing a form of "feel."

The differences in findings from the weighted and unweighted data could result from several possibilities. Between sentences, two possible variations could account for one sentence containing a higher proportion of emotion words: either the raw number of emotion words used in one sentence could be larger than the other while the total number of words in the sentences are equal, or the number of emotion words could be equal in the two sentences while the total number of words is different. The findings of this study suggest that the former is more likely. The unweighted data showed that people use more raw emotion words per "feel" sentence in the past tense. However, the weighted data shows a smaller proportion of emotion words in past tense sentences. Therefore, this discrepancy must be due to differences in total word use. In general, people use more emotion words in the past tense in online blogs, but the total amount of writing is also greater in the past tense. The proportion of emotion words used in blog sentences containing forms of "feel" is greater in the present tense.

A possible explanation for using proportionally more emotion words in the present may be that emotions are more salient as they are currently being experienced. When writing about an emotional experience as it is occurring, the emotion may be more central to a person's thoughts; therefore, it may take up a greater proportion of each sentence. On the other hand, when discussing emotions in the past, people may be more likely to describe situations and details that were a part of the experience, using nonemotion words. Similarly, a possible explanation for the greater proportional use of neutral emotion words in both the past and the present is that people may tend to use more words to describe, explain, or qualify positive or negative emotions. It may seem descriptive enough to state neutral emotions with fewer accompanying words. It is possible

that comparable reasoning occurs with the proportional uses of high and low arousal emotion words as well. People may use more nonemotion words to complement high arousal words, in order to better describe the emotions they are feeling, and the reasons they are feeling these emotions.

In the current findings of the unweighted data set, the number of emotion words used when discussing the past in online blogs is greater than the number of emotion words used to describe current feelings. The overall significance of these results appears to be driven by the negative emotion word category, an effect which could be explained by the adaptive theory of emotions. The adaptive theory posits that emotions are beneficial for guiding behavior and emotion regulation strategies (Levine & Safer, 2002). Generally, negative emotions show this adaptive effect more than positive emotions do. People tend to have more ways to describe undesirable negative emotions as a means to prevent feeling similarly in the future; this is shown by the greater number of negatively valence ANEW words (Bradley & Lang, 1999). Conversely, when feeling happy, individuals are content with their emotional state; therefore, they tend to take part in less analysis. Because of this, the effect of verb tense on number of emotion words may be stronger for negative emotions than for positive based on the idea that we have more words for negative feelings than for positive. Furthermore, it is reasonable that negative emotion words could be differently affected by verb tense than positive emotion words, because positive and negative substrates are separable and do not fall onto a single continuum (Cacioppo & Berntson, 1994).

However, negative emotion words tend to be more arousing than positive emotion words. Therefore, controlling for arousal is important in determining whether the negative emotion word category is driving the results. The weighted data set does control for arousal, and the effect is

much less defined with this data set than with the unweighted data set. Therefore, deeper investigations must be done in order to determine what is causing this differential use of emotion adjectives in the past vs. the present.

The large scale of the current study is one of its greatest contributions for several reasons. First, the data were able to be collected from a massive population of people—that of all English-speaking bloggers. A sample of this magnitude provides greater representativeness and diversity than is possible in a clinical study. Additionally, the large sample size compensated for the relatively small proportion of past tense sentences, compared to present tense sentences. Although far fewer sentences were written using the word "felt," over 1000 sentences were still available for analysis.

Despite online blog data's numerous benefits, though, using data strictly from blog sources raises questions of a full understanding of emotional meaning. With blog data, it is difficult to fully comprehend what each individual is feeling as he or she types. While it is valid that an isolated sentence on an online blog cannot provide consistent and unfailing insight into the emotional experiences of the blogger, programs like Linguistic Inquiry and Word Count (LIWC) show that written language use is a reliable source of data for psychological research (Pennebaker, 1999). Although emotional experiences are incredibly complicated, text analysis, like LIWC or the methods used in the current study, allows us to pick up patterns. According to Pennebaker, it is important to look at these patterns that emerge in written language, even if it is not possible to fully understand the meaning of the sentence. Once an overall pattern has been uncovered, it becomes possible to form hypotheses about different psychological concepts, and further investigations can then be conducted.

The pattern revealed through the present analysis may have implications in several areas of psychology. Although emotional differentiation was not directly measured in this study, using more emotion words may be representative of greater differentiation of emotion. More emotion adjectives could be used to refer to a greater number of emotion states, and therefore more differentiation. As with most psychological research, emotional differentiation research can benefit from the potential of exponentially larger sample sizes that blogs allow.

This application to emotional differentiation could have implications for individuals with Major Depressive Disorder (MDD) as well. Past research has shown that those with MDD experience less emotional differentiation in negative emotions than control subjects, while differentiation in positive emotions is equal between groups (Demiralp et al., in press). Investigating differences in emotional differentiation in the past vs. present between individuals with MDD and a healthy control group could provide a better understanding of the effects of MDD on emotional experiences, and could suggest possibilities for better treatment strategies.

The current research can relate to mindfulness as well. A major component of mindfulness involves a focus on the present. Both trait and state mindfulness have been shown to be predictive of positive emotional states (Brown & Ryan, 2003). In the current study, a greater proportion of emotion words were used in the present. Bloggers may be receiving some of the same benefits of mindfulness while blogging. Online writing may cause them to focus on the present, and thereby increase their positive emotional state.

Although blogs provide numerous benefits to psychological experimentation, limitations inherently exist in the methods used. First, text analysis does not account for sarcasm, humor, and other subtleties in writing. However, if the majority of sentences using tenses of the word "feel" are discussing their emotions in a relatively straightforward manner, the large sample size

used should help to circumvent this issue. Second, the population sampled is composed of subjects who choose to post publicly about their emotions. Although using bloggers as a population increases diversity of samples in many ways, as discussed above, it does include only a certain population: those who have access to a computer and who freely decide to share their feelings. Third, usinzag ANEW as a source of emotion words is not infallible. The word "blue," for instance, is characterized by ANEW as a positively valenced, low arousal word. However, when used to describe one's emotions, most people would consider "blue" to be a negatively valenced word. In future studies, it will be useful to consider other approaches to categorizing words.

Future studies should also be done using blog posts from other languages, in order to determine the universality of these results. Additionally, future studies should include investigations into the underlying neural mechanisms regarding disparate use of emotion words in different time frames.

The findings in the current study have important implications in fields outside of psychology as well. Patent law is one such area that can benefit from increased research in the topic of emotion localization. Although neuroscience has grown exponentially as a field of research, it is still not well represented in patents. One explanation of this is that a majority of major neuroscience findings include unpatentable topics such as "laws of nature, physical phenomena, abstract ideas or the discovery of a product of nature" (Ergenzinger, Cunningham, Webber, & Spruill, 2004, p. 660). In order to circumvent this, neuroscience patent writers must use extremely careful and perceptive language (Ergenzinger et al., 2004). A deeper understanding of such concepts as the lack of localization of emotion in the brain can facilitate the balance between a broad patent and an overly open one. Previous inventions have been

patented that imply defined areas of the brain for such emotional experiences as depression (Lozano & Mayberg, 2010). This type of patent could be made more specific by a greater understanding of areas of the brain that subtend emotion. Patents covering the topic of the longitudinal analysis of mood disorders can also benefit from this—understanding more about how moods are described in self-reports would be beneficial (Glenn & Whybrow, 2002). Overall, these patents suggest that there are tangible consequences for a better understanding of emotional experience.

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Table 1.

Weighted mean number of emotion words per sentence

Feel	Feeling	Feels	Felt
0.0011 (0.00095)	0.001 (0.00083)	0.00066 (0.00045)	0.00059 (0.0004)

Note. The number of emotion words in sentences of each form of the verb, "feel," was counted. This count was weighted to account for differences in length of sentences. The weighted means and standard deviations are shown here. Standard deviations are in parentheses

Table 2.

Weighted mean number of emotion words of each valence

Negative	Positive	Neutral
0.0029 (0.0029)	0.0026 (.0025)	0.0041 (.0035)

Note. The number of emotion words of each valence was counted in all sentences that contain a form of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared the category (i.e., negative valence). The weighted means and standard deviations are shown here. Standard deviations are in parentheses

Table 3.

Weighted mean number of emotion words of high and low arousal

High Arousal	Low Arousal
0.00088 (0.00073)	0.0014 (0.0012)

Note. The number of emotion words of each valence was counted in all sentences that contain a form of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared the category (i.e., high arousal). The weighted means and standard deviations are shown here.

Table 4.

Weighted mean number of emotion words broken down by valence

	Feel	Feeling	Feels	Felt
Neg	0.003103	0.002753	0.001694	0.001578
Pos	0.002654	0.00258	0.001772	0.001544
Neut	0.004131	0.00421	0.002756	0.002605

Note. The number of emotion words of each type of valence was counted for sentences of each tense of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

Table 5.

Weighted mean number of emotion words broken down by arousal

	Feel	Feeling	Feels	Felt
High	0.002235	0.002303	0.001453	0.001296
Low	0.004654	0.004018	0.002886	0.00243

Note. The number of emotion words of each type of arousal was counted for sentences of each tense of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

Table 6.

Mean number of emotion words used in online blogs

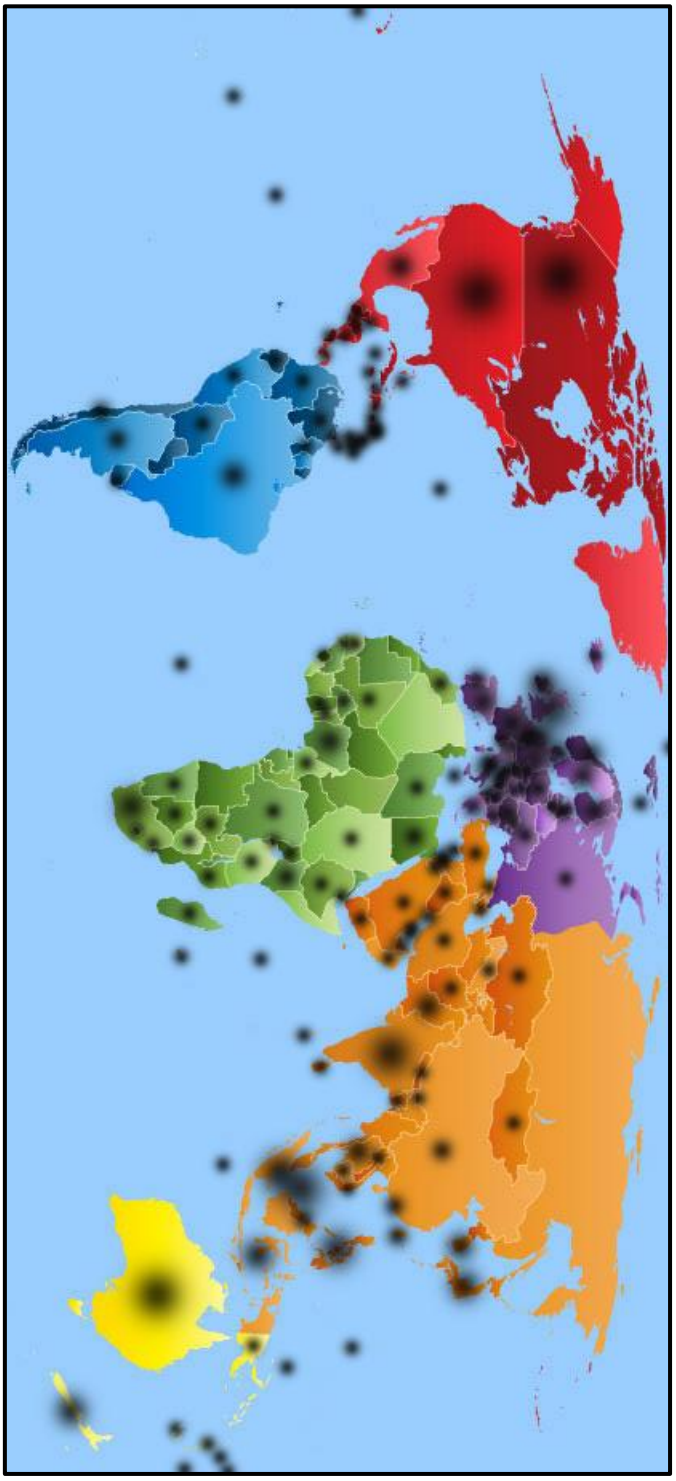
Valence	Arousal	Feel	Feeling	Feels	Felt
Neg	High	0.00195 (0.00166)	0.00171 (0.0013)	0.00108 (0.00081)	0.00111 (0.00083)
	Low	0.00478 (0.0039)	0.00394 (0.003)	0.00257 (0.0019)	0.00219 (0.00131)
Pos	High	0.00213 (0.00183)	0.00217 (0.00185)	0.00146 (0.00088)	0.00118 (0.00069)
	Low	0.00498 (0.0041)	0.00461 (0.00349)	0.0034 (0.00204)	0.00291 (0.00175)
Neut	High	0.00511 (0.00417)	0.00493 (0.00372)	0.00337 (0.00158)	0.00288 (0.00161)
	Low	0.00284 (0.00234)	0.00281 (0.00221)	0.00198 (0.00122)	0.00193 (0.00153)

The number of emotion words of each type of valence was counted and separated by arousal for sentences of each tense of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence, high arousal). The weighted means and standard deviations are shown here.

Note: Standard deviations are in parentheses

Figure 1. Example screenshots of wefeelfine.org

Wefeelfine.org collects all blog sentences that contain a tense of the verb, "feel." The sentences are individually displayed in several ways, including "Madness" and "Murmurs," shown here.



Key

Number of bloggers	Diameter (px)
0-15	15
16-40	20
41-100	25
101-300	30
301-600	35
601-1000	40
1001-2500	45
>2500	50

Figure 2. Map of reported blogging locations

Wefeelfine.org collects bloggers' reported locations, which are displayed here. The diameter of the circle corresponds with the number of bloggers from that country, as shown in the key.

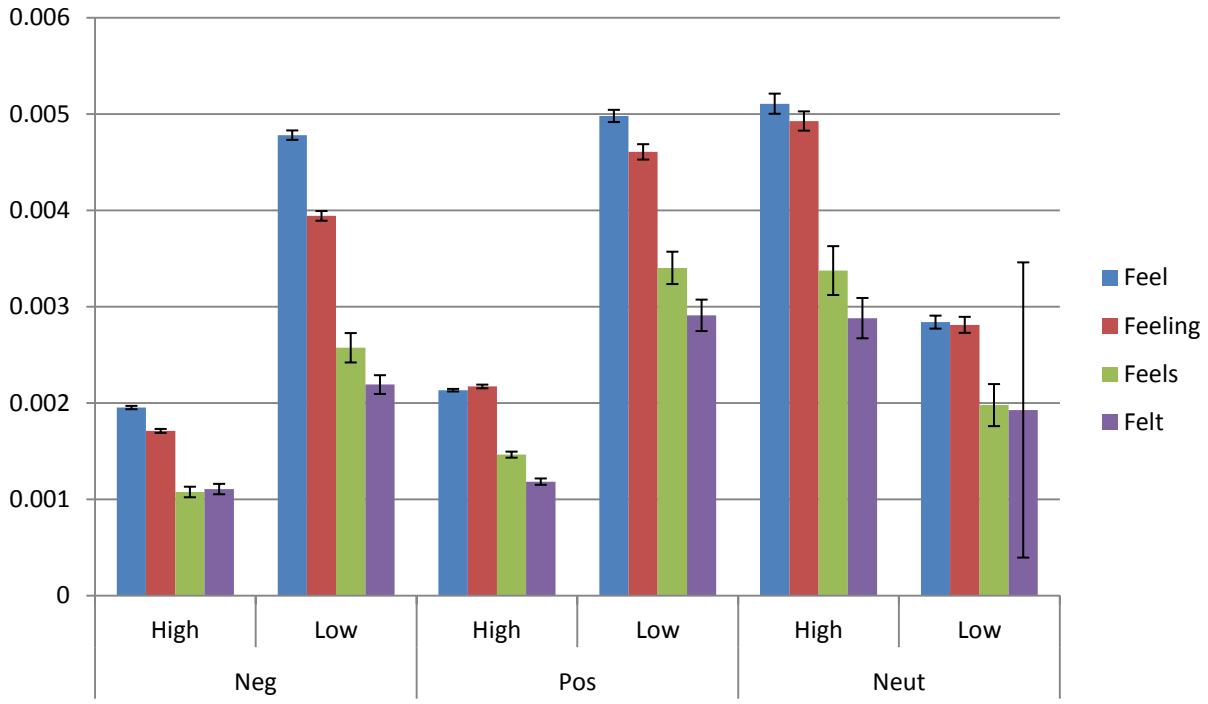


Figure 3. Weighted mean number of emotion words in sentences of different tenses of "feel," broken down by valence and arousal

The mean number of emotion words in sentences containing different tenses of the verb, "feel" were collected. The means were weighted to account for differences in length of sentences and number of words that share the category (i.e., negative valence high arousal). The weighted means are shown here.

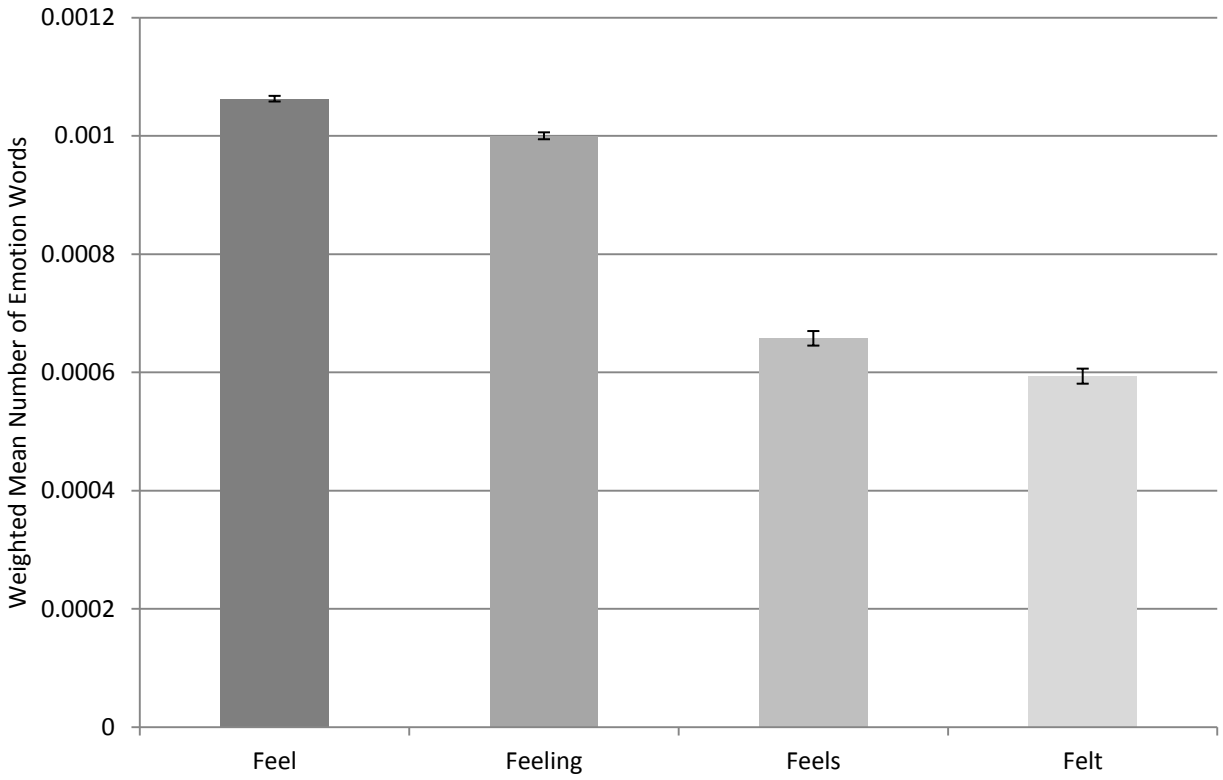


Figure 4. Weighted mean number of emotion words with different tenses of "feel"

The mean number of emotion words in sentences containing different forms of the verb, "feel." Means were weighted to account for differences in length of sentences.

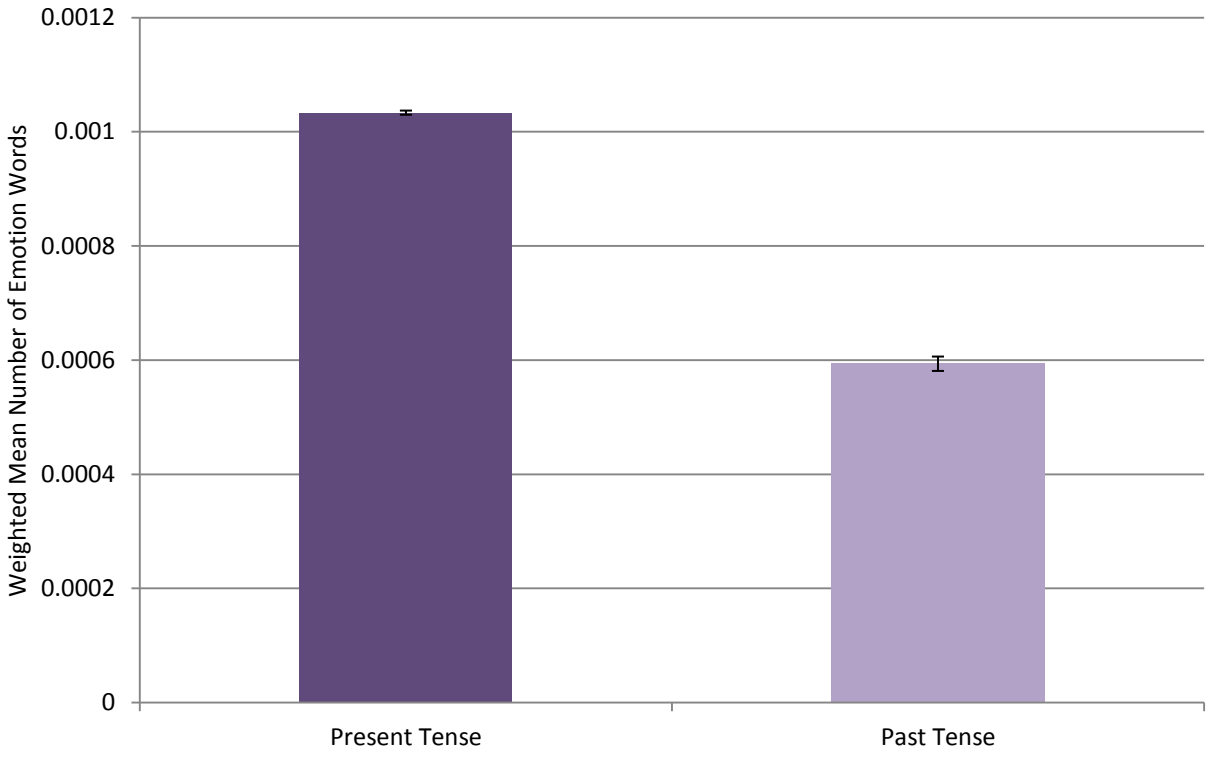


Figure 5. Weighted mean number of emotion words used in present tense vs. past tense sentences

The mean number of emotion words in sentences containing present and past tense forms of the verb, "feel." Means were weighted to account for differences in length of sentences.

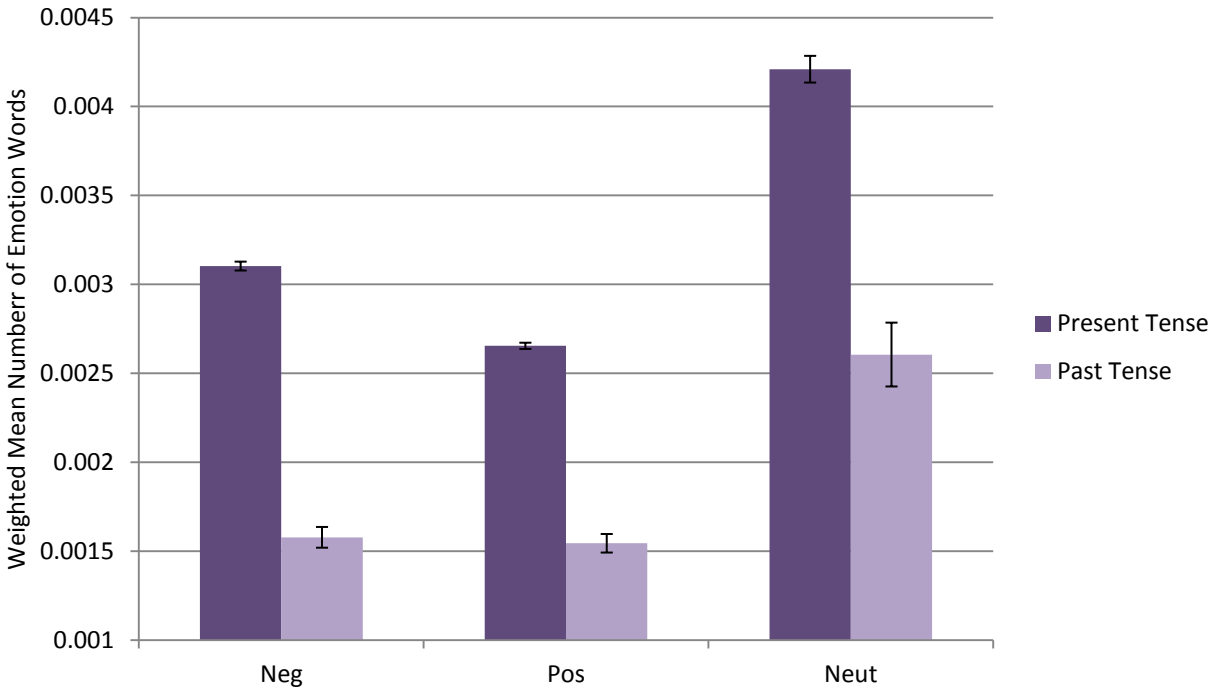


Figure 6. Weighted mean number of emotion words used in past vs. present tense sentences, broken down by valence

The number of emotion words of each type of valence was counted in sentences that contained present and past tense forms of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

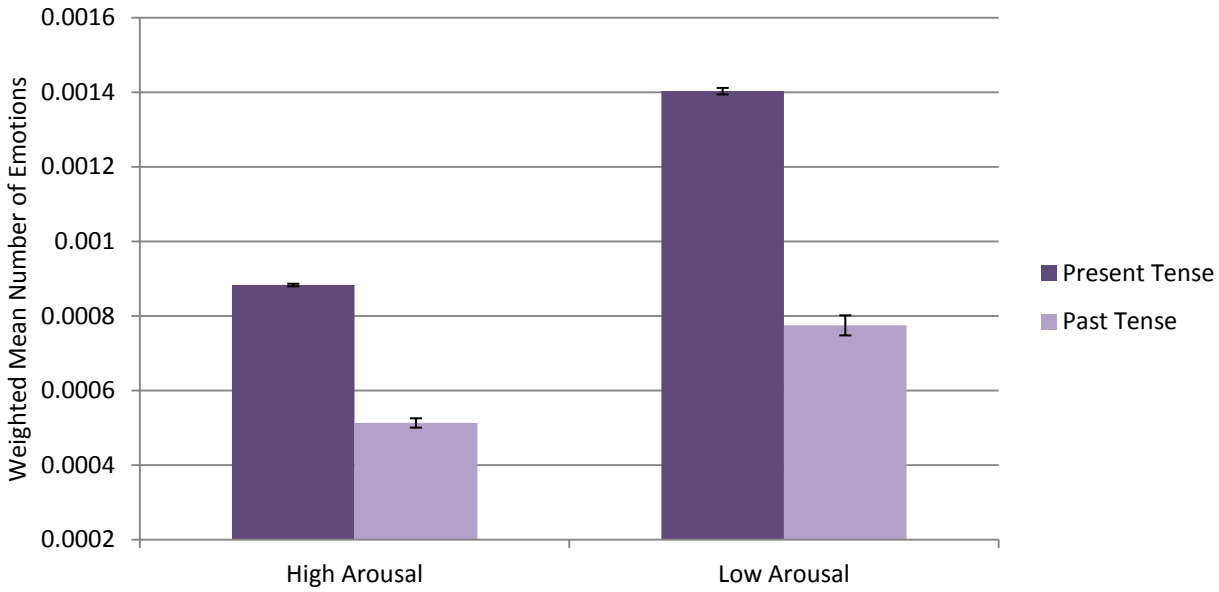


Figure 7. Weighted mean number of emotion words used in present tense vs. past tense sentences, broken down by arousal

The number of emotion words of each category of arousal was counted in sentences that contained present and past tense forms of the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

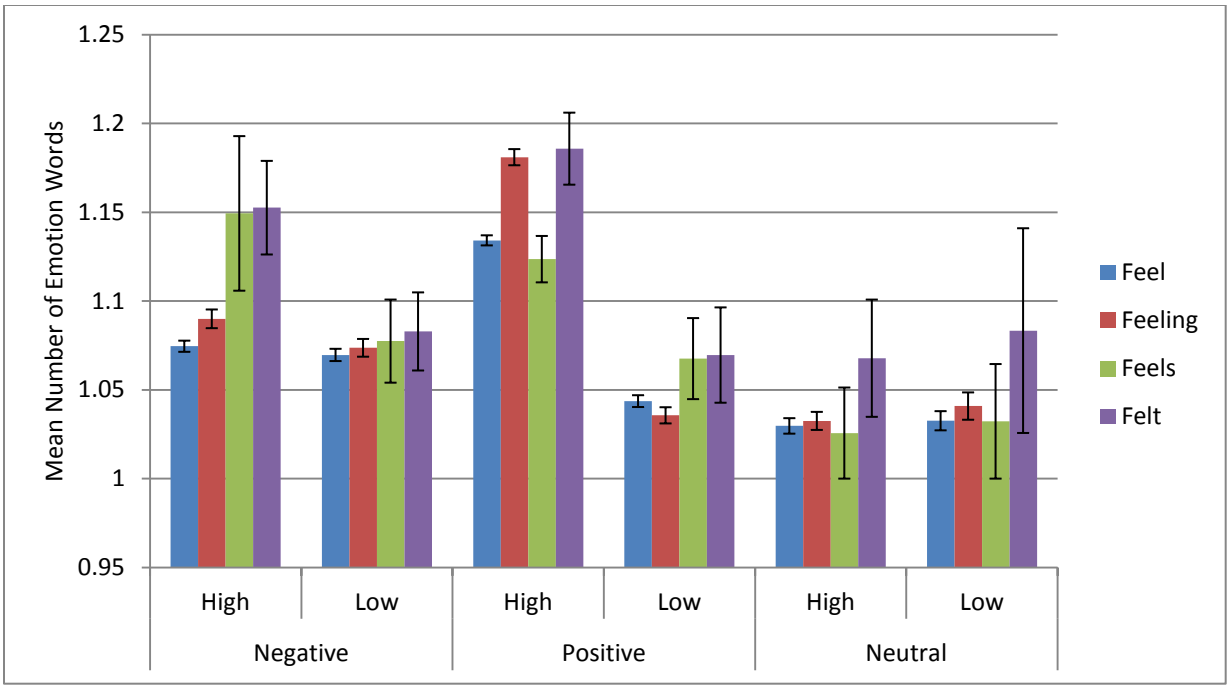


Figure 8. Unweighted mean number of emotion words in sentences containing forms of the verb, "feel," broken down by valence and arousal

The number of emotion words of each category of valence and arousal was counted for blog sentences containing a form of the verb, "feel." The means are shown here.

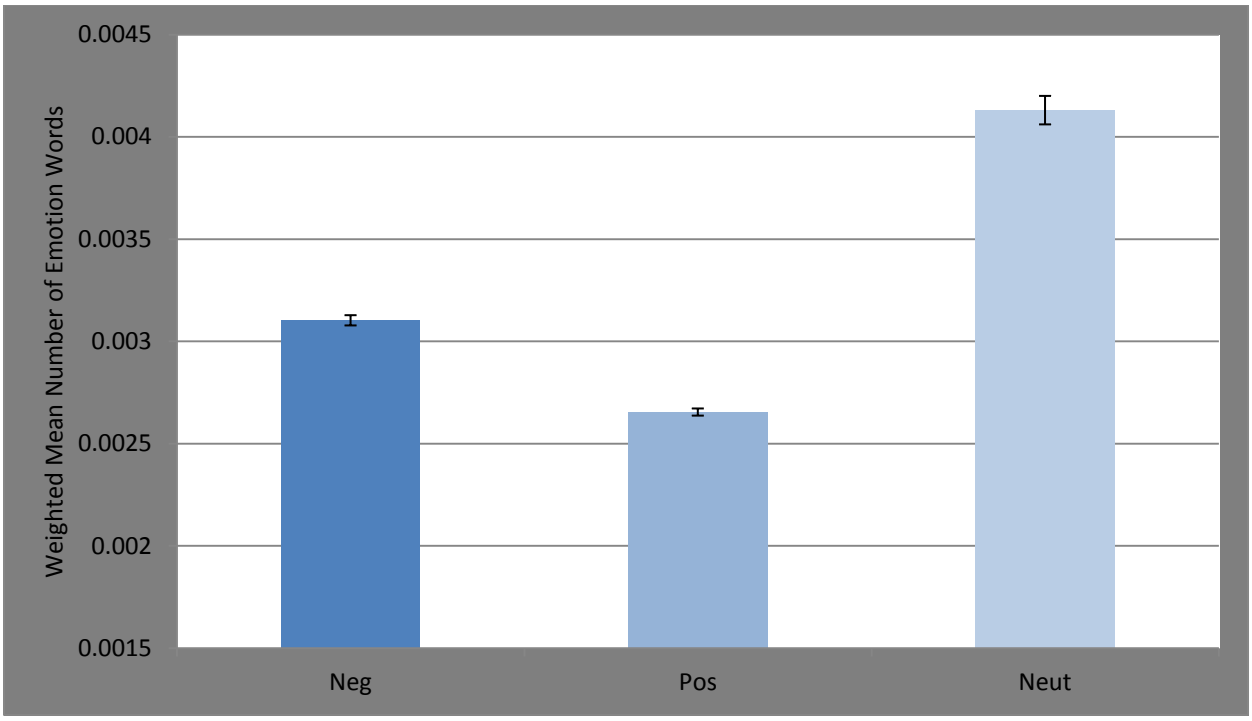


Figure 9. Weighted mean number of emotion words in "feel" sentences broken down by valence The number of emotion words of each type of valence was counted for sentences containing the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

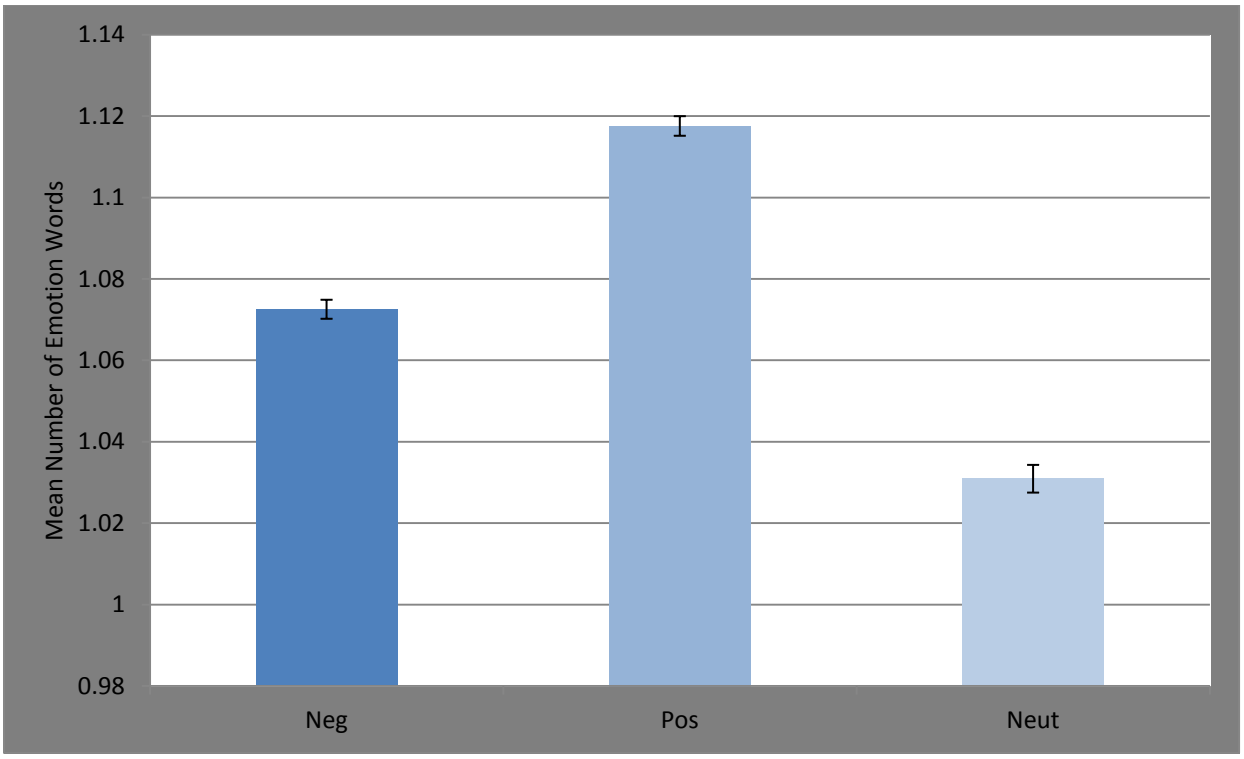


Figure 10. Unweighted mean number of emotion words in "feel" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "feel."The means are shown here.

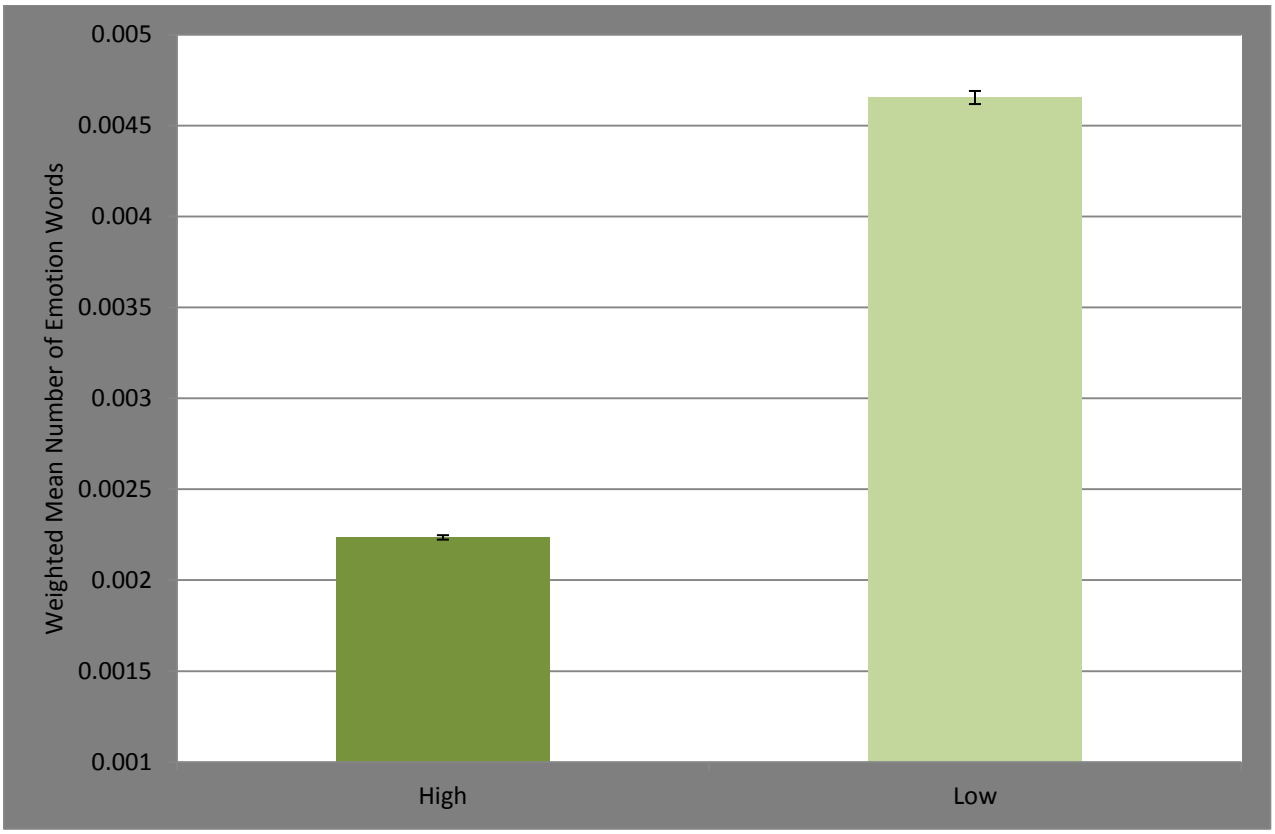


Figure 11. Weighted mean number of emotion words in "feel" sentences broken down by arousal

The number of emotion words of each category of arousal was counted for sentences containing the verb, "feel." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

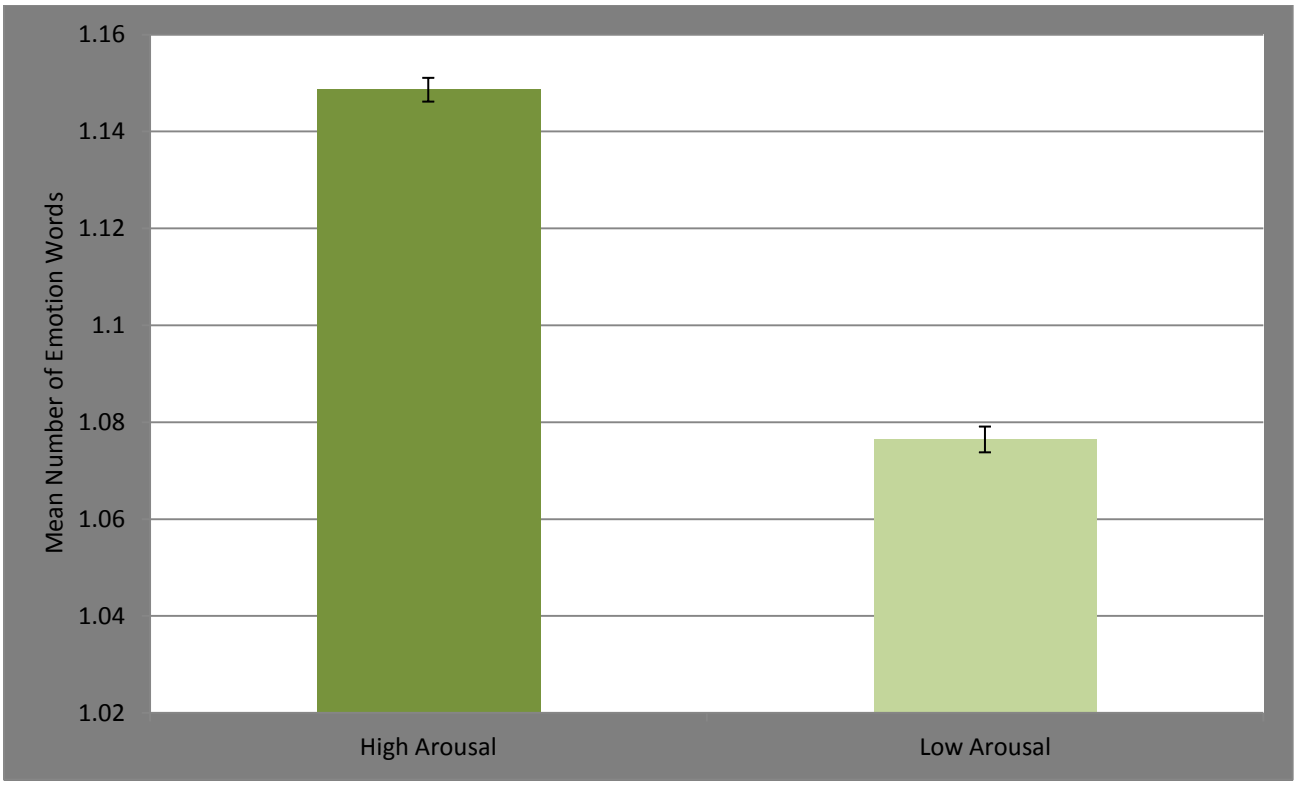


Figure 12. Unweighted mean number of emotion words in "feel" sentences broken down by arousal

The number of emotion words of each category of valence was counted for sentences containing the verb, "feel." The means are shown here.

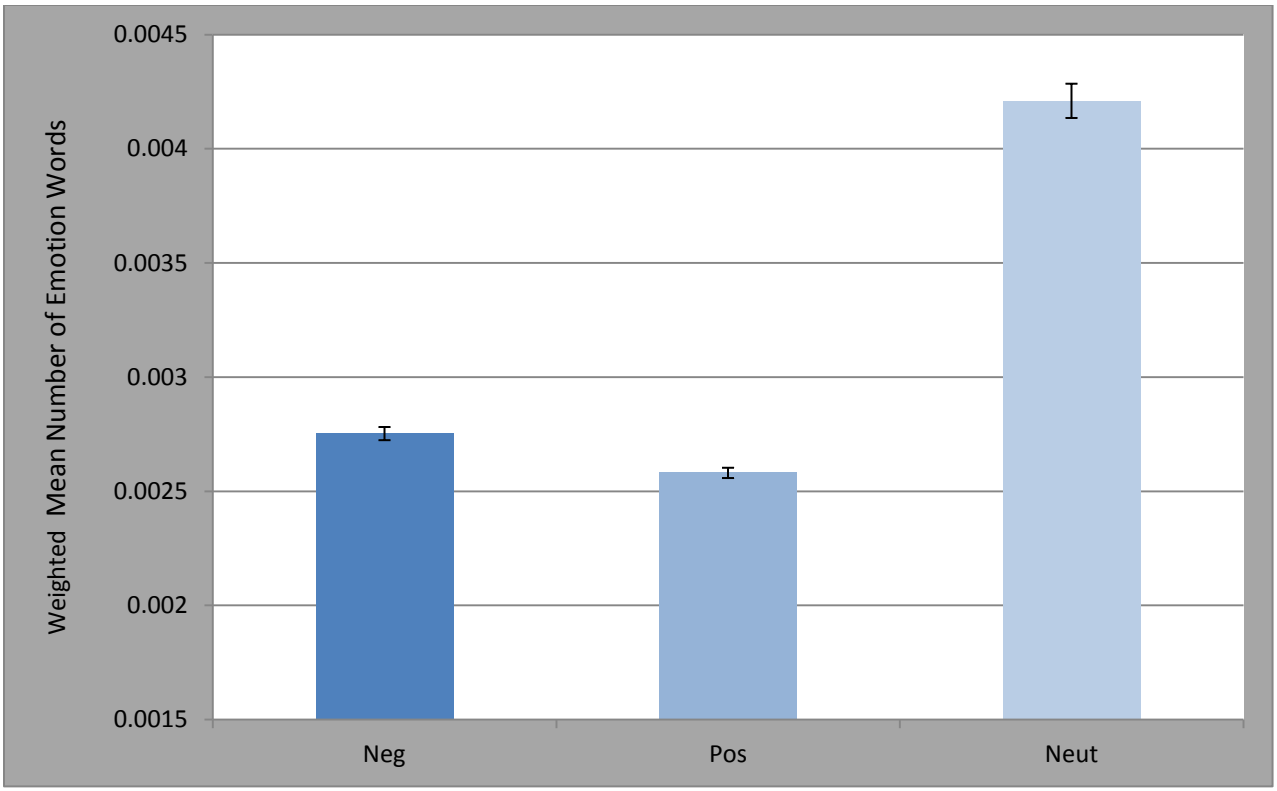


Figure 13. Weighted mean number of emotion words in "feeling" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "feeling." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

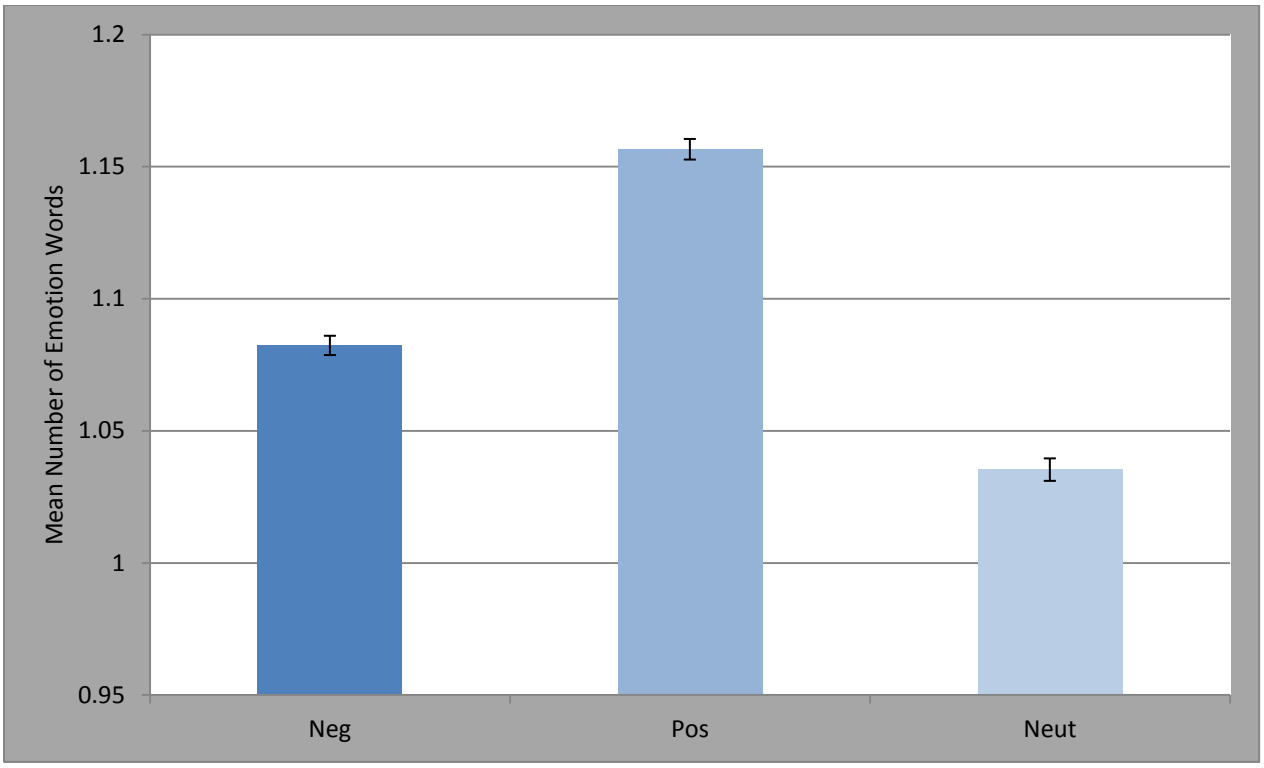


Figure 14. Unweighted mean number of emotion words in "feeling" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "feeling." The means are shown here.

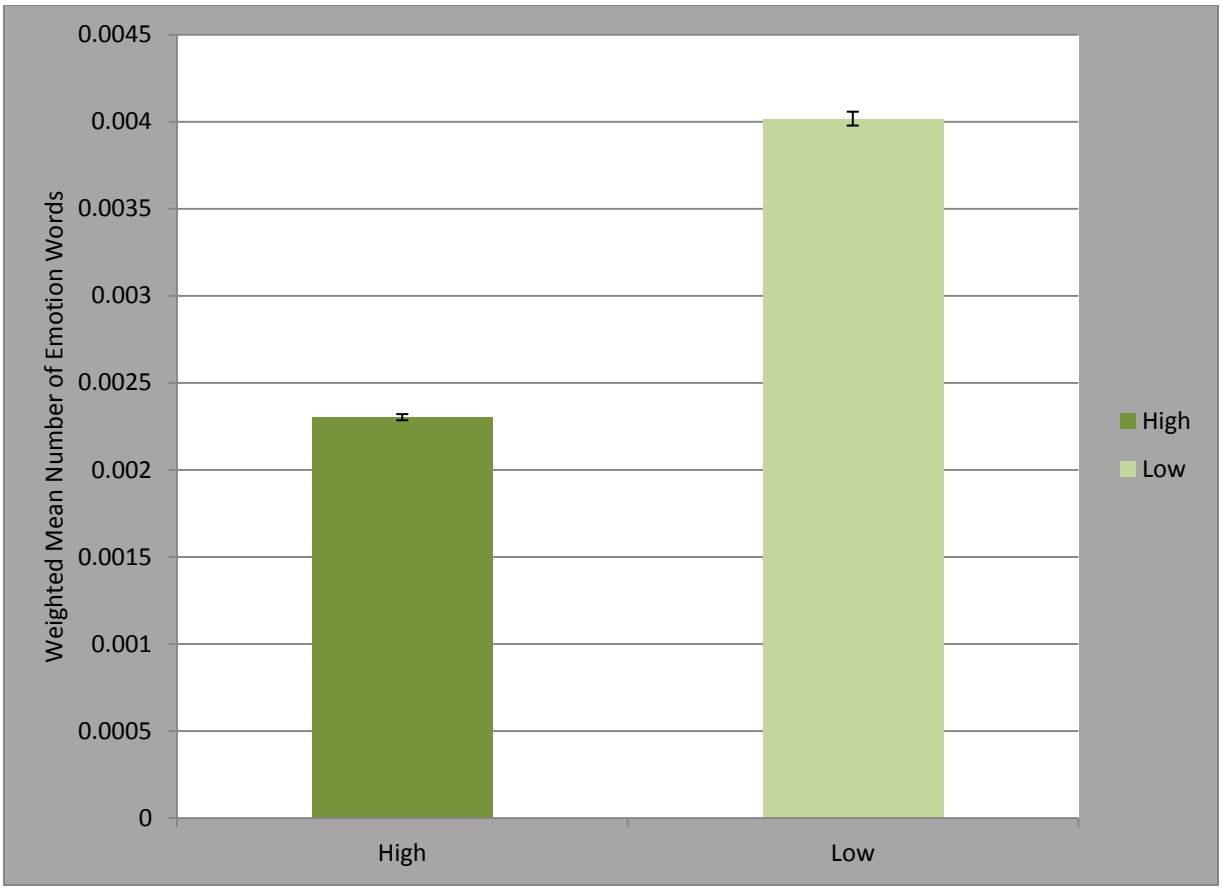


Figure 15. Weighted mean number of emotion words in "feeling" sentences broken down by arousal

The number of emotion words of each category of arousal was counted for sentences containing the verb, "feeling." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

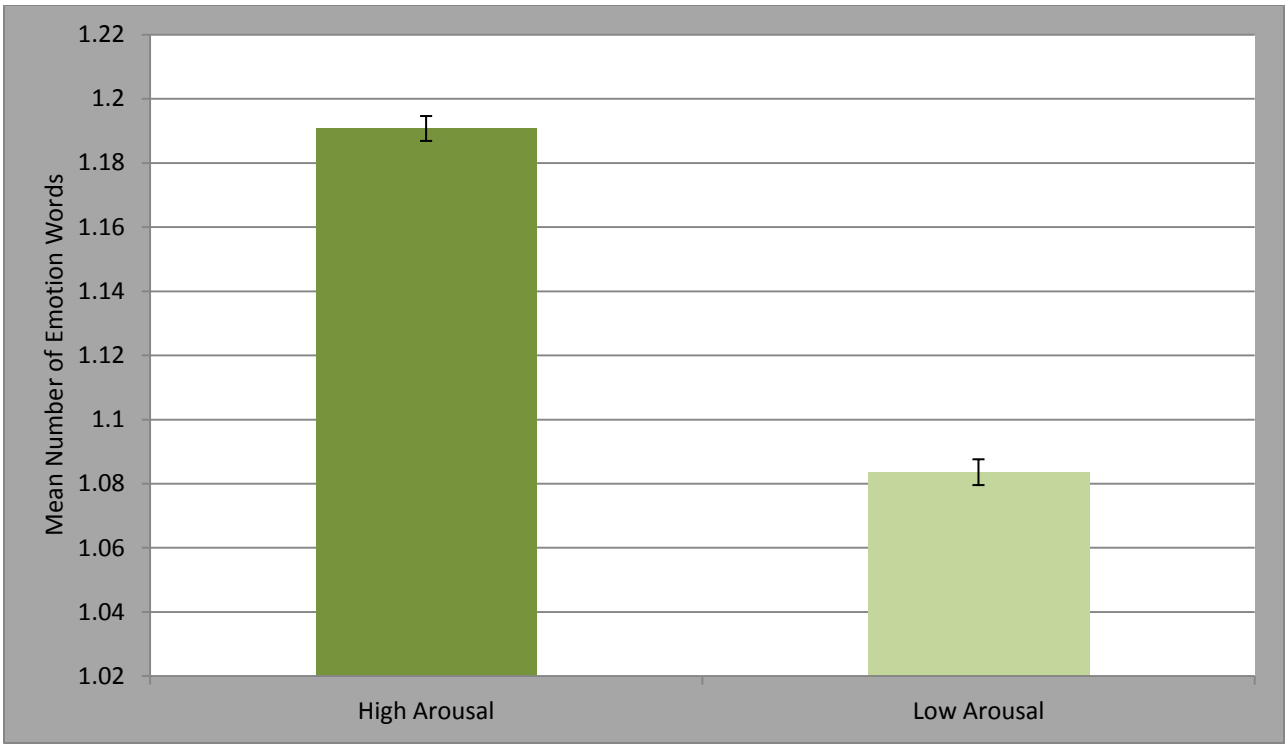


Figure 16. Unweighted mean number of emotion words in "feeling" sentences broken down by arousal

The number of emotion words of each type of valence was counted for sentences containing the verb, "feeling." The means are shown here.

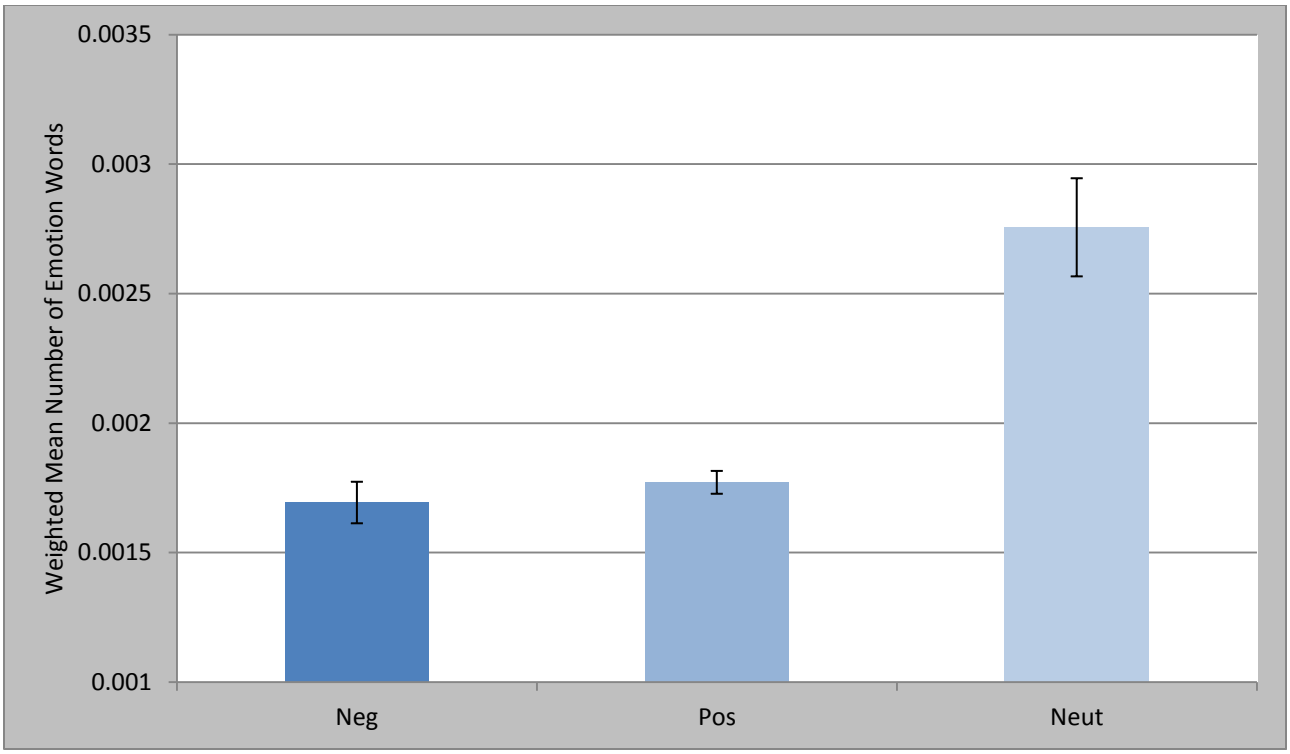


Figure 17. Weighted mean number of emotion words in "feels" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "feels." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

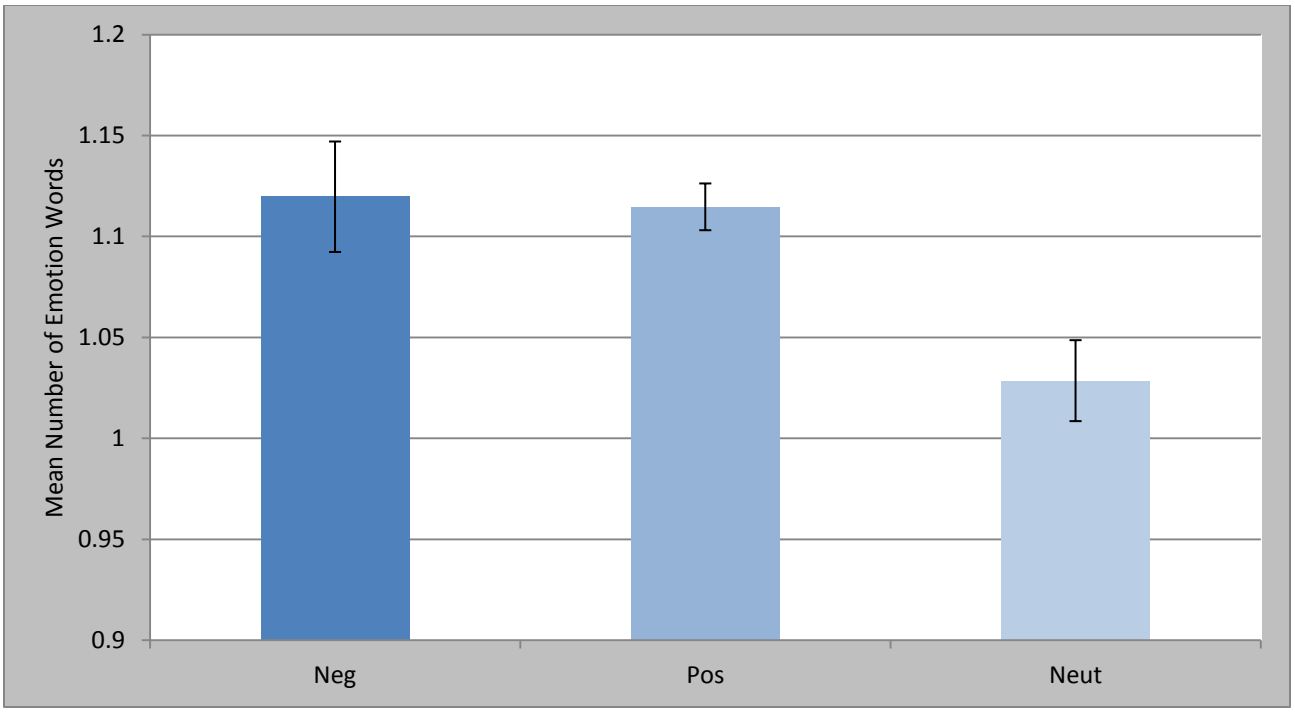


Figure 18. Unweighted mean number of emotion words in "feels" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "feels." The weighted means are shown here.

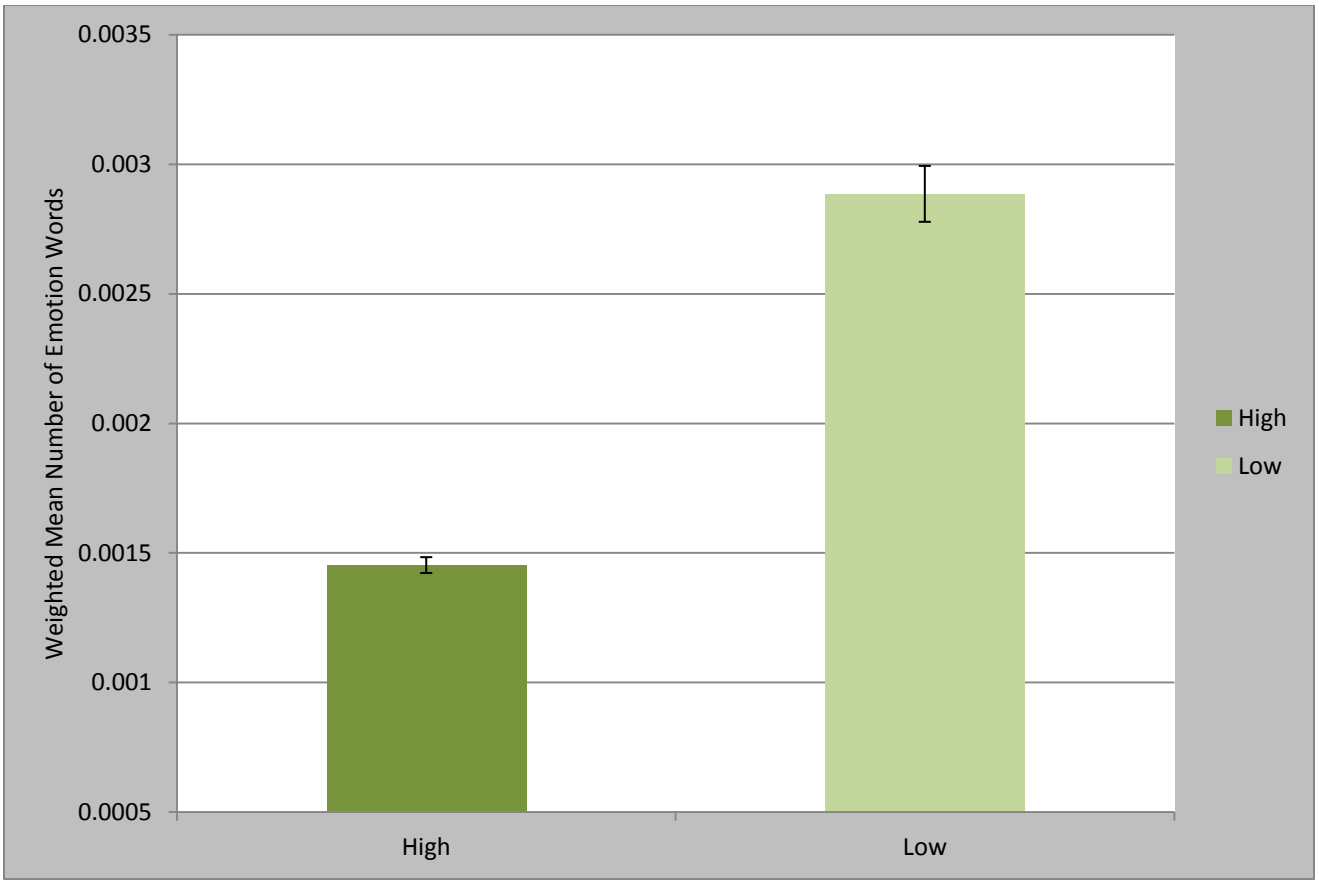


Figure 19. Weighted mean number of emotion words in "feels" sentences broken down by arousal

The number of emotion words of each category of arousal was counted for sentences containing the verb, "feels." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

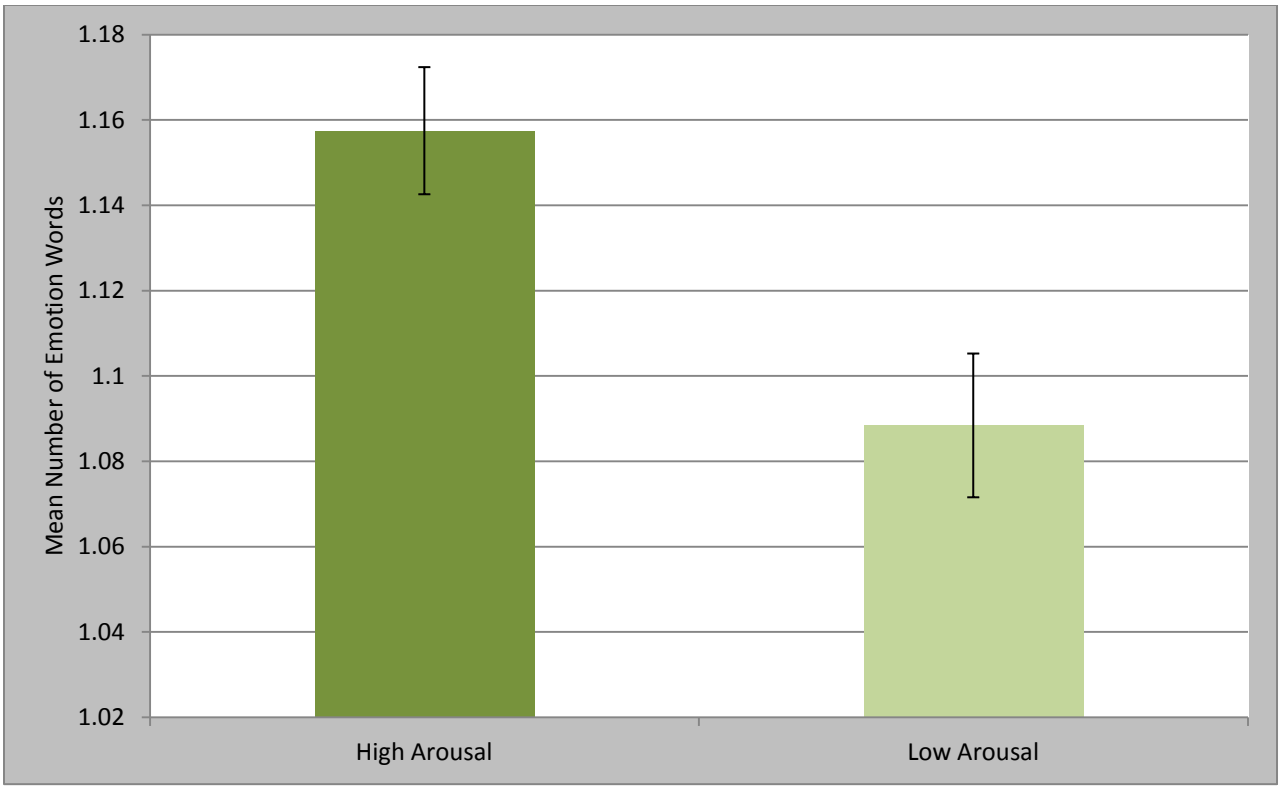


Figure 20. Unweighted mean number of emotion words in "feels" sentences broken down by arousal

The number of emotion words of each type of valence was counted for sentences containing the verb, "feels." The means are shown here.

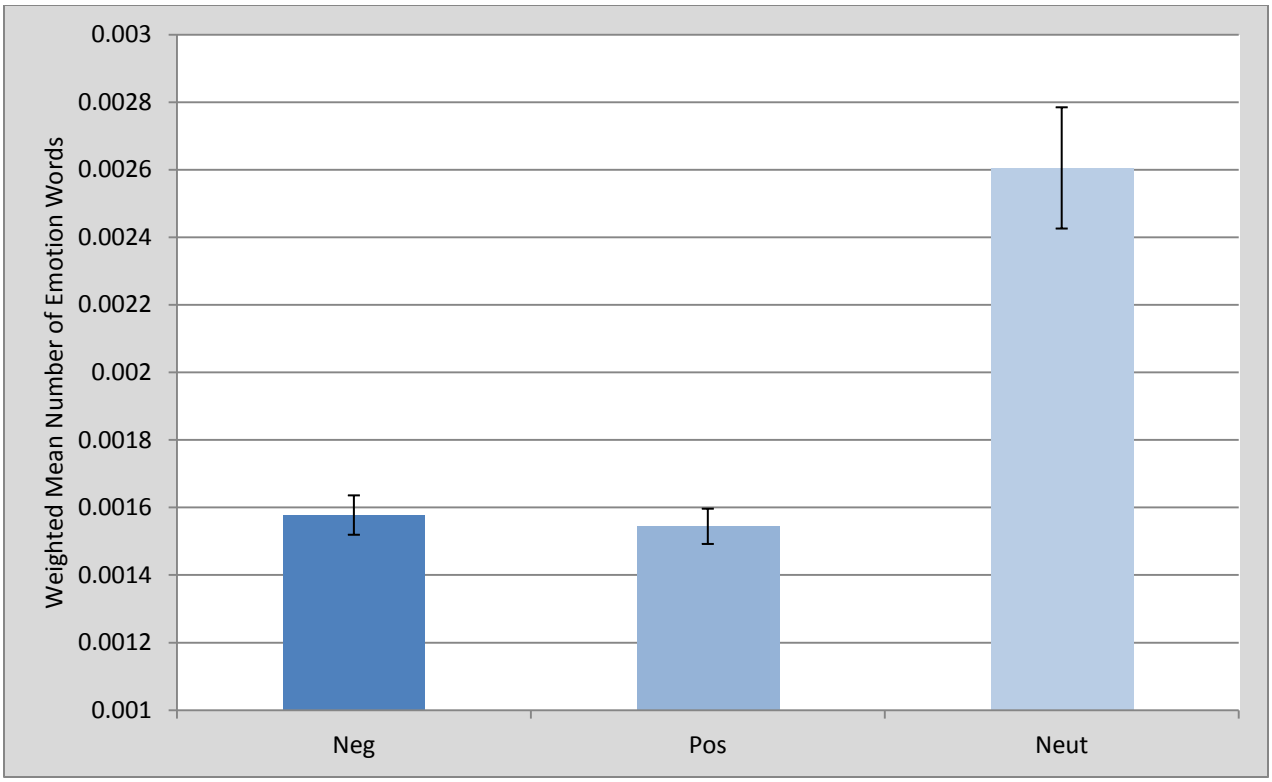


Figure 21. Weighted mean number of emotion words in "felt" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "felt." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., negative valence). The weighted means are shown here.

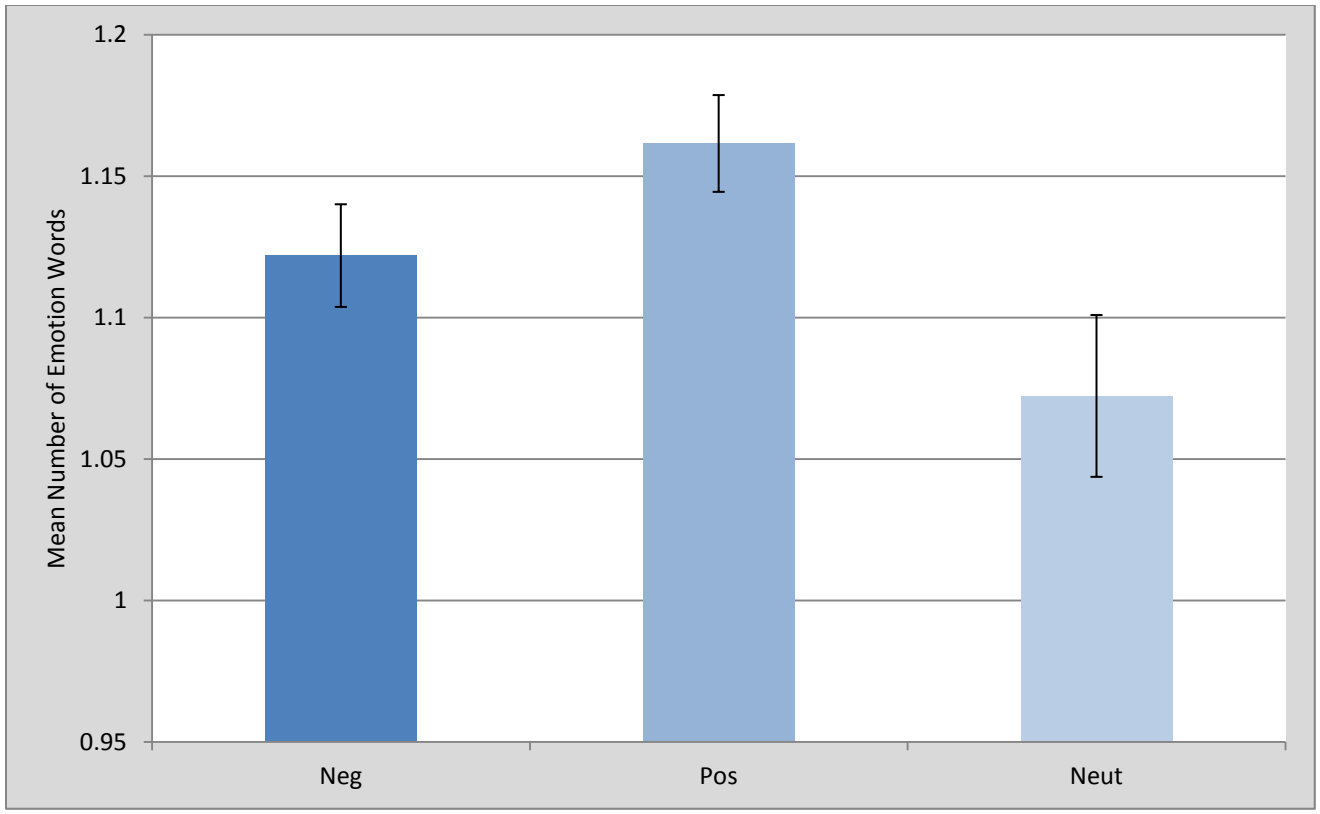


Figure 22. Unweighted mean number of emotion words in "felt" sentences broken down by valence

The number of emotion words of each type of valence was counted for sentences containing the verb, "felt." The means are shown here.

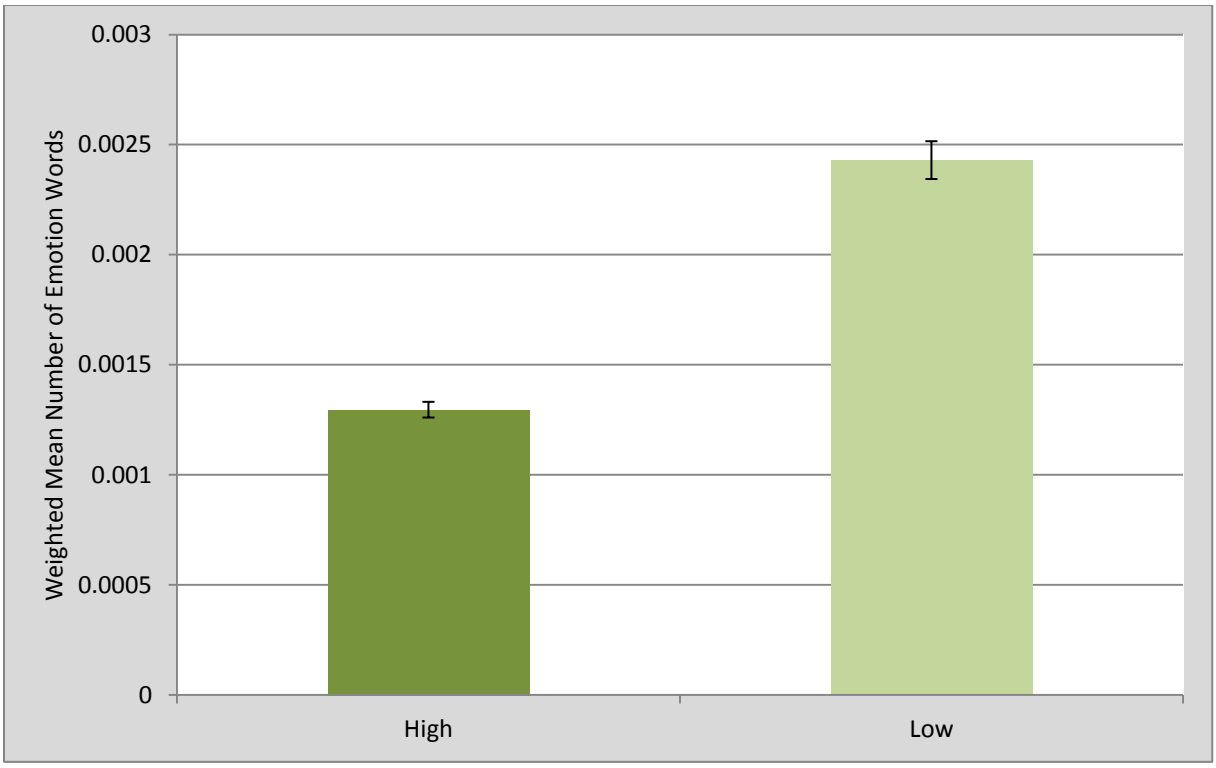


Figure 23. Weighted mean number of emotion words in "felt" sentences broken down by arousal The number of emotion words of each category of arousal was counted for sentences containing the verb, "felt." This count was weighted to account for differences in length of sentences and number of words that shared a category (i.e., high arousal). The weighted means are shown here.

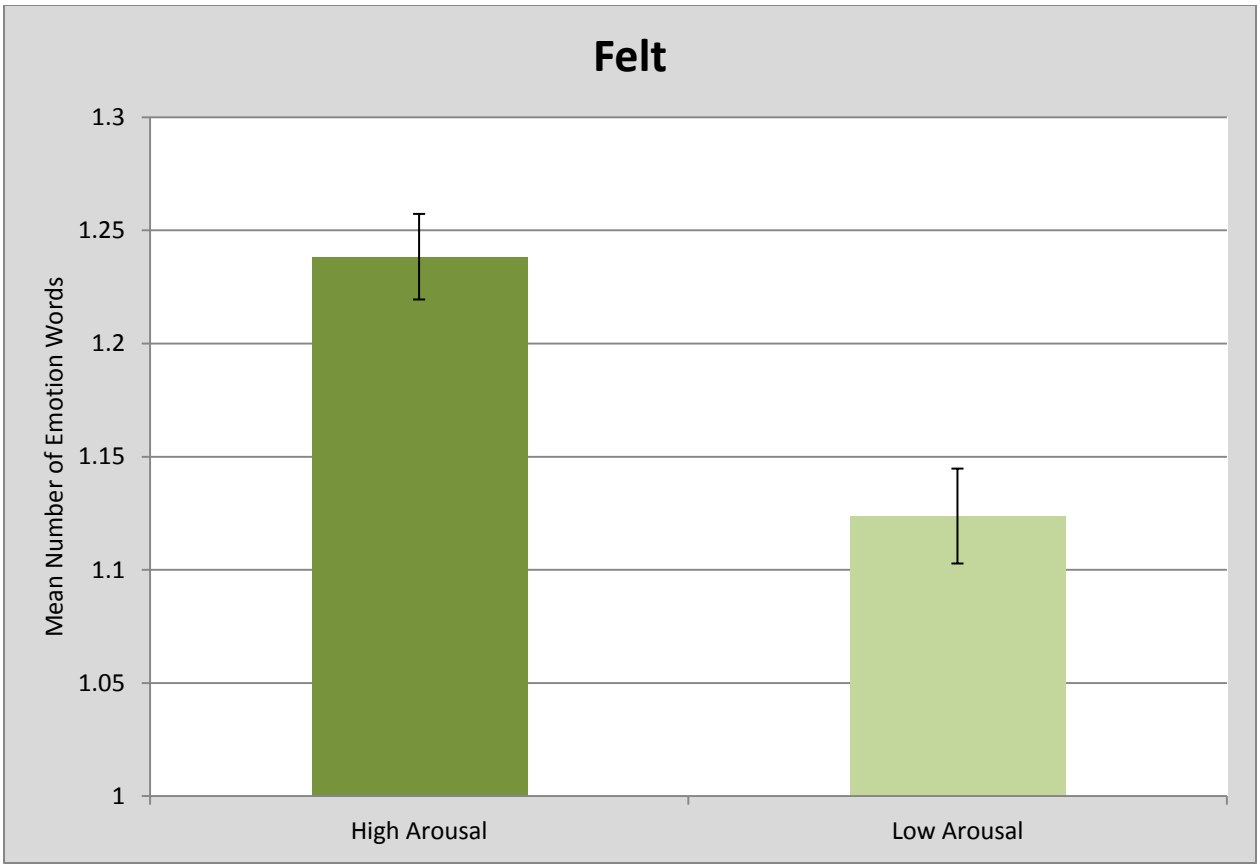


Figure 24. Unweighted mean number of emotion words in "felt" sentences broken down by arousal

The number of emotion words of each category of arousal was counted for sentences containing the verb, "felt." The means are shown here.

Appendix A. *List of ANEW emotion words used*

The emotion words counted in each sentence are shown here. Selection was based on affective norms for English words (ANEW; Bradley & Lang, 1999). All words that could follow the phrase, "I feel…" were included.

Negative	High	afraid	defeated	frustrated	regretful	terrified
		angry	despairing	guilty	rejected	troubled
		anguished	disgusted	helpless	scornful	ugly
		broken	disloyal	hostile	seasick	unfaithful
		burdened	displeased	insane	selfish	upset
		confused	distressed	insecure	sinful	wicked
		crude	embarrassed	lost	starving	
		cruel	enraged	morbid	tense	
		crushed	fearful	nervous	terrible	
	Low	addicted	discouraged	immoral	rotten	useless
		alone	dreary	inferior	sad	
		bored	fatigued	lonely	shamed	
		deformed	foul	moody	sick	
		depressed	frigid	obnoxious	unhappy	
Positive	High	ace	brave	good	merry	strong
		admired	capable	happy	mighty	surprised
		adorable	confident	hopeful	outstanding	terrific
		alive	cute	impressed	powerful	thoughtful
		aroused	devoted	inspired	pretty	triumphant
		astonished	elated	joyful	proud	vigorous
		awed	engaged	lively	romantic	
		beautiful	festive	loved	sexy	
		bold	free	lucky	silly	
	Low	blue	innocent	relaxed	satisfied	untroubled
		carefree	kind	respectful	secure	useful
		grateful	protected	safe	thankful	wise
Neutral	High	aggressive	anxious	cold	disdainful	overwhelmed
		alert	arrogant	curious	embattled	startled
		alien	clumsy	defiant	neurotic	suspicious
	Low	absurd	indifferent	nonchalant	serious	solemn
		aloof	lazy	plain	sheltered	stagnant
		blasé	listless	repentant	shy	subdued
		detached	meek	reserved	skeptical	timid
		humble	modest	reverent	slow	weary