Emotion words and categories:

Evidence from lexical decision

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Abstract

We examined the categorical nature of emotion word recognition. Positive, negative, and neutral words were presented in lexical decision tasks. Word frequency was additionally manipulated. In Experiment 1, “positive” and “negative” categories of words were implicitly indicated by the blocked design employed. A significant emotion-frequency interaction was obtained, replicating past research. While positive words consistently elicited faster responses than neutral words, only low frequency negative words demonstrated a similar advantage. In Experiments 2a and 2b, explicit categories (“positive,” “negative,” and “household” items) were specified to participants. Positive words again elicited faster responses than did neutral words. Responses to negative words, however, were no different than those to neutral words, regardless of their frequency. The overall pattern of effects indicates that positive words are always facilitated, frequency plays a greater role in the recognition of negative words, and a “negative” category represents a somewhat disparate set of emotions. These results support the notion that emotion word processing may be moderated by distinct systems.

Key words: emotion, word frequency, category, lexical decision, arousal, valence

Recent word recognition research has reported an interaction between a word's emotional quality (characterized as positive, negative, or neutral) and its frequency of occurrence (having a higher or lower prevalence of use). These results were found in lexical decision reaction times (Kuchinke, Võ, Hofmann, & Jacobs, 2007; Scott, O'Donnell, Leuthold, & Sereno, 2009), in electrophysiological voltages (Scott et al., 2009), as well as in eye fixation times during fluent reading (Scott, O'Donnell, & Sereno, 2012). Specifically, for low frequency (LF) words, behavioral responses to both positive and negative words were faster than those to neutral words; for high frequency (HF) words, responses to positive words alone were faster than those to either negative or neutral words (which did not differ). Early word frequency effects have consistently been demonstrated in eye movement and electrophysiological paradigms (see Hand, Miellet, O'Donnell, & Sereno, 2010), and are considered to reliably indicate lexical access (e.g., Sereno & Rayner, 2003). Thus, an interaction of a word's emotional quality with its frequency suggests a central role of emotion in the initial stages of word recognition.

The underlying theoretical mechanisms of emotion word processing, however, are less well understood. One account is derived from Taylor's (1991) two-stage mobilization-minimization hypothesis, developed from McGinnies' (1949) theory of perceptual defense (see also Pratto and John's (1991) automatic vigilance hypothesis). Because of their high arousal, emotion words are initially facilitated relative to neutral words. Potential negative consequences of such emotional content, however, are guarded against by delaying their processing to provide time to diminish their impact. Accordingly, although both positive and negative words enjoy an initial advantage, negative words are subsequently inhibited. Scott et al. (2009) further suggested that minimization could be stronger for HF than LF negative words because, by definition, HF concepts are more salient. An alternative explanation for the differential pattern of responses to HF and LF negative words is based on the clinical notion of desensitization. In their 'boy who cried wolf' hypothesis, Scott et al. (2012) proposed that the relative slowness of responses to HF negative words may be because their negative semantics are diluted or lost through repeated exposure. Thus, while such words are consciously considered as negative in off-line rating tasks, on-line task performance may be more closely linked to automatic word recognition processes in which only vestigial emotional activations are elicited.

Emotion words are typically characterized by their dual properties of arousal (internal activation) and valence (value or worth). In comparison to neutral words, emotion words have high arousal values correlated with extreme valence (e.g., Bradley & Lang, 1999; see also the circumplex model of Russell, 1980). While emotion words reside at polar opposites of a valence continuum, the question remains as to whether positive and negative words comprise a single "emotion" category or form independent categories. For example, some researchers suggest that the relationship between valence and recognition is linear, extending over a single dimension (e.g., Kousta, Vinson, & Vigliocco, 2009; Larsen, Mercer, Balota, & Strube, 2008), while others maintain it is categorical, with distinct positive and negative types (e.g., Estes & Adelman, 2008a, 2008b). Research into the organization and representation of categories has demonstrated selective facilitation of category members across a variety of paradigms and measures (e.g., Bermeitinger, Wentura, & Frings, 2011; Sachs et al., 2008; Segalowitz & Zheng, 2009). Moreover, what defines a category (e.g., Barsalou, 1983) and whether a category is established implicitly or explicitly, for example, via the context afforded by a list of related items or by an encompassing label (e.g., Bazzanella & Bouquet, 2011; Becker, 1980; Schacter & Badgaiyan, 2001), has implications for the amount of benefit conferred on its members.

To investigate the categorical nature of emotion word processing, we designed a series of lexical decision experiments that all additionally manipulated word frequency, in particular, because of its differential effect on responses to negative words. In the prior emotion × frequency lexical decision studies, positive and negative words were intermixed with neutral words within a single block. In our first study (Experiment 1), we examined whether the same pattern of effects would be obtained under conditions of implicit categorical priming – when positive and negative words were presented in separate blocks. In the subsequent two studies, we examined the effect of explicit category priming, comparing responses to words belonging to the neutral category of "household" items to those within the category of either "positive" (Experiment 2a) or "negative" (Experiment 2b) items. In the Kuchinke et al. (2007) and Scott et al. (2009) experiments (as in most emotion word experiments and in our Experiment 1), neutral words did not form a coherent category; they were simply items that shared the characteristics of low arousal and intermediate valence. Thus, it is possible that the response time advantage found for (most) emotion over neutral words may be due in part to unbalanced implicit categorical priming across conditions, where a greater degree of semantic links exist between a selection of emotion versus neutral words. Consequently, while explicit category priming should facilitate the processing of all word types, this effect may appear more pronounced for neutral words. We expected that the current set of experiments would provide complementary results. That is, Experiment 1 should establish a baseline of implicit categorical emotion processing (positive and negative) relative to neutral words that do not form any coherent category. Experiments 2a and 2b should provide evidence of the effect of explicit categorical priming when it has been applied to all conditions (emotional or not). Taken together, the results of these experiments should begin to address the role that categorical priming plays in experimental research into emotion word processing.

Experiment 1

Method

Participants. Twenty-four members of the University of Glasgow community (16 female; mean age 25) received compensation for their participation. All were native English speakers, were right-handed, had normal or corrected-to-normal vision, and were naïve as to the purpose of the experiment.

Apparatus. The experiment was run on a Mac G4 using PsyScope 1.2.5 PPC software. Stimuli were presented in 24-point Courier (black characters on a white background) on a Hansol 2100A 19” monitor. At a viewing distance of 25”, 3 characters subtended 1^{o} of visual angle. Responses were made via a PsyScope Button Box and reaction times (RTs) were recorded with millisecond accuracy.

Design and Materials. A 4 (Emotion: Positive, Negative, Neutral1, Neutral2) × 2 (Frequency: LF, HF) within-participants design was used with 27 items in each of the 8 conditions. Arousal and valence ratings for all words were acquired from the Affective Norms for English Words (ANEW) database (Bradley & Lang, 1999). Each word has associated ratings for arousal, from 1 (low) to 9 (high), and for valence, from 1 (low, having a negative meaning) to 9 (high, having a positive meaning). Arousal values ranged from 6-9 for emotion words and 1-5.5 for neutral words. Valence values ranged from 6-9 for positive words, 1-4 for negative words, and 4-6 for neutral words. Word frequencies were obtained from the British National Corpus (BNC; http://www.natcorp.ox.ac.uk), a database of 90 million written word tokens (with frequencies expressed in occurrences per million). Example items are presented in Table 1. Average word frequency, length (in letters and syllables), arousal, and valence values across conditions are presented in Table 2. For each word, a nonword of equal length was constructed. Nonwords comprised pronounceable, orthographically legal pseudowords (e.g., *famper*).

Insert Tables 1 and 2

Procedure. Participants were tested individually. Word responses were made using the right forefinger on the right (green) key of the Button Box, labelled “W,” and nonword responses with the left forefinger on the left (red) key, labelled “NW.” Participants were first presented with a set of practice items to become accustomed to the task.

The experiment comprised two blocks, with Positive and Neutral1 words in one block, and Negative and Neutral2 words in the other. Half of the participants received the Positive and Netural1 block first, while the other half received the Negative and Neutral2 block first. Within each block, trials were presented in a different random order for each participant. Each trial consisted of a blank screen (1000 ms), a central fixation cross (200 ms), another blank screen (500 ms), and a letter string presented centrally (until response).

Results

The RTs from correct responses (96% of the data) were subjected to two trimming procedures. Items with RTs less than 250 ms or greater than 1500 ms were excluded from further analyses. For each participant in each condition, items with RTs beyond two standard deviations of the mean were additionally excluded. These procedures resulted in an average data loss of 5% per participant (approx. one item per condition).

The mean RT data are presented in Table 3 and are graphically depicted in Figure 1. A 4 (Emotion) × 2 (Frequency) analysis of variance (ANOVA) was performed on the data by participants (F_1) and by items (F_2). There were significant main effects of Emotion and Frequency as well as a significant Emotion × Frequency interaction [Emotion: $F_1(3,69)=6.83$, $p<.001$, and $F_2(3,78)=12.77$, $p<.001$; Frequency: $F_1(1,23)=114.89$, $p<.001$, and $F_2(1,26)=146.84$, $p<.001$; Emotion × Frequency: $F_1(3,69)=6.86$, $p<.001$, and $F_2(3,78)=4.11$, $p=.009$]. Follow-up contrasts to the interaction demonstrated significant effects of Frequency, with faster responses to HF than LF words, for all Emotion conditions [*F*s>7.09, *p*s<.01]. For LF words, RTs to both Positive and Negative words, which did not differ [*F*s<1], were significantly faster than those to either Neutral1 or Neutral2 words [*F*s>15.35, *p*s<.001], which did not differ [$F_1=1.14$, $p>.25$; $F_2<1$]. For HF words, responses to Positive words alone were significantly faster than responses to Negative, Neutral1, or Neutral2 words, although some of these effects were marginal by items [F_1s>7.19, *p*s<.01; F_2s from 4.00 to 3.66, *p*s from .049 to .060]. HF Neutral1, Neutral2, and Negative conditions did not differ [*F*s<1].

Insert Table 3 and Figure 1

Discussion

HF and LF positive, negative, and neutral words were presented in a lexical decision task. Unlike the prior emotion-frequency studies, positive and negative words appeared in separate blocks. Nonetheless, a similar pattern of results emerged showing a significant interaction. It could be that the implicit category structure of “positive” and “negative” (separate blocks) is just as effective as that of “emotion” (single block). A simpler explanation for these findings is that the emotion-frequency interaction is immune to relatively weak contextual manipulations.

Experiments 2a and 2b

In Experiments 2a and 2b, a stronger semantic context was implemented by providing explicit category labels. Specifically, participants were told that they would be presented with words belonging to two categories: “positive” and “household” items (Experiment 2a) or “negative” and “household” items (Experiment 2b).

Method

Participants. Thirty-six members of the University of Glasgow community were compensated for their participation – 18 (15 female; mean age 19) in Experiment 2a, and a different set of 18 (17 female; mean age 20) in Experiment 2b. None had participated in Experiment 1. All conformed to the same criteria used in Experiment 1.

Apparatus. The apparatus was identical to that of Experiment 1.

Design and Materials. Both experiments utilized a 2 (Category: emotional, neutral) × 2 (Frequency: LF, HF) within-participants design, with 18 items in each of the 4 conditions. The emotional category was “Positive” items in Experiment 2a and “Negative” items in Experiment 2b, while the neutral category was “Household” items in both experiments. Emotion and neutral words were selected from ANEW within the same ranges of arousal and valence values used in Experiment 1. Example items are presented in Table 1 and average stimulus properties in Table 2. For each experiment, nonwords employing the same criteria as in Experiment 1 were used.

Procedure. The procedure of Experiment 1 was used with two modifications. First, as part of their instructions, participants were informed that the words consisted of items from two categories – "Positive" and "Household" items (Experiment 2a) or "Negative" and "Household" items (Experiment 2b). Second, items were presented within a single block.

Results

The RTs from correct responses (96% in both experiments) were subjected to the trimming procedures of Experiment 1, resulting in an average data loss of 5% per participant (approx. one item per condition). RT means are presented in Table 3 and Figure 1. For each experiment, 2 (Category) × 2 (Frequency) ANOVAs (F_1 and F_2) were performed on the RT means and these results appear in Table 4.

In Experiment 2a, the main effects of Category and Frequency were both significant [Category: $F_1(1,17)=7.82$, $p=.012$, and $F_2(1,17)=7.94$, $p=.012$; Frequency: $F_1(1,17)=16.94$, $p<.001$, and $F_2(1,17)=12.31$, $p=.003$]. Responses to "Positive" items (555 ms) were faster than those to "Household" items (578 ms). In addition, faster responses were made to HF (546 ms) than to LF (586 ms) words. There was no evidence of an interaction [all Fs<1].

In Experiment 2b, only the main effect of Frequency was significant [Frequency: $F_1(1,17)=40.59$, $p<.001$, and $F_2(1,17)=36.29$, $p<.001$]. Responses to HF words (516 ms) were faster than those to LF words (578 ms). There was no effect of Category nor was the interaction significant [all Fs<1].

Discussion

Experiments 2a and 2b explicitly manipulated category membership for both emotion and neutral items. In both experiments, significant word frequency effects were obtained, with faster responses to HF than LF words. "Positive" words elicited faster responses than "household" words (Experiment 2a), whereas "negative" words were no different (Experiment 2b). In comparison to the pattern of results of Experiment 1, the relative relationship between positive and neutral words remained the same, while that between negative and neutral words changed. Specifically, the previous advantage within the LF condition of negative over neutral words disappeared. Accordingly, it seems that category priming similarly affected positive and neutral, but not negative, words. One explanation draws on the differential effects of category priming in relation to both word frequency and category breadth, discussed in greater depth in the next section.

General Discussion

We sought to determine the role of implicit and explicit category membership on lexical decision responses to positive, negative, and neutral words. Word frequency was additionally manipulated because of its central relationship with lexical access. Prior investigations demonstrated an emotion-frequency interaction using different paradigms and measures (Kuchinke et al., 2007; Scott et al., 2009, 2012). These studies share the methodological feature that all word types were presented together. It is possible that emotion words (positive and negative) were selectively facilitated in their processing because implicit categorical priming was present for emotion but not neutral words.

In Experiment 1, positive and negative words were embedded in separate blocks, with neutral words included in each block. We reasoned that implementing such a design should help activate the implicit categories of "positive" and "negative" rather than that of "emotion." Nevertheless, as with the single-block studies, a similar emotion-frequency interaction was obtained. All word types demonstrated frequency effects. For LF words, positive and negative word responses were faster than neutral word responses; for HF words, only positive word response were faster than negative and neutral responses. It is possible that the benefit provided by two focal implicit categories offset the cost of eliminating a single general one. Indeed, a recent study that only employed a subset of our conditions – HF and LF negative and neutral words – reported an identical pattern of results corresponding to these conditions (Méndez-Bértolo, Pozo, & Hinojosa, 2011; cf. Nakic, Smith, Busis, Vythilingam, & Blair, 2006). It is also possible that, although positive and negative items were blocked in the current study, participants nonetheless relied upon a more general implicit category. More parsimoniously, the effect of such implicit category priming could be too weak to sufficiently influence word recognition processes. This is substantiated by the Scott et al. (2012) study which demonstrated a similar emotion-frequency interaction in eye fixation times on target words during fluent reading. Because targets were embedded in emotionally neutral sentence frames, the word recognition process was less susceptible to local priming by semantically related exemplars.

Experiments 2a and 2b examined whether explicit category priming of both emotion and neutral words would alter their response time relationships. Participants were instructed that word stimuli belonged to two categories – “positive” and “household” items (Experiment 2a), or “negative” and “household” items (Experiment 2b). Word frequency effects were obtained across all word categories. “Positive” words elicited consistently faster responses than “household” words, while no differences emerged for “negative” versus “household” words. What distinguishes these combined results from those of the prior emotion-frequency experiments is the lack of a difference between LF negative and neutral words. It has been demonstrated that semantic variables, including category priming, often exert a greater facilitative effect on LF than HF words (e.g., Becker, 1979; Hauk, Davis, Ford, Pulvermüller, & Marslen-Wilson, 2006; for reviews, see Borowsky & Besner, 2006; Hand et al., 2010). As one consequence, the magnitude of word frequency effects should be reduced. Our current study, however, does not address this particular aspect of the data as independent samples of participants were used. Nevertheless, it is possible that explicit category priming, with particular benefits to LF words, is selectively effective for positive and neutral, but not negative, categories. While all three categories are fairly broad, the negative category is perhaps the most heterogeneous and, hence, the least susceptible to such priming. In their density hypothesis, Unkelbach, Fiedler, Bayer, Stegmüller, and Danner (2008) proposed that positive information is processed more quickly because, in comparison with negative information, it is more densely clustered in semantic space. Emotions have typically been classified into the subtypes of “happiness,” “surprise,” “sadness,” “anger,” “fear,” and “disgust” (e.g., Ekman & Friesen, 1971). In comparison to the category “positive,” the category “negative” comprises a greater range of distinct emotions. For example, while many negative words will engage the activation of an avoidance mechanism, words that belong to the category "anger" often involve approach actions. Moreover, depending on the perspective (subject/object) taken by the reader, a word's interpretation can be influenced by their appraisal (Lerner & Keltner, 2000).

Theoretically, to more effectively assess explicit categorical priming of emotional words, it might be beneficial to include additional baseline conditions (e.g., HF and LF non-categorical neutral words) as well as discrete subcategories of emotion words (e.g., HF and LF "happy" and "anger" words). On the practical side, however, implementing such control conditions within a single experiment would be methodologically challenging and the results could be problematic to interpret. First, it would be difficult to generate an adequate number of items across all conditions that are controlled for relevant lexical properties. Second, responses to a minority of non-categorical items within the broader context of a task involving categories may not be representative. Finally, it is unclear whether words belonging to categories of distinct emotions (e.g., "happy" and "anger" words) would be additionally considered as members of the generic positive and negative word categories. Nevertheless, there may be other ways of addressing concerns about what can and cannot be directly attributable to explicit category priming of emotional words.

Recently, a growing minority of researchers have begun to investigate distinct emotional subcategories underpinning the meaning of words (e.g., Briesemeister, Kuchinke, & Jacobs, 2011a, 2011b; Fontaine, Scherer, Roesch, & Ellsworth, 2007; Stevenson, Mikels & James, 2007; Wurm, 2007). For example, Briesemeister et al. (2011a) showed that a word's membership within certain discrete emotional categories ("happiness", "disgust", and "fear", but not "anger" or "sadness") could explain as much variance in lexical decision RTs as a two-dimensional (arousal × valence) model of emotion. Although word frequency was statistically controlled via regression, interactions with frequency were not tested. One experiment was in German and used a set of affectively-laden words. However, the English data from the other experiments were taken from the English Lexicon Project (Balota et al., 2007) representing responses to over 40 thousand words collected from many experiments across several labs (different stimulus lists comprised nonadjacent words from an alphabetized master list). Consequently, it is difficult to ascertain the semantic features of any subset of materials, in particular, whether any form of categorical priming could have occurred. Further studies examining the categorical nature of emotion word processing should use appropriate neutral words having comparable categorical characteristics.

In sum, we examined the categorical nature of emotion word processing in a series of experiments. When implicit categories of “positive” and “negative” were implied (Experiment 1), the emotion-frequency interaction found in prior studies was maintained. When explicit categories were employed (Experiments 2a and 2b), including one representative of neutral words, only positive words retained their relative behavioral advantage over neutral words; responses to LF negative words lost their prior advantage and were no different than their neutral counterparts. We suggested that the pattern of results might be explained by effects of categorical priming that depend on both word frequency and category coherence. In this respect, our work represents an initial exploration of these issues. Recent developments in establishing larger and more comprehensive databases of words that are normed on several emotional dimensions are encouraging. Such work will permit more systematic assessments of how a word’s emotional content as well as its frequency and context can affect its recognition.

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Table 1

Example Materials from Experiments 1, 2a, and 2b

		Frequency	
		LF	**HF**
Experiment 1	**Positive**	*cheer*, *miracle*, *treasure*	*cash*, *travel*, *victory*
	Negative	*snake*, *outrage*, *mutilate*	*fire*, *cancer*, *hostile*
	Neutral1	*muddy*, *lantern*, *highway*	*tower*, *finger*, *museum*
	Neutral2	*salad*, *basket*, *hairpin*	*clock*, *writer*, *square*
Experiment 2a	**Positive**	*flirt*, *reunion*, *valentine*	*cash*, *passion*, *birthday*
	Household	*stove*, *hammer*, *hairdryer*	*door*, *window*, *corridor*
Experiment 2b	**Negative**	*shark*, *slave*, *terrorist*	*bomb*, *panic*, *disaster*
	Household	*stool*, *poster*, *appliance*	*bowl*, *bench*, *bathroom*

Note: LF = low frequency; HF = high frequency.

Table 2

Specifications of Materials in Experiments 1, 2a, and 2b

	Frequency		Letters		Syllables		Arousal		Valence	
	LF	**HF**	**LF**	**HF**	**LF**	**HF**	**LF**	**HF**	**LF**	**HF**
Experiment 1										
Positive	7.1	56.9	6.9	6.0	2.2	1.9	6.6	6.6	7.7	7.8
Negative	6.7	56.4	6.7	5.8	2.0	1.8	6.6	6.8	2.6	2.6
Neutral1	6.2	57.9	6.6	5.8	2.0	1.9	4.3	3.7	5.1	5.4
Neutral2	6.4	54.9	6.6	5.9	2.1	1.8	3.8	4.1	5.3	5.1
Experiment 2a										
Negative	7.5	56.6	6.6	5.6	1.9	1.9	6.7	6.9	2.6	2.4
Household	6.0	63.7	6.7	5.6	2.1	1.7	3.9	3.7	5.2	5.3
Experiment 2b										
Positive	5.9	56.4	6.4	5.8	2.0	1.7	6.7	6.6	7.7	7.8
Household	5.8	60.0	6.4	5.7	2.1	1.7	3.8	3.8	5.2	5.2

Note: Units of measurement are as follows: Frequency in occurrences per million, word length in number of Letters and Syllables, Arousal on a scale from 1 (low) to 9 (high); Valence on a scale from 1 (low, having a negative meaning) to 9 (high, having a positive meaning). LF = low frequency; HF = high frequency.

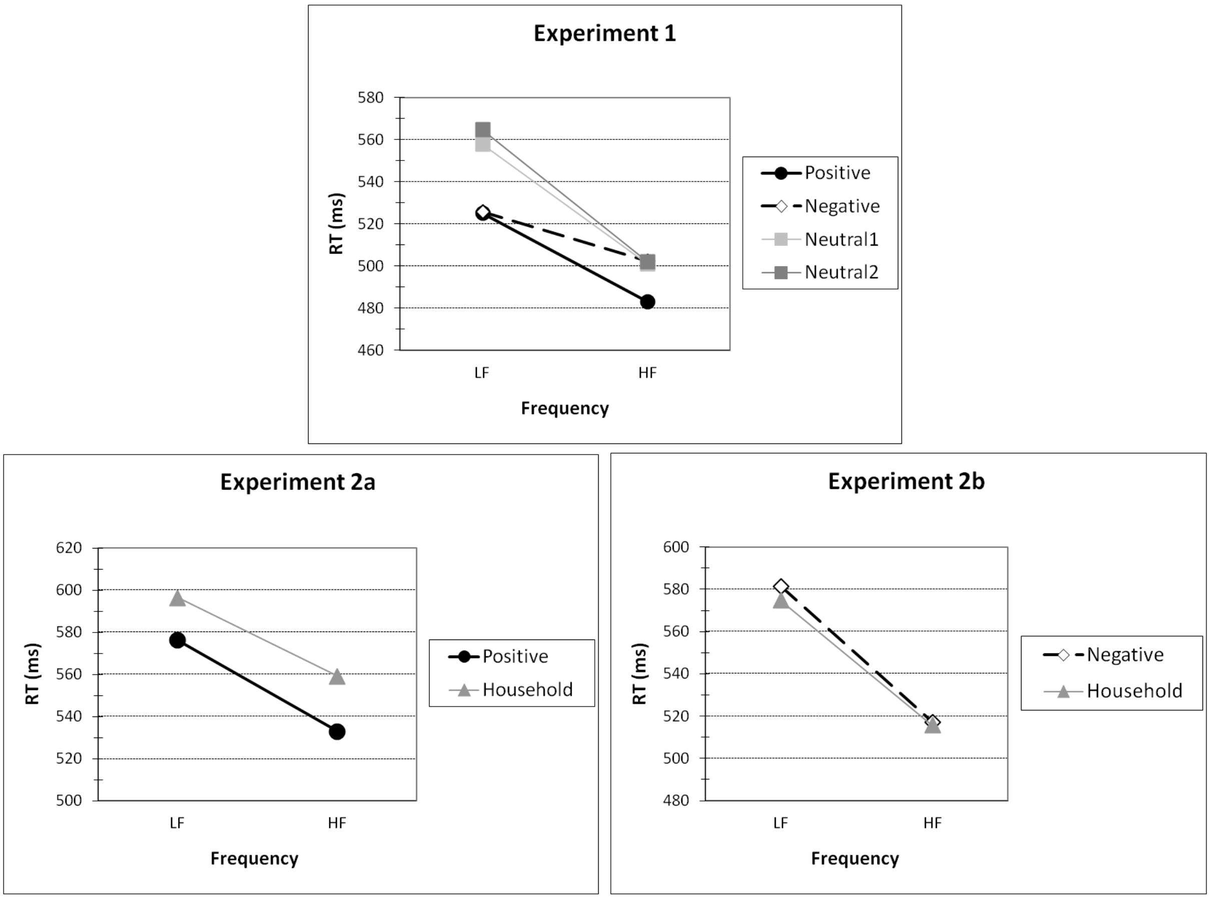
Table 3

Mean Reaction Time (RT) in Milliseconds (with Standard Deviations) across Conditions in Experiments 1, 2a, and 2b

		Frequency	
		LF	**HF**
Experiment 1	**Positive**	525 (81)	483 (63)
	Negative	526 (81)	502 (82)
	Neutral1	558 (96)	501 (72)
	Neutral2	565 (81)	502 (65)
Experiment 2a	**Positive**	576 (97)	533 (84)
	Household	597 (105)	559 (119)
Experiment 2b	**Negative**	581 (103)	517 (74)
	Household	575 (80)	516 (75)

Note: LF = low frequency; HF = high frequency.

Figure 1. Average RT (ms) in Emotion × Frequency conditions in Experiments 1, 2a, and 2b.



Note: LF = low frequency; HF = high frequency.