Emotional Connotation in Speech Perception: Semantic Associations in the General Lexicon

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Lexical access of emotion words has been shown to depend on three underlying dimensions (Evaluation, Activity, and Potency). The importance of these dimensions of emotional connotation was assessed during on-line speech perception of words drawn from the general lexicon. Lexical decision times were significantly predicted by main effects of Evaluation and Potency, as well as by an Evaluation × Activity interaction and an Evaluation × Potency interaction. An evolutionary account is proposed to explain the differential processing of words in the general and affective lexica. Whereas the affective lexicon seems to be structured to avoid threats to the individual, the general lexicon appears to be designed for obtaining scarce but valuable resources.

INTRODUCTION

From an evolutionary perspective, organisms gather information for one purpose: To help them survive. There are two basic ways that information can serve this function. First, information can help the organism gain desirable resources. Central to Darwin's (1859/1968) theory of evolution is the Malthusian principle that organisms are in competition for scarce resources. This competition can either be between conspecifics or between

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members of different species. Those organisms that survive long enough to reproduce—and thus perpetuate their genes—are the ones that have found ways to gather the necessary resources, in spite of the potential paucity of these resources.

The second requisite to survival is to avoid predators and other dangers. No matter how well the organism is able to garner resources needed for day-to-day activities, unless it can defend itself from attack, access to scarce resources does no good. Potential threats to the organism can be dealt with either by confronting the threat (a “fight” response) or evading it (a “flight” response).

Previous research has shown that the emotional connotation of words can be described in terms of a small number of underlying dimensions. One argument for understanding evolutionarily relevant perception in dimensional terms is that it is computationally less expensive to store information dimensionally than if discrete categories were used. In a dimensional model, each item is arranged according to its location on each of a few dimensions. There is no comparably parsimonious means of ordering items into categories. Instead, additional items yield a rapid proliferation of categories, each of which adds computational cost for the organism (Anderson, 1991). Such costs are critical when information processing is viewed in evolutionary terms, because each such cost represents a burden on the organism that makes it more difficult to compete with other organisms.

The dimensions most consistently found by other researchers have been Evaluation, Potency, and Activity (e.g. Osgood & Suci, 1955; Osgood, Suci, & Tannenbaum, 1957). Evaluation carries emotional connotations ranging from “pleasant” to “unpleasant”, whereas Activity connotes a dimension ranging from “lively” to “still”, and Potency goes from “strong” to “weak”. These dimensions have been proposed as cross-cultural universals (Osgood, May, & Miron, 1975) that are apparent in many contexts (e.g. Apple & Hecht, 1982; Daly, Lancee, & Polivy, 1983; Green & Cliff, 1975; Heise, 1965; Morgan & Heise, 1988). According to Osgood (1969), the ability to order items quickly along these three dimensions of emotional connotation gives organisms a selective advantage.

These three dimensions of Evaluation, Potency, and Activity are most often examined using judgement tasks in which participants rate the similarity of a range of emotion states (Bush, 1973; Daly et al. 1983; Morgan & Heise, 1988). Such studies are said to involve post-perceptual judgements, because these judgements occur only after the basic perceptual act has been completed. But these dimensions have also been used to study perceptual processing (Wurm & Vakoch, 1996). Perception occurs when a physical stimulus first makes contact with a mental representation. Perception is a low-level, involuntary process that occurs “on-line”. An effect can be categorised as on-line if the actual perception of a
stimulus can be influenced by the effect. For example, word frequency is considered an on-line effect because it partially determines speed of lexical access: The higher the frequency of a word, the more rapidly it can be accessed (e.g. Forster & Chambers, 1973; Oldfield, 1966; Segui, Mehler, Frauenfelder, & Morton, 1982). In contrast, if an effect does not influence perception of a stimulus, but only later judgements or interpretations of the stimulus, then that effect is post-perceptual.

Several models of perception contend that apparently categorical perceptual effects can also be understood in dimensional terms (e.g. Goldstone, 1994; Masarro, 1987), but most such models are vague about which dimensions are used and why these dimensions in particular are used. An exception is our approach, which explicitly relies on Osgood’s three dimensions of emotional connotation, interpreted within an evolutionary framework (Wurm & Vakoch, 1996). In our approach, we specify which dimensions (Evaluation, Potency, and Activity) and why these dimensions (they contribute to the survival of the organism).

In our first study, we examined the impact of Evaluation, Potency, and Activity on speed of access of words from the affective lexicon (Wurm & Vakoch, 1996). By the affective lexicon, we mean the part of semantic memory in which emotion words are stored. We studied the dimensional structure of the affective lexicon through lexical access, which is the process by which words in the lexicon are triggered by an acoustic signal. Our study of the affective lexicon demonstrated that the emotional connotation of pure emotion words—emotion words not admixed with cognitive, bodily, or external conditions—(Clare, Ortony, & Foss, 1987; Ortony, Clare, & Foss, 1987) influenced how those words were processed (Wurm & Vakoch, 1996). By examining the connotative meaning of these words, we were able to predict more accurately the on-line processing of emotion words.

As noted earlier, organisms have two evolutionary goals in gathering information: (1) obtaining desirable resources; and (2) avoiding danger. Given that organisms are typically in competition with others for scarce resources, the first goal is often a priority. However, in circumstances where the organism is in danger, the second goal of defence becomes more important. Unless the organism survives an immediate threat, it will not survive for the more protracted goal of gathering necessary resources.

Looking at the processing of emotion words from an evolutionary perspective, we noted that for words high on both Evaluation and Potency, their degree of Activity was of little importance (Wurm & Vakoch, 1996). In terms of the organism’s self-defence, this makes sense; although the words here are powerful (high Potency), they represent no danger because they are also pleasant (high Evaluation). Thus, the
organism has no need to attend quickly. If Potency remains high but Evaluation is low, however, to avoid danger the degree of Activity is imperative. The organism can afford to take time processing information about emotions that reflect the conjunction of strength (high Potency), badness (low Evaluation), and slowness (low Activity), and this matched experimental results. However, when the words connote strength, badness, and quickness (high Activity), then the organism might be in peril, and much faster processing is called for. Again, this was consistent with our findings.

In our first study of pure emotion words, one of the criteria used in selecting these words was to cover the entire range of the “fight” versus “flight” dimension (Wurm & Vakoch, 1996). Given the overall importance of emotion for providing information allowing self-protection, we might well expect these emotion words to be processed for the information they bear about potential dangers to the organism.

But as we have seen, there is another information-processing strategy focused on getting beneficial resources that we might expect to be even more important in nonthreatening contexts. Given that the organism may spend more of its time pursuing the alternative goal of obtaining valuable resources, it is plausible that words from the general lexicon would be processed quite differently. To examine how words in the general lexicon are perceived, in the current study we used a methodology that paralleled that of our study of emotion words (Wurm & Vakoch, 1996). In the present study, we assess whether the responses are more consistent with the goal of obtaining scarce resources or the goal of avoiding danger.

Although previous studies have shown that semantic category can affect speed of lexical processing, such studies have not used a dimensional approach. For example, both Ferguson (1989) and Kitayama (1991) examined Evaluation, but in terms of discrete categories rather than along a continuum. The goal of the current study is to assess the importance of the three basic dimensions, separately and in interaction, in accessing words from the general lexicon.

METHOD

Subjects

Forty-seven undergraduates from the psychology subject pool at the State University of New York at Stony Brook participated in the rating study, and 93 undergraduates from the same population participated in the lexical decision study. All were native speakers of English who received course credit for their participation.
Materials

A total of 130 nonhyphenated words were randomly selected from *Webster's dictionary* (1993). Only words that two independent judges agreed were likely to be familiar to the subject population were included.

For the lexical decision study, half of the words were changed into nonwords. We did this by changing the phoneme at the point in the acoustic signal where the word in question diverges from all other words in English (the uniqueness point; see Marslen-Wilson, 1984). The phoneme at the uniqueness point was changed to a different phoneme from the same broad class (i.e. stops replaced stops, vowels replaced vowels, and so on). For example, the word “martini” was changed to the nonword “martoni”. The words and nonwords used in this study are listed in the Appendix.

These words and nonwords were read by a male native speaker of English unfamiliar with the study. Stimuli were digitised at a sampling rate of 10kHz (low-pass filtered at 4.8kHz) and stored in disc files.

Procedure

Packets in two different random orders were printed that contained the 65 words to be rated. Participants in the rating study judged each word against a pair of adjectives on a 7-point scale ranging from one to seven. For each word, six ratings were made, two of which were intended to tap each of the three dimensions. Anchor points for Evaluation were “good vs. bad” and “pleasant vs. unpleasant”; for Potency, “strong vs. weak” and “tough vs. tender”; and for Activity, “lively vs. still” and “active vs. passive”. Order of ratings and positioning of each adjective within a pair were randomised.

All participants in the second study made a speeded lexical decision about each recorded stimulus. Participants used their dominant hands to make responses on a button board, pushing one button for words and another for nonwords. Prior to the study proper, participants made word/nonword judgements for a separate set of practice stimuli also randomly sampled from the general lexicon. This provided practice with the task as well as a context that would prime participants to respond to words drawn from the general lexicon (as opposed to the affective lexicon).

Reaction times (RTs) were measured from the onset of the phoneme at the uniqueness point of each word. Participants were tested in groups of one to four in a sound-attenuating chamber. Each group of participants heard a different random order. Digitised speech files were played for the participants—all of whom had normal hearing—over headphones at a comfortable listening level, with a delay of 2000msec between items.
RESULTS

For our regression analyses reported below, the location of each of the word stimuli in three-dimensional connotative lexical space was specified by the mean ratings for each word on Evaluation, Potency, and Activity. Mean ratings for the 65 words were 3.93 for Evaluation (SD = 1.16), 4.68 for Potency (SD = 0.75), and 4.42 for Activity (SD = 0.89). Correlations between the independent variables are listed in Table 1. Only the correlation between Potency and Activity was significant.

Participants who had error rates greater than .30 or mean RTs greater than 900msec were excluded from our analyses. Nine participants’ data were excluded by these criteria. For the remaining 84 participants, data were discarded for trials on which the word/nonword decision was made incorrectly (11.1% of all trials).

The RT data were not normally distributed, so we performed a square root transformation. The dependent variable in all reported analyses was the transformed RT on correct trials (word targets only).

We conducted a hierarchical regression analysis, with Step 1 including two variables to address two separate considerations. First, to control for possible effects of word frequency, we entered log word frequency values (taken from Francis & Kučera, 1982) into the equation. Second, as the study used a repeated-measures design (i.e. each participant provided more than one observation), the observations in the data set were not independent of each other. In repeated-measures regression analyses, this is controlled by including \( n - 1 \) (83, in this case) dummy variables that represent the participants (see Cohen & Cohen, 1983, for a detailed discussion of repeated-measures regression analysis).

In Step 2 of the analysis, the main effects of Evaluation, Potency, and Activity were added. Step 3 consisted of the two-way interactions between these three variables, and Step 4 consisted of the three-way interaction. The results of this analysis are shown in Table 2.

Ratings on Evaluation and Potency were significant predictors of lexical decision time. Activity was not a significant predictor. Before interpreting these effects, however, we must consider any possible interactions.

| TABLE 1 |  
| Correlations between Independent Variables |  
| Evaluation | Potency | Activity |
| Log Word Frequency | .02 | .01 | .01 |
| Evaluation | −.18 | .21 |  
| Potency |  | .64*** |

***\( P < .001 \).
Of the two-way interactions, the Evaluation × Potency interaction and the Evaluation × Activity interaction were both significant. Neither the Activity × Potency interaction nor the three-way interaction of the dimensions was significant.

The significant two-way interactions are shown in Figs 1 and 2. Both depict the same general pattern. The figures show mean RTs as a function of ratings on the various dimensions. High and low values on each dimension shown in the figures were determined by median splits. The resulting dichotomies are included to aid interpretation of the interactions, and they were not used in the actual regression analysis.

To examine the possibility that Evaluation extremity, and not Evaluation per se, might account for these results, we conducted a supplementary regression analysis. This analysis was identical to our main analysis except that we included Evaluation extremity as an additional predictor (with log word frequency and subjects) in the first step. For our measure of Evaluation extremity, we transformed Evaluation ratings into Evaluation extremity ratings by determining how far each Evaluation rating was from the neutral point, without respect to whether it was positive or negative. In short, we partialed out the effects of Evaluation extremity before testing for main effects of Evaluation, Activity, or Potency, or for any of the two- or three-way interactions. We found exactly the same variables were significant predictors in this second analysis. Thus, we found no evidence that Evaluation extremity accounts for our results.
Let us return to the question we raised earlier: Which adaptive concern of the organism is best reflected in processing words from the general lexicon: (1) the resource desirability motive; or (2) the goal of avoiding danger? To preview the following discussion, the resource desirability explanation seems most consistent with each of the main effects and interactions that we found.

**FIG. 1.** Mean reaction time (RT) as a function of dimension weight on Evaluation and Activity, in milliseconds (msec). Error bars show +/- 1 SEM.
As suggested by the main effect of Potency, if a word has connotations of being strong (high Potency), then as a general rule it is processed more quickly. This makes sense in an evolutionary context because unless we act quickly, we may not deal effectively with something that is strong. Similarly, words high on Evaluation were processed more quickly than those low on this dimension. This is consistent with previous studies that defined Evaluation categorically (Bray, 1984; Williams & Evans, 1980; but see
Hill & Kemp-Wheeler, 1989, for a critique of these studies). But both of these main effects—and any of the previous literature that considers a single dimension in isolation (e.g. Ferguson, 1989; Kitayama, 1991)—must be interpreted with caution, because we found that Evaluation interacts with both Potency and Activity.

As seen in the graph of the Evaluation × Activity interaction (Fig. 1), the words processed most quickly have connotations of being very good and very fast (high Evaluation and high Activity). Consistent with the resource desirability explanation, if we are to acquire something that is beneficial but quick, we must do so rapidly. We need less rapid processing if the word refers to something that is very good but very slow (because it's not going anywhere) or that is not good but very fast (because we do not gain much by pursuing it). The slowest RTs are to those words that are neither fast nor good. We have no need to attend to those words quickly because their referents are not very valuable, and they are not going anywhere very rapidly.

A parallel explanation holds for the Evaluation × Potency interaction (Fig. 2). A word with a referent that is very good and very strong (high Evaluation and high Potency) may be difficult to deal with unless it can be dealt with quickly (e.g. apprehended before it has a chance to deploy its strength), and thus is processed quickly. A very weak but still very good word (high Evaluation and low Potency) will be attended to less quickly, because even though it may be valuable to attend to (as suggested by the high Evaluation), there is not as urgent a need to do so quickly because of the limited Potency. Similar reaction times were found for words that have high Potency but low Evaluation. From the perspective of resource desirability, there is little to gain by attending to a strong referent that is low in Evaluation. The slowest reaction times are found for words that are neither desirable nor strong (low Evaluation and low Potency).

To summarise, the emotional connotation of words appears to influence speed of processing in a way that enables the organism to obtain valuable resources. In those cases in which the referent of a word is beneficial yet difficult to obtain because it is either fast or strong, the word is processed very quickly. Words with referents that are either less desirable or easily obtained are processed more slowly. Thus, the structure of the general lexicon makes sense from an evolutionary perspective because it explains speed of on-line processing in terms of the adaptiveness of recognising desirable resources.

Although the same three dimensions were used for processing entries in both the affective and general lexica, the dimensions were used in radically different ways. Whereas the general lexicon seems to be structured for obtaining scarce but beneficial resources, the affective lexicon appears to be designed to avoid threats to the organism. As noted earlier, the fastest
responses in our previous study were to emotion words that are strong, fast, and bad (high Potency, high Activity, and low Evaluation). This contrasts with words in general in the current study, for which the quickest processing is of words that are either: (1) strong and good (high Potency and high Evaluation); or (2) fast and good (high Activity and high Evaluation).

Although the data from these studies are consistent with an evolutionary account, there may be alternative explanations. For instance, the emotional connotation of speech can also be understood in terms of the interpersonal context of communication (Hart & Brown, 1974). As an example, judgements of personality characteristics from the content of people’s speech can be predicted by Evaluation ratings, but not by Potency or Activity ratings (Markel & Roblin, 1965). Previous studies of the role of connotation in interpersonal communication, however, have focused on the post-perceptual processing of speech. There may also be an interpersonal basis for the on-line processing of speech.

Existing models of speech perception could easily be adapted to incorporate the emotional connotations of words. Particularly promising candidates are network models (e.g. McClelland & Elman, 1986), which might incorporate dimension weights of words in one of two ways: (1) connection weights between words in the network could be modified in accordance with the words’ dimension weights; or (2) the resting activation levels of words could be related directly to dimension weights.

The current study also offers a methodological innovation over previous attempts to understand the structure of the lexicon. Numerous past studies have examined the lexicon through semantic priming (Emmorey, 1989; Fowler, Napps, & Feldman, 1985; Kempley & Morton, 1982; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Shillcock, 1990; Swinney, 1981). With that method, lexical access is facilitated by prior presentation of semantically related words. In the current study and its precursor (Wurm & Vakoch, 1996), the lexicon is studied via characteristics intrinsic to the words themselves (i.e. their dimension weights). Although we have focused on Evaluation, Potency, and Activity, the same strategy could be used to study other possible dimensions of the lexicon.

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REFERENCES


**APPENDIX**

**Stimuli**

*Words*: monotone, freshen, pomegranate, sandbag, vase, tricycle, prospect, abandon, plod, teriyaki, legality, dragnet, indivisible, pocket, crucify, birthstone, powerful, methane, nonetheless, balancer, sapphire, cupful, trajectory, landscaping, unconnected, squad, orphan, elderly, babble, posse, sadism, workday, empty, issue, caddy, identity, transition, perennial, poltergeist, incident, enchant, material, fighter, frosting, majorette, chessboard, baloney, polynomial, register, gander, frustrated, halogen, minimize, affliction, pitiless, raccoon, overly, heat, fictitious, whiskey, stillbirth, ballerina, cookery, indecency, leverage.

*Nonwords*: coldglooded, apprave, sirlown, differuntiate, nimkle, quadrutic, centerdiece, shazer, organic, epipemic, westamer, rooshless, ateenable, martoni, icon, louth, relotionship, effeptively, temperait, cebus, noweeday, probabol, helmfman, nominile, pude, reli- chion, donol, arsenol, liberol, hyposenuse, pillege, constroct, roban, barehondoed, budgat, chanche, sedfection, mountek, sillay, sundual, verithy, scoog, barboturate, frighkened, cei- long, altarnative, perfactible, mure, uronal, levikate, octokus, anchelfish, minnoo, amoose, bumptin, blomd, brupe, shemanigans, expoment, progresive, badmon, curkle, repoortedly, badgeer, likemess.