# EMOTION AND LEXICAL EFFECTS IN AN AUDITORY LEXICAL DECISION TASK WITH VOCAL AFFECT

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## ABSTRACT

The present experiment investigated the role of vocal affect in spoken word recognition. Participants performed an auditory lexical decision task with stimuli articulated by a professional male actor with different acoustic realizations of vocal affect (Angry, Neutral, and Joyful). In addition, the effects of Valence, Arousal, Danger, and Usefulness, measures shown to affect lexical processing, were assessed. Results reveal faster responses to stimuli articulated in the Angry vocal affect compared to Joyful and Neutral stimuli. In addition, higher Valence, but not Arousal, Danger, nor Usefulness facilitated word recognition. These results partially replicate the findings of past studies and also contradict the results of some studies. Implications of the results are discussed.

**Keywords**: emotion, auditory lexical decision, psycholinguistics

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## 1. INTRODUCTION

The expression and recognition of emotion is a vital aspect of the human experience; this is evident in social interactions, interpersonal relationships, and in the context of emotional and behavioral disorders [18]. Many current theories of emotion begin from a psychoevolutionary perspective, which contend that emotions evolved in a manner that aids in the organism's survival [e.g. 14].

Oft-used measures in emotion research involve the dimensions of Valence, "the pleasantness of a stimulus" and Arousal, "the intensity of emotion provoked by a stimulus" [19]. A consistently observed effect of positive Valence exhibiting speeded response times in lexical decision tasks has been reported [e.g., 8, 17]. Also, some studies have found faster reaction times to high-Arousal stimuli regardless of Valence [e.g., 9, 13] and to high-Arousal negative stimuli [7]. Of importance, these results have been limited to visual lexical decision and auditory lexical decision with auditory stimuli that do not possess vocal affect.

Kissler and Koessler [8] relate these results to the psychoevolutionary perspective in that: "Emotions prepare the organism to react rapidly to the environment via two motivational systems, an appetitive system that responds to positive valence and a defensive system responding to negative valence. Arousal indicates the degree to which either system is activated". These appetitive and aversive systems are sometimes described as approach and avoid mechanisms [5].

Wurm and Vakoch [23] developed the Danger and Usefulness framework in part to investigate psychoevolutionary effects in a more direct manner. The Danger measure refers to how dangerous a referent is and the Usefulness measure refers to how useful a referent is in terms of human survival. Both measures have exhibited significant effects in lexical decision tasks, with higher values of Danger and Usefulness resulting in faster response latencies [11, 20, 22].

However, despite the effect of emotion on lexical processing, most lexical processing studies, including those cited above, have utilized visual lexical decision or auditory lexical decision with auditory stimuli that do not possess vocal affect. A thorough search of the literature uncovered few lexical processing studies that have explored the effects of processing auditory stimuli articulated with different acoustic realizations of vocal affect [24]. In addition to the semantic components of emotion that each lexical item might contain (as described above), vocal affect also plays a role in the comprehension of language [4]. This study investigates how the emotion introduced to the speech signal, when produced in an emotional state, influences and interacts with the process of spoken word recognition.

More precisely, we endeavor to shed light on the role of how auditory stimuli articulated with different acoustic realizations of vocal affect are processed by performing an auditory lexical decision task with stimuli articulated in different, acted vocal affects. It is important to note here that the emotions produced as part of the construction

of the stimuli are acted and may not perfectly reflect the acoustic realization of true emotion. Furthermore, we investigate how comprehension of the stimuli utilized for the experiment described herein differ or resemble those of more commonly studied types of stimuli.

## 2. EXPERIMENT

### 2.1. Materials

The stimuli utilized for this experiment were collected from wordlists created by Fischer [6], Wurm [20], and Wurm and Seaman [21], for which values for Danger and Usefulness were available. Additionally, values for Valence, Arousal, and Dominance were available for all stimuli from Warriner et al. [19]. A number of lexical control variables were also available from Kryuchkova and Tucker [10], who originally recorded the stimuli, Frequency, Uniqueness Point, and Number of Phonological Competitors.

Together, the wordlists contained 280 English nouns; 270 nonce words were developed and utilized in the experiment as well by selecting words from the CELEX lexical database [2] and changing one phoneme in the word to another phoneme of the same general class, e.g. *neglect* to *neblect*. A professional male actor (Speaker D) recorded all 550 stimuli over two sessions in various vocal affects, including Angry, Joyful, and Neutral, by reading items from a list; fillers were added at the beginning and end of the reading lists to account for list intonation [10]. All stimuli were pre-validated in a forced choice identification task involving 82 participants. Overall accuracy of the forced choice identification task was 63% (39853/62395), and a Pearson's chi-square test rejected the null hypothesis ($p < .001$) that the observed difference in correct and incorrect responses was achieved by chance.

### 2.2 Procedure

The stimuli were counterbalanced across vocal affect such that items appeared only once during an experimental session. As a result, participants heard all 280 words and 270 pseudo-words in each experimental session. Counterbalanced lists were presented randomly in an auditory lexical decision task. Each participant was presented with an equal number of word and non-word stimuli in each vocal affect. The auditory lexical decision task experiment was designed using the experiment design software E-Prime [15]. Following a fixation cross that was on the screen for 500 ms, participants were presented with the auditory stimulus. Each trial lasted 5000 ms or until the participant responded. Following each trial there was an inter-stimulus interval of 1000 ms.

Participants performed the auditory lexical decision task in sound-attenuated booths at the Alberta Phonetics Laboratory at the University of Alberta. Participants were presented with the auditory stimuli over headphones while facing a computer screen, which presented instructions prompting them to record their responses on a button box ("Yes" for a word/"No" for a non-word) based on their initial impression of the stimuli. In this experiment, participants always responded "Yes" with their left hand.

### 2.3 Participants

A total of 66 students (23 males), enrolled in introductory Linguistics courses at the University of Alberta, participated in the experiment and received course credit for their participation. The average age of all participants was 20.7 years ($SD$ = 2.48). None reported any hearing difficulties.

### 2.4 Predictions

We predicted that the acoustic characteristics of emotion would have an effect on lexical processing by activating the approach and avoid mechanisms. Specifically, stimuli articulated in the Joyful manner would activate the approach mechanism and thereby facilitate processing, resulting in speeded reaction times, and stimuli articulated in the Angry manner would activate the avoid mechanism and thereby facilitate processing, resulting in speeded reaction times. Another possible result to investigate will be whether processes thought to activate the same mechanism will interact by jointly contributing to facilitative processing, such as high-Danger stimuli articulated in the Angry affect exhibiting speeded response times and high-Valence stimuli articulated in the Joyful affect exhibiting speeded response times. Another possibility is that effects of vocal affect and effects of the semantic measures will exhibit effects independently and in parallel.

## 3. ANALYSIS

All statistical analyses were performed using the statistical analysis software R [16]. Reaction times of less than 300 ms or greater than 2000 ms post-onset of the word were excluded in order to eliminate responses that are so short that they imply incomplete processing or so long that they imply participant error or an overly delayed response. Incorrect responses (15.7%) were excluded

from the dataset prior to analysis. After trimming, a total of 15006 observations were included in the reaction time analysis.

Linear mixed effects regression analyses were then employed to analyze the results using the lmer function in the R packages 'lme4' [3] and 'lmerTest' [12]. The initial model implemented reaction time as a function of emotional modality with random intercepts of subject and stimulus. Initially, all two-way interactions were included in the model. The model of best fit was determined by backfitting and removing non-significant effects from the model. Finally, model criticism and trimming [1] was performed by identifying and removing outliers that might serve to skew the data, thereby removing 2.5% (369) of the data points. The final best-fit model is summarized in Table 1.

**Table 1**: Table of linear mixed-effects results.

| Fixed effects | Slope | df | T-score | P-value |
|---|---|---|---|---|
| Intercept (Angry) | 6.0 | 756 | 52.04 | < .001 * |
| Joyful | 0.04 | 741 | 4.03 | < .001 * |
| Neutral | 0.03 | 734 | 2.79 | < .01 * |
| Uniqueness point (scaled) | 0.14 | 737 | 7.51 | < .001 * |
| Frequency (scaled) | -0.03 | 745 | -7.21 | < .001 * |
| Trial (scaled) | -0.03 | 14810 | -17.0 | < .001 * |
| Valence (scaled) | -0.02 | 736 | -5.49 | < .001 * |

## 4. RESULTS

The resultant analysis uncovered statistically significant speeded reaction times for Angry stimuli as compared to Joyful and Neutral stimuli, as illustrated in Figure 1, and no statistically significant difference in reaction times between Joyful and Neutral stimuli (when releveled).

We also observed a significant effect of Valence (Figure 2), with more positive stimuli exhibiting faster response latencies. We further observed effects of: Uniqueness Point, with stimuli with more latent uniqueness points exhibiting slower response latencies; Frequency, with more frequent nouns exhibiting speeded response latencies; and the control variable Trial, with stimuli appearing later in the experiment exhibiting shorter response latencies. The effect of Trial is likely a result of the participants becoming more familiar with the nature of the task and stimuli as the sessions progressed. All significant effects were warranted in the model according to model comparison ANOVAs (using likelihood ratio testing). The analysis did not reveal any significant interactions between any of the variables and no significant effects of Arousal, Dominance, Danger, Usefulness, or other measures, such as Number of Phonological Competitors, Age, Gender, and Speaker status (i.e. native/non-native English speaker).

**Figure 1**: Effect of vocal affect on response latency.

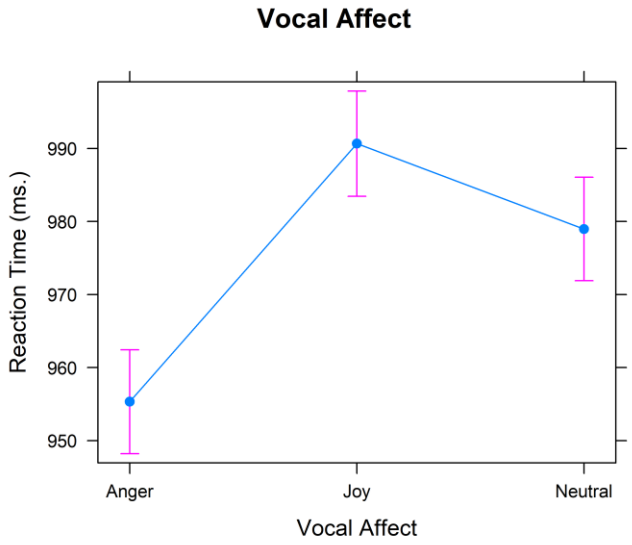
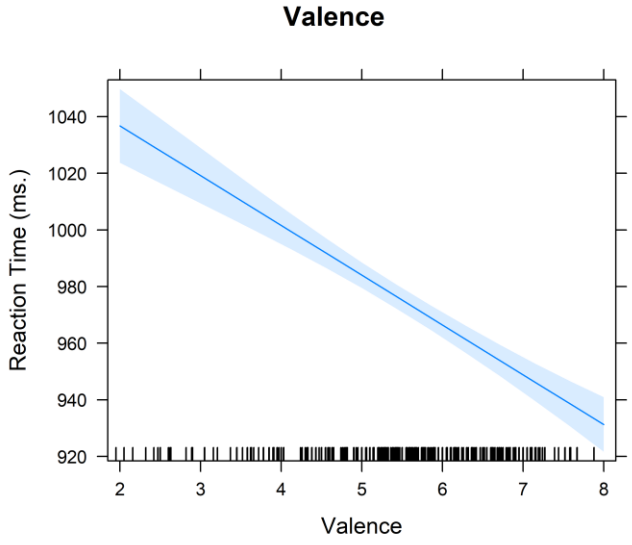



**Figure 2**: Significant correlation between Valence and response latency.




## 5. DISCUSSION

The stimuli articulated in an Angry manner exhibited a more threatening stimulus, which we posit would result in a faster reaction due to activation of the avoid mechanism. This finding contributes to the growing body of evidence in favor of accounts that claim that the rapid processing of emotion is advantageous. The analysis also uncovered

a statistically significant effect of positive Valence speeding responses that is consistently reported in previous lexical decision tasks and is often cited as evidence in favor of a psychoevolutionary theory of emotion insofar as more positive stimuli are thought to activate an approach mechanism [8]. Interestingly, our results did not show any significant effects or interactions for Arousal. Nor did we find anything involving the Danger and Usefulness measures adopted from the framework established by Wurm and Vakoch [23].

One implication of this finding could be that with respect to the stimuli articulated with the Angry vocal affect that the emotion was salient enough to diminish the semantic effects of Danger, Usefulness, and Arousal, which might suggest that vocal affect is a more salient cue than the semantics of the nouns with regard to the processing of emotion in the context of lexical processing for negative emotions.

With respect to the positive stimuli, the oft-observed effect of positive Valence speeding reaction times did emerge in this study. This might suggest that Valence is a salient aspect of the stimuli even in the presence of vocal affect. Furthermore, Joyful vocal affect did not significantly facilitate lexical decisions in this study. Taken together, these results suggest certain processing preferences of positive and negative emotions in the context of lexical processing. Finally, given the results reported herein, further investigation of processing auditory stimuli possessing vocal affect is warranted.

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