Research Article

RESOLUTION OF LEXICAL AMBIGUITY BY EMOTIONAL STATE

Jamin B. Halberstadt, Paula M. Niedenthal, and Julia Kushner

Indiana University at Bloomington

Abstract—*The role of emotion in the resolution of lexical ambiguity was investigated. Happy and sad subjects listened to a list of words that included homophones that had happy and neutral meanings (e.g.,* presents-presence*) and homophones that had sad and neutral meanings (e.g.,* mourning-morning*). Words were presented every 3 s, and subjects wrote down the words as they heard them. (Meaning could be identified by spelling in all cases.) An interaction between emotional state and homophone category was observed: Sad subjects were more likely to write down sad meanings than were happy subjects. Results are discussed with reference to the literatures on both emotion and lexical access.*

It is almost a tautology that people who are feeling "down" tend to see events in a negative light, whereas people who are feeling happy seem more generally optimistic. From a theoretical standpoint, these observations pose a number of interesting issues regarding the relation between affect and cognition. The present study examined whether emotional states can influence the resolution of lexical ambiguity. That is, it addressed the question: Are individuals more likely to access the emotion-congruent meanings of spoken words when those words have both affective and relatively neutral interpretations?

The resolution of lexical ambiguity is a special case of the more general problem of word recognition in which multiple meanings of a single word must be disambiguated (Simpson, 1984). A person is rarely aware of competition among word meanings, and a debate continues in the literature regarding the degree to which meanings other than the selected meaning are accessed. For example, Tabossi (1988, Experiment 3) presented subjects with sentences that biased the dominant meanings of ambiguous words (e.g., *port*). At the offset of each ambiguous word, a word related to the dominant (*sea*) or subordinate (*liqueur*) meaning of the word, or an unrelated control word (*hand*), was visually presented, and subjects made a lexical decision. Lexical decisions about context-congruent words were faster than responses to context-incongruent words. Tabossi concluded that, at least in the case of dominant meanings, semantic context can constrain lexical access (see also Simpson & Krueger, 1991; Tabossi & Zardon, 1993).[1] In contrast, Swinney (1979) found that both context-appropriate and context-inappropriate meanings were primed by an auditorily presented homophone when the target word came immediately after the prime, even when a strongly biasing semantic context was present (providing support for an exhaustive access model). When the target word was presented three syllables after the prime, however, only the appropriate meaning was primed. Simpson (1984) has concluded that a hybrid of the selective and exhaustive access models best fits the available data. According to his framework, all meanings of an ambiguous word are activated to some degree, but the amount of activation can vary as a function of context, dominance of the meaning, and time delay, among other factors.

EMOTION AS CONTEXT, AND LEXICAL AMBIGUITY

The current research investigated the possibility that, like semantic context, emotional state guides the resolution of lexical ambiguity. Such an effect is predicted by Bower's (1981, 1987, 1991) emotion network model, in which emotions are represented as central, organizing units in a semantic network. According to this model, when an emotion unit is activated, as by the experience of an emotional state, activation spreads to other concepts as a function of their strength of association to the emotion unit. Consistent with interactive activation models (e.g., McClelland & Rummelhart, 1981), activation might also spread to the semantic codes for emotion-congruent words (Niedenthal, Halberstadt, & Setterlund, 1994; Niedenthal, Setterlund, & Jones, 1994). Access to a particular word meaning is assumed to be a function of various sources of activation, including priming from within the conceptual network, as well as input from the perceptual system. If the affective meanings of homonyms are activated by the experience of an emotion, then a person in an emotional state should be more likely to access the emotional than the neutral meanings of these words. For example, when sad, a person should access the sad meanings of the words *down* and *blue*.

Several recent studies, using clinically anxious subjects, have found results consistent with such a process. Eysenck, Mogg, May, Richards, and Mathews (1991, Study 1) found that anxious subjects were more likely than nonanxious or recovered-anxious subjects to interpret ambiguous sentences (e.g., *The doctor examined little Emma's growth*) in a threatening way (i.e., interpreting *growth* to mean *tumor* rather than *height*). Similarly, Mathews, Richards, and Eysenck (1989) showed that relative to nonanxious control subjects, anxious subjects were more likely to generate a threatening spelling for homophones that had both threatening and nonthreatening meanings (e.g., *die-dye, slay-sleigh*). Richards, Reynolds, and French (1993) exposed subjects with high and low trait anxiety to a positive or negative "mood" manipulation (presentation of pleasant or unpleasant pictures). Subjects then heard and wrote

Address correspondence to Jamin B. Halberstadt, Department of Psychology, Indiana University, Bloomington, IN 47405; e-mail: jhalbers@indiana.edu.

1. Some researchers (e.g., Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982) have interpreted demonstrations of contextual influence on lexical access as due to intralexical priming.

down a list of words, some of which were homophones with threatening and nonthreatening meanings. Both trait anxiety and manipulated mood influenced the percentage of threatening disambiguations: Anxious subjects and those in negative moods were more likely to spell the threatening meanings than subjects low in anxiety or in positive moods.

Studies such as these suggest that emotions can influence the resolution of lexical ambiguity. But the studies are lacking in several respects. First, the investigations have concerned primarily trait anxiety, and not emotion per se. It is inappropriate to generalize the influences of trait anxiety to influences of transient emotions. There are many stable differences between anxious and nonanxious individuals other than their chronic emotional state. Second, these studies have generally employed stimuli with negative and neutral meanings, and subjects in negative and neutral affective states. It is also important to examine the influence of positive emotional states on the resolution of ambiguous positive stimuli.

Finally, in these studies, subjects were under little or no time pressure to respond. In the study by Mathews et al. (1989), for example, the presentation of a homophone was followed by a 5-s pause before a tone signaled the subject to begin spelling the word. Subjects therefore had time to consider multiple meanings, and to choose one that was most familiar to them, or that fit a general response bias.

CURRENT RESEARCH

The current study employed a methodology similar to that used by Mathews et al. (1989). Subjects were exposed to either a sad or a happy mood induction. They were then presented with a list of words and instructed to spell the words as they heard them. Some of the words were affective homophones (i.e., words that have both affect-related and neutral meanings). The words were read at a fast pace, limiting somewhat subjects' opportunity to choose consciously among word meanings. An emotion-congruence effect was predicted: Happy subjects were expected to generate more happy meanings of happy-neutral homophones (e.g., *presents* vs. *presence*) than sad subjects, and sad subjects were expected to generate more sad meanings of sad-neutral homophones (e.g., *die* vs. *dye*) than happy subjects.

METHOD

Subjects and Design

Subjects were 78 undergraduates at Indiana University. They took part in the research in exchange for credit toward partial fulfillment of a research requirement for their introductory psychology class. The study involved a 2 (mood condition) × 2 (homophone type) mixed design, with the second factor varying within subjects.

Selection of Homophones

The critical stimuli were drawn from *A Dictionary of American Homophones and Homographs* (Whitford, 1966). Twelve homophones that had one meaning related to happiness and one relatively neutral meaning (happy homophones), and 10 homophones that had one meaning related to sadness and one neutral meaning (sad homophones), were initially selected as stimuli. Pretest subjects (N = 41) rated the 22 words, along with other homophones, on their relatedness to the concept of happiness and the concept of sadness using separate 7-point scales, where 1 indicated minimal relatedness and 7 maximal relatedness. Each subject rated either the affective or the neutral meaning of each homophone.

Homophones selected for use in the main study met the following criteria: For a happy homophone, the happiness rating for its affective meaning had to be greater than 1 standard deviation above the mean happiness rating for all pretest words; for a sad homophone, the sadness rating for its affective meaning had to be greater than 1 standard deviation above the mean sadness rating for all pretest words; and for either kind of homophone, the happiness and sadness ratings of its affective meaning had to differ significantly in the expected direction. One happy homophone and two sad homophones failed to meet these criteria; the selected stimuli and their pretest ratings appear in Table 1. The affective meanings of happy homophones were more related to happiness than the affective meanings of sad words, $t(17) = 25.73$, $p < .001$, and the affective meanings of sad words were more related to sadness than the affective

Table 1. *Ratings of relatedness of the affective meanings of the stimuli to happiness and sadness*

Homophone pair	Relatedness to happiness	Relatedness to sadness
Happy homophones		
bridal-bridle	5.80	1.85
dear-deer	5.67	1.91
heal-heel	5.65	1.45
hymn-him	5.10	2.47
medal-metal	5.70	2.00
peace-piece	6.48	1.81
presents-presence	5.95	1.70
pride-pried	5.90	1.80
rose-rows	5.95	2.05
sweet-suite	6.19	1.76
won-one	5.95	1.85
Mean	5.85	1.88
Sad homophones		
banned-band	1.85	5.55
bored-board	2.15	5.47
die-dye	1.50	6.75
fined-find	2.10	5.15
missed-mist	1.85	5.75
mourning-morning	1.25	6.80
pain-pane	1.30	6.75
poor-pore	1.81	6.29
Mean	1.73	6.06

Note. Ratings are on a Likert-type scale on which 7 indicates the strongest relation and 1 the weakest relation.

meanings of happy words, $t(17) = 19.26$, $p < .001$. Results of t tests indicated that the affective and neutral meanings of all critical homophones did not differ in their frequency in the English language ($p > .1$). The 19 stimulus words and 107 filler words (including homophones and nonhomophones) were assembled into a word list with one random order.

Manipulation of Emotional State

Subjects' emotional states were manipulated using a variation of Eich and Metcalfe's (1989) continuous music technique. Subjects in the happy condition listened to 8 min of allegros from Mozart's *Eine Kleine Nacht Musik, Divertimento #136,* and *Ein Musikalischer Spass* and Vivaldi's *Concerto for Two Mandolins and Strings* (in G Major). Subjects in the sad condition listened to Mahler's *Adagietto* (from Symphony no. 5 in C# Minor) and Barber's *Adagio for Strings*. These selections have been used effectively in previous research (e.g., Niedenthal & Setterlund, 1994).

Procedure

Subjects were tested individually in small cubicles with subdued lighting. Each cubicle contained a comfortable chair, a clipboard with a lined work sheet, and two pencils. The subject was seated in the chair and instructed to put on headphones and to follow the instructions presented on tape. The introduction indicated that the experiment was concerned with "the effects of auditory sensation on word comprehension." Subjects first listened to 8 min of either happy or sad music. They were then told that they would hear a list of words, one pronounced every 3 s, and that they should spell out each word in the appropriate space on the work sheet.

The music then returned at a low volume, and the words were presented, above the level of the music. There were 10 practice words, followed by the primary word list. At the end of the spelling task, subjects wrote brief definitions for all 126 words.

Upon completion of the definition task, subjects filled out Mayer and Gaschke's (1988) Brief Mood Introspection Scale (BMIS), which asks for self-report of 16 emotional states (e.g., lively, happy, gloomy) on 4-point scales. Subjects were then debriefed, thanked, and dismissed. The procedure lasted approximately 1 hr.

RESULTS

Manipulation Check

A BMIS score was computed for each subject as follows: First, a happy score was computed by averaging the subject's self-ratings of happy, active, lively, peppy, and content. Second, a sad score was computed by averaging the subject's self-ratings of sad, gloomy, tired, and drowsy (see Niedenthal & Setterlund, 1994, for details). Finally, the subject's BMIS score was taken as the difference between his or her happy and sad scores. Higher numbers therefore reflect greater happiness.

Because the predictions in this study assume the effectiveness of the mood manipulation, it was decided a priori to eliminate subjects whose BMIS scores indicated that they had not been influenced as intended by the emotional music (Niedenthal & Setterlund, 1994). The data from subjects who were in the happy condition but whose BMIS scores fell beyond 1 standard deviation toward the sad end of the scale (8 subjects) were removed. Likewise, data from subjects who were in the sad condition but whose mood scores fell beyond 1 standard deviation toward the happy end of the scale (6 subjects) were removed. The mean BMIS scores of the remaining subjects in the happy and sad conditions (.353 and −.662) differed significantly, $t(62) = 5.03$, $p < .001$.

Homophone Spellings

Both spellings and definitions of the experimental words were obtained because it was possible that subjects would access one meaning of a word but spell the other. Judges compared the spellings and definitions of all items. Mismatches constituted less than 1% of the data, so these items were removed from further analysis. Judges then coded the accessed meaning of each critical homophone according to whether the affective spelling or the neutral spelling had been produced. An item was coded 1 if it reflected the affective meaning of the homophone and 0 if it reflected the neutral meaning of the homophone. A subject's score for each homophone category therefore reflected the proportion of words for which affective meanings were generated. The mean proportions of affective meanings for happy and sad homophones generated by happy and sad subjects are presented in Table 2.

To examine the congruence hypothesis, the means were compared in a 2 (emotional state: happy, sad) × 2 (homophone: happy, sad) mixed analysis of variance, with the second factor varying within subjects. As predicted, the two-way interaction was significant, $F(1, 62) = 6.66$, $p < .02$. Independent sample t tests performed on each homophone category separately revealed that compared with happy subjects, sad subjects wrote significantly more affective meanings of sad words, $t(62) =$

Table 2. *Mean proportion of affective meanings for happy and sad homophones spelled by happy and sad subjects*

	Emotional state	
Homophone type	Happy (N = 30)	Sad (N = 34)
Happy	.547 (.102)	.546 (.137)
Sad	.403 (.112)	.494 (.127)

Note. Standard deviations are in parentheses.

3.03, $p < .005$, but the two groups did not differ on the proportion of affective meanings generated for happy words, $p > .05$.

DISCUSSION

The present result replicates and extends previous research on the role of emotion in low-level cognitive processes—specifically, in the resolution of lexical ambiguity. We predicted and found an interaction between the emotional state of the subject (happy, sad) and homophone type (happy, sad) in subjects' access to affective versus neutral meanings of homophones. The interaction, however, was due to the fact that sad subjects were more likely than happy subjects to generate sad meanings of homophones. This result is consistent with the findings of Richards et al. (1993) and Mathews et al. (1989) showing that a negative state (anxiety) can influence the resolution of lexical ambiguity in an affect-congruent way. The present study extends the previous research to different emotional states, happiness and sadness, and is consistent with Bower's (1981, 1987) framework in which an emotion unit spreads activation to emotion-related lexical items in memory, thereby affording them a processing advantage.

However, although many tests of Bower's model (e.g., Niedenthal et al., 1994; Niedenthal & Setterlund, 1994) have reported emotion-congruence effects of both happiness and sadness in word processing, the present study found an asymmetry for happy and sad emotional states: Happy subjects did not access affective meanings of happy homophones more often than sad subjects. Thus, the findings do not support the hypothesis that emotion-congruent resolution of lexical ambiguity generalizes to positive emotions and positive meanings of words.

We can only speculate about this asymmetry. One possible explanation may lie in the nature of the influences of negative and positive emotion in language processing. Specifically, happy subjects might have tended to see many "neutral" meanings of the happy homophones as relatively positive. For example, happy subjects might have accessed *dear* and *deer* equally often because the latter word (temporarily) had positive meaning for them.

Some support for this interpretation comes from research on the effects of positive and negative affect on categorization. Isen, Niedenthal, and Cantor (1992), for example, found that happy subjects rated peripheral members of positive social categories as better members of those categories than did subjects who had not received a mood induction, but this differential flexibility in category boundaries did not extend to negative social categories. Similarly, Isen, Johnson, Mertz, and Robinson (1985) found that happy subjects produced more positive, and more unique, first associations to neutral target words than did control subjects. Their findings were interpreted as indicating that happiness influences the organization of material in memory such that there is increased integration of ideas, perhaps because positive aspects of nonnegative ideas are accessed automatically (Isen, 1987). It is therefore possible that in the present study, another effect of happiness on cognitive processing (more flexible categorization) prevented the observation of increased access to happy meanings of homophones by happy subjects.

The results are also consistent with an interactive framework for language processing in which there are top-down contextual influences on processing of lower level representations (cf. Simpson & Krueger, 1991; Tabossi, 1988; Tabossi & Zardon, 1993; see Tanenhaus & Lucas, 1987, for discussion), and suggest that context can include a subject's emotional state. Unfortunately, although our procedure was designed to limit subjects' ability to choose consciously among meanings, it does not permit strong claims to be made about whether the observed effects occurred at the level of lexical access or at a later stage of processing.

Future studies should examine response time, so that more definitive conclusions can be drawn about the stage at which emotion exerts its effects in lexical access. Studies to this end are being pursued in our laboratory, using a lexical decision methodology modeled after Schvaneveldt, Meyer, and Becker (1976), Swinney (1979), and Onifer and Swinney (1981). In these experiments, subjects in happy or sad emotional states make lexical decisions about words that are related to either the affective or neutral meanings of homograph primes presented visually. Thus, some subjects see *present::gift* and other subjects see *present::past*. We expect facilitation for the former pairing to be greater for happy subjects than for sad subjects if indeed emotions can serve to guide lexical access. By varying the stimulus onset asynchrony of the prime and target items, we hope to determine more exactly the stage of lexical access at which emotion exerts effects (i.e., at an initial stage of spreading activation or at a postaccess decision stage; see Simpson, 1984). Localizing and specifying the role of affect in the perceptual and lexical access systems will, in turn, help to improve understanding of those systems, and continue to integrate the heretofore distinct domains of affect and cognition.

Acknowledgments—This research was supported by a Javits Predoctoral Fellowship awarded to the first author by the Department of Education, and by Grants R29 MH44811 from the National Institute of Mental Health and BNS-8919755 and DBS-921019 from the National Science Foundation to the second author. Portions of this work were presented at the Social Psychology of Indiana semiannual conference, Bloomington, Indiana, April 1994, and at the meeting of the Midwestern Psychological Association, Chicago, May 1994. Thanks go to Denise Beike, Cindy Hall, Gary Levine, Jon Margolin, Allen McConnell, Hugh McDonald, and Robert Peterson for their support and helpful comments on these ideas. The authors also wish to acknowledge the assistance of their undergraduate research assistants, Michelle Hausken, Debbie Kasef, Tom Kixmiller, Darren Schmidt, Alison Sheffield, Michele Tank, Marti Taylor, Kim Towarak, and Roxanne Waite.

REFERENCES

Bower, G.H. (1981). Mood and memory. *American Psychologist, 36,* 129–148.

Bower, G.H. (1987). Commentary on mood and memory. *Behaviour Therapy and Research, 25,* 443–455.

Bower, G.H. (1991). Mood congruity of social judgments. In J.P. Forgas (Ed.), *Emotion and social judgments* (pp. 31–53). Oxford: Pergamon Press.

Eich, E., & Metcalfe, J. (1989). Mood dependent memory for internal versus external events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 443–455.

Eysenck, M.W., Mogg, K., May, J., Richards, A., & Mathews, A. (1991). Bias in interpretation of ambiguous sentences related to threat in anxiety. *Journal of Abnormal Psychology, 100,* 144–150.

Isen, A.M. (1987). Positive affect, cognitive processes, and social behavior. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 20, pp. 203–253). New York: Academic Press.

Isen, A.M., Johnson, M.M.S., Mertz, E., & Robinson, G.F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of Personality and Social Psychology, 48,* 1413–1426.

Isen, A.M., Niedenthal, P.M., & Cantor, N. (1992). An influence of positive affect on social categorization. *Motivation and Emotion, 16,* 66–78.

Mathews, A., Richards, A., & Eysenck, M. (1989). Interpretation of homophones related to threat in anxiety states. *Journal of Abnormal Psychology, 98,* 31–34.

Mayer, J.D., & Gaschke, Y.N. (1988). The experience and meta-experience of mood. *Journal of Personality and Social Psychology, 55,* 102–111.

McClelland, J.L., & Rummelhart, D.E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review, 88,* 375–407.

Niedenthal, P.M., Halberstadt, J.B., & Setterlund, M.B. (1994). *Emotional state and emotional connotation in word perception* (Indiana University Cognitive Science Program Research Report No. 119). Bloomington: Indiana University.

Niedenthal, P.M., & Setterlund, M.B. (1994). Emotion congruence in perception. *Personality and Social Psychology Bulletin, 20,* 401–411.

Niedenthal, P.M., Setterlund, M.B., & Jones, D.E. (1994). Emotional organization of perceptual memory. In P.M. Niedenthal & S. Kitayama (Eds.), *The heart's eye: Emotional influences in perception and attention* (pp. 87–113). New York: Academic Press.

Onifer, W., & Swinney, D.A. (1981). Accessing lexical ambiguities during sentence comprehension: Effects of frequency of meaning and contextual bias. *Memory and Cognition, 9,* 225–236.

Richards, A., Reynolds, A., & French, C. (1993). Anxiety and the spelling and use in sentences of threat/neutral homophones. *Current Psychology: Research and Reviews, 12,* 18–25.

Schvaneveldt, R.W., Meyer, D.E., & Becker, C.A. (1976). Lexical ambiguity, semantic context, and visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 2,* 243–256.

Seidenberg, M.S., Tanenhaus, M.K., Leiman, J.M., & Bienkowski, M. (1982). Automatic access of meanings of ambiguous words in context: Some limitations of knowledge-based processing. *Cognitive Psychology, 14,* 489–537.

Simpson, G.B. (1984). Lexical ambiguity and its role in models of word recognition. *Psychological Bulletin, 96,* 316–340.

Simpson, G.B., & Krueger, M.A. (1991). Selective access of homograph meanings in sentence context. *Journal of Memory and Language, 30,* 627–643.

Swinney, D.A. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. *Journal of Verbal Learning and Verbal Behavior, 18,* 645–659.

Tabossi, P. (1988). Accessing lexical ambiguity in different types of sentential contexts. *Journal of Memory and Language, 27,* 324–340.

Tabossi, P., & Zardon, F. (1993). Processing ambiguous words in context. *Journal of Memory and Language, 32,* 359–372.

Tanenhaus, M.K., & Lucas, M.M. (1987). Context effects in lexical processing. *Cognition, 25,* 213–234.

Whitford, H.C. (1966). *A dictionary of American homophones and homographs.* New York: Teachers College Press.

(RECEIVED 6/13/94; ACCEPTED 10/26/94)