

Interpretation of Homophones Related to Threat in Anxiety States

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In previous studies, we have established that anxiety states are characterized by an attentional bias that favors the processing of threatening stimuli. In the present study we extend this finding to ambiguous stimuli, specifically, homophones with spellings that correspond to either a threatening or a neutral meaning. As predicted, clinically anxious subjects used the threatening spellings relatively more than did controls, whereas recovered subjects were intermediate in this respect. Threatening words were associated with greater skin conductance responses than were neutral words, but the groups did not differ in their electrodermal reactions to homophones. We take these findings as evidence that, although the different meanings of ambiguous stimuli may be processed in parallel by all subjects, an interpretive bias operates such that anxiety-prone individuals tend to become preferentially aware of the more threatening meaning of such events.

Many everyday events have both threatening and nonthreatening attributes or interpretations. For example, a small lump on one's body may be dismissed as a trivial blemish or be interpreted as the possible onset of skin cancer. Similarly, the lack of warmth from a friend may arise from a temporary preoccupation with other matters or may signify rejection. In this article we argue that anxious individuals systematically attend to the more personally threatening of two or more possible interpretations of such ambiguous events. If so, then this should lead them to encode their environment in a particularly threatening way and thus account for the high subjective estimates of personal danger found in anxiety states (Butler & Mathews, 1983).

To examine this possibility, we (Eysenck, MacLeod, & Mathews, 1987) have investigated the interpretation of homophones having both threatening and nonthreatening meanings but having distinct spellings for each meaning (e.g., *guilt*, *gilt*; *dye*, *die*). With this type of material, there was a significant correlation between the tendency to select the more threatening interpretation and level of trait anxiety. Hence high trait anxious subjects were more likely to use the spelling *die* than the spelling *dye* in comparison with nonanxious controls, when writing down a list of homophones that they heard on tape.

However, a number of important questions remain. Our previous experimental study using homophones showed only a significant association between the number of threatening spellings written down and level of trait anxiety in a group of normal subjects. This finding might indicate that choice of threatening meaning is a function of enduring cognitive features associated with high vulnerability to anxiety rather than with current mood. If so, then a similar bias should be found in clinically anxious subjects, both when disturbed and after recovery. If, on the other hand, such a bias is present only when such individuals

are in an anxious mood state, then it will be found in currently anxious, but not in recovered, subjects.

The present experiment represented an attempt to resolve some of these uncertainties and also to extend our previous findings to the physiological domain. We assumed that awareness of the threatening rather than the nonthreatening meaning of an event might result in a larger skin conductance response. However, it is also possible that word content actually reported would be influenced by social desirability or attempts by subjects to portray themselves in a particular way. Thus the relative magnitude of initial reactions to ambiguous words might reveal whether predominantly threatening or nonthreatening meaning had been perceived, regardless of the actual spellings chosen subsequently. A questionnaire measure of social desirability was included for related reasons.

The aims of the present experiment can thus be summarized as follows. First, we wished to establish that an interpretive bias favoring the more threatening meaning of ambiguous homophones, which we had observed previously in high trait anxious subjects, could be confirmed with a clinically anxious population. Second, results from a group of recovered anxious subjects should indicate whether any interpretive (or response) bias should be viewed as an enduring cognitive characteristic or as dependent on current mood state. Finally, we planned to use skin conductance measures to reveal whether any such bias could be attributed to initial interpretations of meaning rather than to later selective report.

Method

Subjects

Three groups of 14 subjects each participated in the study. One group consisted of outpatients who had been referred for anxiety management training and were waiting for treatment to start. For inclusion in this currently anxious group, subjects had to have a primary diagnosis of generalized anxiety disorder (*DSM-III*) as determined by a structured interview. Any subject with another diagnosis, or who complained of obsessional symptomatology, specific situational anxiety, or substantial phobic avoidance, was excluded from the study. Occasional tranquilizer use was not considered grounds for exclusion, although the majority were drug-free at the time of testing, and none of the remainder were taking a regular course of psychotropic medication.

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Table 1
Mean Questionnaire Scores and Descriptive
Data for Each Group

Measure	Control	Anxious	Recovered
Spielberger State Anxiety ^a	33.9	43.7	28.6
Spielberger Trait Anxiety ^a	37.1	56.2	39.9
Beck Depression Inventory ^a	4.6	15.8	5.4
Hospital Anxiety and Depression—Anxiety ^a	5.9	14.6	8.4
Hospital Anxiety and Depression—Depression ^a	3.1	6.8	3.4
Crowne-Marlowe Social Desirability Scale	14.8	16.7	16.1
Mill Hill Vocabulary	20.6	20.3	19.9
Age	37.4	39.4	39.4
Sex ratio (women/men)	8/6	8/6	6/8

^a Significant differences between currently anxious group and other groups, $p < .05$.

The recovered anxious group was selected from outpatients who had previously met *DSM-III* criteria for generalized anxiety disorders but had been recovered for at least 6 months. They had received various types of treatment, including medication, but the most common form was simple advice on anxiety management. Control subjects were volunteers who had not received treatment for anxiety and were matched with the other two groups as closely as possible for age, gender, and verbal intelligence. All subjects completed the state and trait versions of the Spielberger State-Trait Anxiety Inventory (STAI), the Beck Depression Inventory, the Social Desirability Scale (Crowne & Marlowe, 1964), the Hospital Anxiety and Depression Questionnaire (Zigmond & Snaith, 1982), and the synonym section of the Mill Hill Vocabulary Scale. Mean scores for the three groups are presented in Table 1.

Analysis of variance (ANOVA) and Tukey tests applied to these data revealed that the currently anxious group differed significantly from both the control group and the recovered group with respect to state and trait anxiety on the Spielberger scales, the anxiety and depression scales of the Hospital Anxiety and Depression Questionnaire, and the Beck Depression Inventory. The control group did not differ significantly from the recovered anxious group on any of these measures.

Materials and Psychophysiological Measurement

A list of 14 homophones was assembled, each homophone having both a threatening and a neutral meaning and a different spelling associated with the two interpretations (see Table 2 for a full list of words). Both spellings were presented to a group of six judges (departmental colleagues) who rated them for threat value. Each threatening interpretation was then matched with an unambiguous threat word of similar word frequency and threat value, and the neutral interpretation was matched to an unambiguous neutral word in a similar way. In addition to this, each unambiguous threat word was matched for frequency with an unambiguous neutral word. This produced a total of 56 words: 14 homophones, 14 unambiguous threat words, and 28 unambiguous neutral words.

The words were auditorily presented using tape-recorded lists, in one of four fixed random orders. In addition to the 56 critical words, there were 10 practice words at the beginning of the tape. For each trial a word was presented on the tape followed by a 5-s interval of silence, during which subjects remained still for physiological recording purposes. After this a short tone was sounded, indicating that the word previously presented was to be written down. The end of the trial was indicated with a second tone 5 s later, followed by a final 5-s rest interval before the next trial began.

Skin resistance was measured with silver-silver chloride electrodes

(contact area, 1 cm²) attached to the second phalanges of the first and second fingers of the nonpreferred hand. A 0.05-M NaCl paste served as electrolyte, prepared according to the recommendations of Fowles et al. (1981). Skin resistance was recorded on the direct current channel of a Grass 7 polygraph.

Procedure

At the beginning of the session, subjects completed the trait version of the Spielberger STAI, the Beck Depression Inventory, the Crowne-Marlowe Social Desirability Scale, and the Hospital Anxiety and Depression Questionnaire. The state version of the STAI and the synonym section of the Mill Hill Vocabulary Scale were completed at the end of the session.

Subjects were seated at a table, and after a preliminary explanation the two electrodes were attached. Subjects were requested to find a comfortable position and avoid unnecessary movement. There then followed a 5-min relaxation period. At the end of this period, subjects were given the following instructions:

In this experiment you are going to hear a series of words. A word will be presented followed by a five-second interval. At the end of this interval you will hear a tone. When you hear this tone please write down the word you heard. A second tone will then be sounded which indicates that the trial is over and you should stop writing. There will then be a few seconds' break before you hear the next word. Please try and keep your movements down to an absolute minimum except when you are writing.

Results

Proportion of Threatening Spellings

The number of spellings corresponding to the more threatening of the two meanings of each homophone were totaled and

Table 2
Words Presented to Subjects

Practice	Neutral	Threat	Homophone
Pencil	Month	Harm	Die/Dye
Shoe	Blanket	Hazard	Slay/Sleigh
Telephone	Survey	Disabled	Foul/Fowl
Plant	Deed	Disease	Moan/Mown
Fabric	Mobile	Inferior	Groan/Grown
Coffee	Signet	Insecure	Liar/Lyre
Salt	Flannel	Infirm	Bore/Boar
Window	Rake	Mortality	Pain/Pane
Bird	Regard	Scorned	Weak/Week
Caravan	Poodle	Inquest	Skull/Scull
	Avenue	Ignored	Tease/Teas
	Playmate	Hearse	Bury/Berry
	Spade	Foolish	Guilt/Gilt
	Clog	Opposed	Flu/Flew
	Radish		
	Putty		
	Stag		
	Beads		
	Melon		
	Rabbit		
	Tadpole		
	Curve		
	Skater		
	Willow		
	Petal		
	Mint		
	Silver		
	Trades		

converted into a percentage of all homophones that were spelled in either form. The few spellings that did not correspond to either meaning were eliminated from this total. There were no significant differences between groups in the average number of homophones that were eliminated in this way (control, 1.3; anxious, 1.7; recovered, 2.1). The resulting mean percentage score was greatest in the currently anxious group (85.4%, $SD = 10.3$) and least in the control group (69.9%, $SD = 11.9$), with the mean for recovered subjects being intermediate (77.1%, $SD = 13.2$). All means were greater than 50%, indicating that the threatening meaning tended to be dominant for all subjects, but an ANOVA showed that degree of dominance was not equivalent across the three groups, $F(2, 39) = 5.93, p < .006$. Subsequent Tukey tests showed that only the control and currently anxious groups differed significantly, whereas the recovered group was not significantly different from either of the other two (anxious vs. control, $p < .01$).

To investigate any possible contribution due to social desirability effects, product-moment correlations were calculated between scores on the Crowne-Marlowe scale and the percentage of threatening spellings. This revealed a nonsignificant correlation that was close to zero ($r = -.02$). Similarly, age was not related to number of threatening spellings ($r = -.14, ns$). A significant correlation between percentage spellings score and trait anxiety across the whole sample ($r = .49, p < .001$), confirmed the ANOVA results, although the equivalent figure for state anxiety failed to reach significance ($r = .24$). More interestingly, the pattern of correlations within groups tended to vary. The magnitude of the association between spelling and trait anxiety score was similar across controls (.49, $p < .10$) and currently anxious subjects (.47, $p < .10$) but differed from that in the recovered group ($r = .00$). The equivalent correlations with state anxiety were never significant (controls, .21; anxious, -.04; recovered, -.03), nor did they differ significantly among themselves. Thus there were trends ($.05 < p < .10$) for the correlation of spelling with trait to be greater than that with state in currently anxious subjects and for the correlation of spellings with trait to be lower in the recovered subjects than in the other two groups.

Skin Conductance Responses to Words

Skin conductance responses were calculated in two different ways. First, the overall difference in logarithmic micromhos was taken between baseline level immediately prior to each word and the level sampled immediately before the signal to write was given (5 s later). Baseline levels themselves (e.g., immediately before onset of the word list) were not significantly different across the three groups. Second, the extent of any increase in skin conductance level at any point in the same 5-s interval was sampled, thus providing an index of reaction magnitude even in cases where levels rose and then subsided. In the event, results from both scores were essentially the same, and only the analysis of the second method will be reported. To avoid unnecessary decimal places, all change scores are reported as $\log \mu\text{mhos} \times 10^3$. These data were subjected to ANOVAs to test for effects due to group, word type (ambiguous vs. nonambiguous), and valence (threat vs. neutral). Homophones were classified by valence according to the actual spelling used by each subject.

Unambiguous words were associated with greater skin conductance responses than were homophones (7.9 vs. 6.6), $F(1,$

39) = 5.6, $p < .03$. More important, the expected effects of valence were significant (threat = 8.7, neutral = 5.9), $F(1, 39) = 47, p < .001$. Finally, there was a significant interaction between valence and type of word, $F(1, 39) = 9.73, p < .003$, suggesting that the greatest reactions followed unambiguous threat words (10.3) and that the smallest followed unambiguously neutral words (5.6). Homophones that were spelled in the threatening form tended to be associated with slightly greater reactions than when spelled in the neutral form (7.1 vs. 6.1), although both were intermediate between unambiguous threat or neutral words. Tukey tests showed only that unambiguous threat words were associated with larger reactions than those to any of the other word types ($p < .01$).

There were no clearly significant differences involving groups, although there was a trend in the case of the Group \times Valence interaction, $F(2, 39) = 2.5, p < .1$. This suggested that the difference between reactions to threat and neutral words was rather less in the case of currently anxious subjects (2.4) than it was in the case of the other two groups (controls = 3.3, recovered = 3.6).

Thus in summary, the expected greater reaction to threat words was confirmed, although this difference in response size was less marked in currently anxious subjects. It was not possible to show clearly that the magnitude of response varied as expected according to interpretation of homophones, although the observed difference was in the expected direction. However, this last effect did not show any tendency to interact with group (Group \times Word Type \times Valence), $F(2, 39) = 0.43, p = .65$. It therefore seems that any association between skin conductance and subsequent spelling did not vary across the three groups.

Discussion

The most obvious finding of the present study was that clinically anxious subjects tend to interpret ambiguous information in the more threatening of two possible ways. This finding, although not unexpected, is of importance in understanding the cognitive mechanisms that accompany, and may serve to maintain, anxiety states. Although our earlier studies have clearly implicated an attentional bias favoring environmental sources of threatening information (MacLeod, Mathews, & Tata, 1986; Mathews & MacLeod, 1985, 1986), the present results extend this evidence of bias to the interpretations made of inherently ambiguous stimuli or events. Thus, in the case of events that could be interpreted benignly or as potential dangers, such as an ambiguous remark from a friend or an unusual somatic sensation, it seems likely that anxious individuals are prone to arrive at relatively alarming interpretations. Because ambiguous events of this type are very common in everyday life, it becomes plausible that such an interpretative bias is involved in provoking or maintaining anxiety states.

Our reason for including a group of recovered patients in the study was to determine if any interpretative bias persisted after anxious mood had returned to normal. All measures of anxious and depressed state had returned to a normal level in the present sample of recovered patients, and there were no significant differences between them and the normal control group. Because the scores of this recovered group on the measure of interpretative bias were intermediate and did not differ significantly from those of either the currently anxious or the normal control group, it was not possible to determine whether the bias was

associated with mood state or with a more enduring characteristic, such as trait anxiety. However, because correlations were generally (although not significantly) higher with trait scores than with state scores, it seems probable that a real association exists between interpretative bias and trait anxiety (see also Eysenck et al., 1987). The striking lack of association between these variables within the recovered group is thus of considerable interest. One possibility is that questionnaire answers given by some recovered subjects might be influenced by a need to present themselves in a favorable light or by residual effects of psychological treatment that some had received.

If this is the case, then it might also be argued that the measure of interpretative bias itself could be subject to similar influences. Using the present methods, it does not seem possible to rule out such a possibility definitively; that is, subjects may have become aware of both meanings of the homophones and then have been influenced by demand or response set in choosing which spelling to use when writing the word. The inclusion of skin conductance measures at the time of word presentation represented an attempt to explore this issue. Although results were not conclusive, it was possible to demonstrate that skin conductance responses were sensitive to threat word meaning and that the pattern of results did not appear consistent with a simple demand explanation. If, for example, recovered subjects actually were aware of more threat meanings than their spellings implied, then the homophones classified as neutral in the analysis on the basis of this spelling should have resulted in unexpectedly large skin conductance responses and thus contributed to a significant Group \times Valence \times Word Type interaction. Similar arguments could be made for currently anxious subjects in whom any demand effects should operate in the reverse direction. Of course, lack of significant findings does not conclusively demonstrate complete absence of an effect but simply failure to demonstrate it with the methods employed. Nonetheless, the failure of this interaction to even approach significance does argue against explanations of group differences based on selective reporting. Similarly, there were no differences between groups on the Crowne-Marlowe measure of social desirability, and there were no significant correlations between this measure and interpretive bias for any of the groups.

Our preferred interpretation of the present results does not in fact rule out the possibility that both meanings of the homophones were processed, irrespective of subject group. Some contemporary positions on this issue suggest that all possible meanings of an ambiguous word are accessed automatically, even when only one of these meanings becomes conscious (e.g., Marcel, 1983). Hence it is quite conceivable that various emotional meanings of an ambiguous event may be accessed, even when only one (or even none) of these is fully reportable. Such a view could simultaneously account for the skin conductance responses to homophones and also for why this pattern did not differ across groups; that is, we could suppose that all subjects automatically accessed both meanings and perhaps thereby provoked composite skin conductance responses of intermediate magnitude. After this, an interpretative bias operated so as to select which of these meanings first became conscious and thus reportable. This further implies that in the case of anxious

subjects, threatening meanings of ambiguous events are particularly likely to reach awareness first and thus be available for subsequent report. Comments from subjects after the experiment indicated that awareness of both meanings of a homophone hardly ever happened; but clearly we cannot be certain that this account, which suggests that subjects were typically conscious of only one meaning of each homophone, is correct or that alternatives based on conscious selection are necessarily false.

At this stage of research, we would therefore only wish to conclude that the clinical impression of a bias in which anxious individuals systematically select the more threatening meaning of ambiguous events has been confirmed in a controlled experiment. It is for further research to establish whether this selection process occurs at a pre- or postawareness stage of processing. Regardless of the outcome of this debate, the present results are consistent with earlier findings that anxious individuals overestimate the risk of future aversive events (Butler & Mathews, 1983). Because anxiety states are associated with a bias that favors the more threatening interpretation of ambiguous stimuli, it is likely that everyday events will commonly be encoded as threatening, leading to the overall impression of personal vulnerability to danger. Thus, although there does not appear to be any bias in memory favoring unambiguously threatening material (Mogg, Mathews, & Weinman, 1987), experience of ambiguous events will result in the accumulation of information in memory relating to personal danger. Such an effect could well play a role in maintaining anxiety states; or because the bias apparently relates more to trait level than to anxious mood, it could be part of the cognitive mechanism responsible for causing such disorders in the first place.

References

- Butler, G., & Mathews, A. (1983). Cognitive processes in anxiety. *Advances in Behaviour Research and Therapy*, 5, 51-62.
- Crowne, D. P., & Marlowe, D. (1964). *The approval motive: Studies in evaluative dependence*. New York: Wiley.
- Eysenck, M. W., MacLeod, C., & Mathews, A. (1987). Cognitive functioning and anxiety. *Psychological Research*, 49, 189-195.
- Fowles, D. C., Christie, M. J., Edelberg, R., Grings, W. W., Lykken, D. T., & Venables, P. H. (1981). Publication recommendations for electrodermal measurements. *Psychophysiology*, 18, 232-239.
- MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in anxiety states. *Journal of Abnormal Psychology*, 95, 15-20.
- Marcel, A. J. (1983). Conscious and unconscious perception: An approach to the relations between phenomenal and perceptual processes. *Cognitive Psychology*, 15, 238-300.
- Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy*, 23, 563-569.
- Mathews, A., & MacLeod, C. (1986). Discrimination of threat cues without awareness in anxiety states. *Journal of Abnormal Psychology*, 95, 131-138.
- Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology*, 96, 94-98.
- Zigmond, A. S., & Snaith, R. P. (1982). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, 67, 361-370.

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