Many Stimuli Are Frightening, But Some Are More Frightening than Others: The Contributions of Preparedness, Dangerousness, and Unpredictability to Making a Stimulus Fearful

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The nonrandom distribution of situational fears has been explained by evolutionary survival relevance of specific fears. Thirty-eight stimuli were taken from the literature on “preparedness” and were scored on fearfulness, objective dangerousness, and spatiotemporal unpredictability by three separate groups of students. The same items were scored on survival relevance by 15 biologists. Fearfulness of cues significantly correlated not only with survival relevance but also, and even more strongly, with dangerousness and unpredictability. While the fear/survival relevance association virtually disappeared when the “unpredictability” contribution was partialed out, the fear/unpredictability correlation was only marginally affected when controlling for survival relevance. This suggests that nonrandomness of feared stimuli may result from the spatiotemporal unpredictability that is attributed to these stimuli. The current practice of using snakes and spiders as “phobia-relevant,” and flowers and mushrooms as “neutral,” cues was not justified by the ratings of the 15 independent experts.

KEY WORDS: phobias; conditioning; preparedness.

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INTRODUCTION

It is a well-established fact that some stimuli (e.g., snakes, thunder) more often become and remain frightening than do other stimuli (Agras, Sylvester, & Oliveau, 1969; Costello, 1982). This selectivity has been explained in terms of Darwinian theory: that is, fear of stimuli that were survival-relevant to our ancestors may have become genetically coded in the form of a predisposition or preparedness to readily associate fear with particular stimuli and may still give rise to phobias (Seligman, 1971).

Experimental support for the preparedness hypothesis comes mainly from the research of Öhman and colleagues. In a series of conditioning experiments, they paired an electric shock with slides of either phobia-relevant stimuli (usually spiders and snakes but recently also angry faces) or neutral stimuli (usually flowers and mushrooms but also happy faces). The extinction of the conditioned electrodermal responses to phobia-relevant slides was strongly delayed compared to the extinction of responses to neutral stimuli (see reviews by Dimberg, 1986; Öhman, 1986; Öhman, Dimberg, & Öst, 1985; Öhman, Fredrikson, & Hughdahl, 1978).

In the majority of their experiments, Öhman and co-workers used a differential conditioning paradigm. Studies in which a different conditioning procedure was followed, however, yielded no preparedness phenomena (Deitz, 1982; Emerson & Lucas, 1981; Vaitl, Gruppe, & Kimmel, 1983; Merckelbach & van den Hout, 1988; McNally, 1981, 1986; McNally & Reiss, 1982, 1984).

Moreover, efforts in other centers to replicate the Öhman et al. results have either failed (McNally & Foa, 1986; Merckelbach, van der Molen, & van den Hout, 1987) or only justified the conclusion that the preparedness phenomenon appears to be a "fragile" effect (Cook, Hodes, & Lang, 1986) or "borderline interaction" (Dawson, Schell, & Tweddle Banis, 1986).

Apart from the phenomena reported by Ohman et al. needing cross validation from other centers and from other experimental paradigms, the preparedness hypothesis and, in its wake, the preparedness research present theoretical problems (see reviews by Merckelbach, van den Hout, & van der Molen, 1988; McNally, 1987). The preparedness hypothesis was formulated to account for the restricted range and nonrandom distribution of situational fears. This nonrandomness was supposed to be an inexplicable anomaly to Pavlovian conditioning theory, whose founder claimed that "any natural phenomenon chosen at will, may be converted into a conditional stimulus... any visual stimulus, any desired sound, any odor and the stimulation of any part of the skin" (Pavlov, 1928, p. 86). This view has been taken to imply that all stimuli are equally likely to become phobic cues. Admittedly, classical Pavlovian theory is heavily biased toward the conditioning of responses
to neutral conditioned stimuli (CS). However, as Gray (1979) rightly remarked, "it is worth asking what conditioning theory is for. Pavlov felt impelled to cross the great divide between the unconditioned and the conditioned reflex when he observed in the phrase cited by Eysenck (see also above) that 'any natural phenomenon chosen at will may be converted into a conditioned stimulus.' Had the salivary reflex been elicited only by tastes or smells closely related to nutritious substances, *there would have been no need to take this step*" (p. 70, our italics). It should not be overlooked that, while the theory does say that, *in principle*, any previously neutral stimuli may, after pairing with an unconditioned stimulus (UCS), become a CS for anxiety, it also implies that whether *in fact* a stimulus often becomes a phobic cue depends on the degree to which the cue signals aversive events. Therefore, in order to be able to determine whether the preparedness hypothesis really has more to offer in terms of an explanation that "traditional" Pavlovian notions, it is necessary to examine how well the nonrandomness of situational fears can be attributed either to phylogenetic survival relevance or to ontogenetic dangerousness in the sense of signalization of objective danger.

Other problems which are addressed in the present study stem primarily from the experimental elaboration of the preparedness hypothesis. It was reported that classically conditioned electrodermal responses to slides of spiders and snakes extinguish more slowly than do such responses to slides of flowers or mushrooms. Before concluding that slower extinction to specific stimuli is due to survival relevance, it needs to be independently established that the two groups of stimuli do, indeed, differ considerably in this respect. Judgments on our evolutionary history are, by their very nature, post hoc and great care should be taken not to confound hypothetical evolutionary scenarios with researchers' bias: thus, our classification of stimuli as "phobia-" or "survival-relevant" should not be deduced from data on the prevalence of fears. To avoid begging the question, the labeling of some stimuli as survival-relevant should preferably not be done by anxiety researchers but rather by independent experts who may be less prone to a biased judgment.

Furthermore, it should be noted that the most frequently used stimulus cues in the psychophysiological research on preparedness—namely, spiders and snakes, on the one hand, and mushrooms and flowers, on the other hand—differ in many more respects than just in their degree of survival relevance. For one thing, the spatiotemporal unpredictability associated with snakes/spiders appears to be much higher than that of flowers/mushrooms. This may be of interest, as there are strong theoretical and experimental indications that unpredictable (poor probabilistic CS/UCS relation) or unpredicted aversive events can produce strong motivational and emotional effects (Arntz & van den Hout, 1987; Mineka & Kihlstrom, 1978; Rachman & Lopatka, 1986; Seligman, 1975). Unpredictable objects are relatively like-
ly to become and remain fear cues. Thus, spatiotemporal unpredictability might provide an alternative explanation for the nonrandomness of fears and of the Öhman et al. findings.

In sum, the present study investigates how closely the nonrandomness of fears is associated with (and might thus possibly be explained by) (a) the potential dangerousness of the pertinent stimuli (i.e., the degree to which the stimulus signals objective harm), (b) the survival relevance of the fears for our prehistoric ancestors, and (c) the spatiotemporal unpredictability of stimuli.

**METHOD**

**Questionnaires**

A list of stimuli was constructed that would be rated on fearfulness, dangerousness, survival relevance, and unpredictability by four separate groups of subjects (see below). In the present context, the most appropriate selection of items was thought to include those stimuli that appear in the current literature on preparedness. Most of these items are often referred to by researchers as prototypical examples of stimuli that are prepared, unprepared, or even contraprepared to become associated with fear or aversion.

The following 38 items were selected: rabbit (Eifert & Schermelleh, 1985), pair of opera glasses (Valentine, 1930), rat, pajamas (Seligman, 1971), Béarnaise sauce, Wagner opera (Seligman & Hager, 1972), curtain (Bregman, 1934; cited by Seligman, 1971), horse (Freud, 1909; cited by Seligman, 1971), spider, snake, flower, mushroom (Öhman, 1986), electrical wire, electrical outlet (Hugdahl & Kårker, 1981), splintered glass, fatal number, wasp, social gathering, predator such as tiger, unfamiliar place, darkness, blood, fire, animal feces (De Silva, Rachman, & Seligman, 1972), chocolate (Rachman & Seligman, 1976), household objects such as coffee mill and scissors, handgun (Cook et al., 1986), angry face, happy face (Dimberg, 1986), dirt (Turner & Michelson, 1984), enclosed place (Eysenck, 1979), dentist (Agras et al., 1969), fearful face (Örr & Lanzetta, 1980), thunderstorm (Freud, 1926; cited by Rachman, 1978), lamb (Rachman, 1978), car door (Marks, 1977), and war-related stimulus such as siren (Rachman, 1977; Saigh, 1984).

Scores for each of the four dimensions were given on a 10-cm visual analogue scale ranging from “not fearful” to “extremely fearful” (fearfulness dimension), “extremely unlikely” to “extremely likely” that the stimulus signals objective harm (dangerousness dimension), “highly predictable” to “not at all predictable” (unpredictability dimension), and “not survival-

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*Sometimes stimulus classes are so abstractly described that they are inappropriate as items. In these instances, we used a concrete example of the stimulus class in question.*
relevant at all" to "extremely survival-relevant" to prehistoric man (survival relevance dimension). The fearfulness dimension was constructed to measure self-reported fear of the 38 items. In the unpredictability and dangerousness versions, subjects were instructed to rate the unpredictability and dangerousness of the stimuli for people in general. As for the survival relevance dimension, the instructions given to the subjects were quite similar to those used by De Silva et al. (1972): subjects were asked to indicate to what extent fear of the stimuli listed facilitated survival of Homo sapiens in pretechnological society. Dimensions were scored by different groups of subjects in order to avoid that scoring on one dimension would influence scores on the other dimensions (i.e., experimentwise errors).

Subjects

The fear dimension, dangerousness dimension, and unpredictability dimension were scored by undergraduate students (fear dimension—$N = 37$, 7 men and 30 women, mean age = 20.6 years; dangerous dimension—$N = 18$, 2 men and 16 women, mean age = 21.1 years; unpredictability dimension—$N = 14$, 5 men and 9 women, mean age = 22.4 years). The survival relevance dimension was given to 15 human biology researchers (10 men and 5 women, mean age = 29.2 years) who were unaware of the subject under investigation and who were professionally intimately acquainted with Darwinian theory.

RESULTS

Internal Consistency of Questionnaires

An analysis of variance approach was used to estimate the reliability of the dimensions (Winer, 1962). It was decided beforehand that individual items which might contribute to a low internal consistency, as indicated by Cronbach’s alpha for the total dimension of less than .70, would be excluded from further analysis. However, when all items were included, alpha coefficients for the four dimensions exceeded this criterion. Alpha coefficients for fearfulness, survival relevance, dangerousness, and unpredictability were .94, .95, .91, and .90, respectively.

Choice of Stimuli in Preparedness Research

As for the choice of stimuli in preparedness research, the following items are the most interesting ones because of their prominent place in prepared-
ness research: flower, spider, mushroom, snake, angry face, and happy face. Recalling that flowers and mushrooms are used as prototypes of neutral cues, while spiders and snakes are used as paradigmatic instances of phobia-relevant stimuli, one would expect that independent scores on survival relevance of snakes and spiders would be significantly higher than survival relevance scores on mushrooms and flowers.

While scores for snakes on survival relevance were, indeed, significantly higher than for flowers, the spider vs. flower difference was statistically not significant (see Table I). The mushroom vs. snake difference reached borderline significance. Interestingly, the independent judges rated fear of mushrooms as considerably more survival relevant than fear of spiders. This is in sharp contrast to current assumptions underlying experimental work in the realm of preparedness.

Fear of angry faces was rated as significantly more survival-relevant than fear of happy faces \( t(14) = 3.33, p < .05 \), one tailed]. In the experimental research on preparedness, these stimuli have never been used in combination with mushrooms, flowers, snakes, or spiders. Therefore, no other comparisons were made. In most psychophysiological studies, responses to groups of phobia-relevant and supposedly neutral stimuli rather than responses to individual stimuli are compared to each other. Therefore, it was decided to cluster the items according to their actual use of phobia-relevant or neutral stimuli. Scores were averaged over the three most commonly used phobia-relevant items, namely, snake, spider, and angry face, and compared to mean scores of a group of neutral items (mushroom, flower, and happy face) on the dimensions fearfulness, survival relevance, dangerousness, and unpredictability (see Fig. 1). As expected, \( t \) tests revealed that the two groups of stimuli differed significantly on the fear dimension \( t(36) = 8.8, p < .05 \),

| Table I. Expert Judgment (0–100) of Survival Relevance of Four Widely Used Stimuli in Preparedness Research: Means (M), Standard Deviations, and \( t \) Values for Relevant Comparisons |
|--------------------------|--------------------------|
| Snake                  | Spider                  |
| \( M = 81.7 \)          | \( M = 45.3 \)          |
| SD = 20.9              | SD = 32.8               |
| Mushroom               | Flower                  |
| \( M = 69.1 \)          | \( M = 34.4 \)          |
| SD = 35.1              | SD = 34.8               |
| \( t = 1.74^* \)         | \( t = 4.73^{**} \)     |
| \( t = -2.76^{**} \)    | \( t = 1.05 \)          |

\*\( p < .10 \) one tailed, \( df = 14 \).
\^{**}p < .05, one tailed, \( df = 14 \).
one tailed]. Furthermore, a significant difference was found on the survival relevance dimension \(t(14) = 2.8, p < .05\), one tailed]. However, differences were also present, and even more markedly, on the unpredictability \(t(13) = 4.1, p < .05\), one tailed] and dangerousness \(t(17) = 5.4, p < .05\), one tailed] dimensions.

**Nonrandomness of Fear: Associations with Danger Signal Value, Survival Relevance, and Spatiotemporal Unpredictability\(^*\)**

If nonrandomness and selectivity of fearful stimuli are due to survival relevance of the pertinent stimulus, one would expect a strong positive correlation between fear and survival relevance. Similarly, to the degree that objective dangerousness or unpredictability is responsible for nonrandomness, close associations should be expected between fear and dangerousness and/or fear and unpredictability. On the basis of the mean score on the 38 items, Pearson product-moment correlations among the four dimensions were computed. Results are shown in Table II.

\(^*\)A table containing mean scores and standard deviations of all items on the four dimensions is available from the first author.
Table II. Pearson Product-Moment Correlations Between Averaged Ratings of 38 Items on Fearfulness, Survival Relevance, Dangerousness, and Unpredictability*  

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Survival relevance</th>
<th>Dangerousness</th>
<th>Unpredictability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fearfulness</td>
<td>.51</td>
<td>.87</td>
<td>.63</td>
</tr>
<tr>
<td>Survival relevance</td>
<td>~</td>
<td>.43</td>
<td>.64</td>
</tr>
<tr>
<td>Dangerousness</td>
<td>~</td>
<td>~</td>
<td>.51</td>
</tr>
</tbody>
</table>

* p < .01, one tailed, N = 38, for all reported correlations.

Fear correlated significantly with all three other variables. To determine how much unique variance can be accounted for by survival relevance, dangerousness, and unpredictability, an analysis with partial correlations was carried out. When the fear/unpredictability correlation was corrected for the contribution of survival relevance, the coefficient dropped to .47 but was still significant (df = 35, p < .05, one tailed). The fear/dangerousness correlation was only marginally affected when variance due to survival relevance was partialed out (r = .85 instead of .87, df = 35, p < .05, one tailed). However, a very different picture emerged when the fear/survival relevance association was corrected for dangerousness and unpredictability. Correcting for dangerousness reduced the fear/survival relevance coefficient from .51 to .31 (df = 35, p < .05, one tailed), while correcting for unpredictability reduced the fear/survival relevance association to the nonsignificant coefficient of .18.

Thus, the significant association between fear and unpredictability can be explained only partly by survival relevance, while survival relevance does not explain at all the high correlation between fear and dangerousness. On the other hand, the fear/survival relevance correlation drops to a nonsignificant level of .18 once the contribution of unpredictability of stimuli is taken into account.

A multiple regression analysis confirmed the above-mentioned findings. The proportion of variance ($R^2$) in fear explained by unpredictability, dangerousness, and survival relevance operating jointly was .82 ($F(3,34) = 50.0$, $p < .05$). This proportion was hardly affected when only unpredictability and dangerousness were used as predictors: $R^2 = .81$ ($F(2,35) = 76.3$, $p < .05$). The t values associated with the regression coefficients of unpredictability, dangerousness, and survival relevance were 8.6 ($p < .05$, two tailed), 2.1 ($p < .05$, two tailed), and .56 ($p = .57$), respectively.

**DISCUSSION**

In line with the Pavlovian view, fear of stimuli proved to be highly correlated with the degree to which these stimuli signalize objective harm. Fear
ratings were further correlated with unpredictability, while a somewhat smaller correlation was found between fear and survival relevance. This fear/survival relevance association virtually disappeared once the variance attributable to unpredictability was eliminated.

The expert judgments on survival relevance strongly diverged from current views and research practices. Mushrooms, for example, were judged to be highly survival-relevant. This result is compatible with the provocative view put forward by Delprato (1980). He stated that mushrooms "have posed a greater threat to the survival of the human species than have spiders and snakes combined. Mushroom toxicosis is especially a threat to humans because poisonous mushrooms are usually extremely difficult to discriminate from non-poisonous varieties" (p. 89).

It was found that, as a group, the most widely used phobia-relevant stimuli differ from neutral stimuli more in terms of dangerousness and unpredictability than in terms of survival relevance. At the same time, the overall correlational analysis revealed that the correlations of fear with dangerousness and unpredictability are relatively independent of the survival relevance dimension.

De Silva et al. (1977) stated that the nonrandom distribution of fear "forms the core of the preparedness concept" (p. 76). The studies by Agras et al. (1969) and by Costello (1982) are frequently cited to document the higher prevalence of biologically relevant fears than fears with an ontogenetic background. Yet as Kirkpatrick (1984) rightly remarks the exact rank order of fears that one observes in a population is highly dependent upon the choice of items that are included in a fear survey. Kirkpatrick found that fear of death of a loved one was generally the strongest fear for women and that fear of being punished by God ranked highest for men. Fear of snakes ranked sixth among women and twenty-first among men. On the basis of his data, he concluded that the hypothesized "prepared fears" can be more parsimoniously explained by "our shared experiences and cultural environment" (p. 149). In a sense, the present findings substantiate Kirkpatrick's position. They suggest that the hypothesis of prepared fear of survival-relevant cues may not be the most fruitful addition to the Pavlovian theory of fear acquisition. Rather, it may turn out that both the nonrandomness of fears and the most important experimental data on prepared learning (Öhman, 1986) can be explained by adding the notion of spatiotemporal unpredictability to Pavlovian theory. That is, given a certain aversive stimulus (UCS) and certain probabilistic associations between the occurrence/nonoccurrence of CS and UCS, with all other variables held constant, the spatiotemporal unpredictability that subjects attribute to the CS is positively related to the state of extinction. This formulation has a number of testable implications. Meanwhile it is acknowledged that problems in replicating and cross-validating the Öhman results (McNally, 1987; Merckelbach et al., 1988) are not clarified by the present data. It might be worthwhile, however, to examine post hoc whether,
in successful replications of the Öhman results, the neutral and phobia-relevant CS are more divergent in terms of spatiotemporal unpredictability than in the unsuccessful replications.

In the same vein as Bennett-Levy and Marteau (1984), who suggested that it is responses to perceptual characteristics rather than complete stimulus templates that have become genetically coded, it may, of course, be argued that the readiness to become fearful of unpredictable cues, is something which evolved through natural selection (Merckelbach, van den Hout, & van der Molen, 1987). The adaptational significance of sensitivity to unpredictable events seems self-evident. Plausibility aside, however, this notion will be hard to prove. It may be more rewarding to examine the merits of the present formulation by means of habituation (e.g., the match/mismatch paradigm introduced by Rachman & Lopatka, 1986) and conditioning procedures. From the present perspective, it would be most relevant to test whether induced fear responses to unpredictable CS are, indeed, quickly acquired and slowly extinguished.

REFERENCES


Preparedness and Fearful Stimuli


