ARE COVARIATION BIASES ATTRIBUTABLE TO 
A PRIORI EXPECTANCY BIASES?

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Summary—Illusory correlation experiments indicate that people overestimate the association between 
random presentations of snake slides and shock, but do not overestimate the association between random 
presentations of slides of damaged and exposed electric outlets (DEEOs) and shock. To investigate 
whether reports of covariation biases might be attributable to expectancy biases, we had Ss rate the a 
priori probabilities with which they would expect slides of snakes (or DEEOs), flowers, and mushrooms 
to be paired with shock, a tone, or nothing. In Study 1, Ss reported a pattern of a priori slide/outcome 
probability estimates that is nearly identical to that reported by Ss who have just undergone an illusory 
correlation procedure involving phylogenetic fear-relevant stimuli (e.g. snakes). Therefore, postexperimen-
tal estimates of covariation involving such stimuli appear at least partly attributable to pre-experimental 
expectancy biases rather than solely attributable to on-line processing biases. Study 2 revealed that Ss 
also display inflated a priori probability estimates for DEEO slides and shock, unlike Ss who have just 
undergone an illusory correlation procedure involving such stimuli. Taken together, these studies suggest 
that random slide/outcome pairings easily abolish pre-experimental expectancy biases for ontogenetic, but 
not phylogenetic, fear-relevant stimuli.

Experimental research on snake phobia has been traditionally based on the assumption that these 
fears are “noncognitive” (McNally, 1987; Seligman, 1971). Most investigators today, however, do 
not conceptualize phobias as noncognitive, but rather endeavor to elucidate the cognitive 
mechanisms and biases that underlie the apparent “irrationality” of such fears (e.g. Davey, 1992; 
Dawson, Schell & Twiddle-Banis, 1986; de Jong & Merckelbach, 1991; de Jong, Merckelbach, 
Arntz & Nijman, 1993; Honeybourne, Matchett & Davey, 1993; Mineka & Sutton, 1992; Öhman, 
Dimberg & Öst, 1985). For example, one mechanism might be a propensity to overestimate the 
correlation between stimuli of evolutionary significance and aversive outcomes (Tomarken, Mineka 
& Cook, 1989). Such a “covariation bias” might partly explain why fears of snakes are more 
common than fears of many threats of contemporary origin.

Mineka and her colleagues have devised an illusory correlation paradigm to investigate whether 
people are, indeed, prone to overestimate the covariation between phylogenetic threat stimuli and 
aversive events (Mineka & Sutton, 1992; Mineka & Tomarken, 1989; Tomarken et al., 1989). In 
this paradigm, Ss are shown slides of fear-relevant (e.g. snakes, spiders) and fear-irrelevant stimuli 
(e.g. flowers, mushrooms) that are followed by either a shock, a tone or nothing. The Ss are told 
to determine the correlation between each slide type and each outcome. Although all outcomes are 
associated with all slide types equally often, Ss typically report that phylogenetic fear-relevant 
stimuli are paired with shock more often than are fear-irrelevant stimuli, and that fear-relevant 
stimuli are paired with shock more often than with tone or with nothing (Tomarken et al., 1989). This 
effect is much less evident in Ss who do not have preexisting fears of snakes and spiders than in 
college students and phobic patients who do (Tomarken et al., 1989), especially when the overall 
rate of shock is low. Interestingly, Ss do not overestimate the covariation between certain 
tonogenetic fear-relevant stimuli (e.g. slides of damaged and exposed electric outlets) and shock 
(Sutton, Mineka & Tomarken, 1991).

The source of the illusory correlation phenomenon is unknown. Although Tomarken et al. (1989) 
apparently suspect that it reflects biased information-processing that occurs during the experiment, 
an “alternative explanation might be that phobic Ss entered the laboratory with a habitual 
tendency to overassociate phobic cues with negative outcomes” (de Jong, Merckelbach & Arntz,

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1990, p. 202). Therefore, postexperimental judgments of covariation might merely reflect pre-experimental expectancy biases rather than "biased on-line processing" (de Jong et al., 1990, p. 202). If fearful Ss arrive at the laboratory with pre-experimental biases that match those reported postexperimentally, then there is little reason to attribute the latter to a covariation bias that develops during the experiment.

We conducted two studies to determine whether Ss report a priori biases that match those typically reported postexperimentally by Ss who have undergone an illusory correlation procedure. The Ss read a brief description of an experimental procedure based closely on that of Tomarken et al. (1989), imagined that they were about to participate in the experiment, and "pre-experimentally" predicted the likely probabilities of the various slide/outcome combinations. In Study 1, Ss who expressed either high or low fear of snakes read a description that involved snake slides as the fear-relevant phylogenetic stimulus class. In Study 2, Ss who expressed either high or low fear of damaged and exposed electric outlets read a description that involved slides of these objects as the ontogenetic fear-relevant stimulus class.

STUDY 1

Method

Subjects

The Ss were 40 Harvard University Extension students who expressed either high (n = 24) or low (n = 16) fear of snakes on a 7-point Likert Scale that ranged from 0 ("none") to 6 ("terror"; Geer, 1965). The high-fear group (79% female) had a mean age of 29.2 yr (SD = 7.7) and a mean snake-fear score of 4.9 (SD = 0.9). The low-fear group (50% female) had a mean age of 28.6 yr (SD = 7.1) and a mean snake-fear score of 1.4 (SD = 0.6).

Materials

The Ss were presented with a brief description of an experiment and a questionnaire based on that description. Incorporating Tomarken et al.'s (1989) instructions, the Thought Experiment questionnaire required Ss to indicate their expectations concerning the relative probabilities of the various slide/outcome combinations. Whereas Tomarken et al. (1989) had Ss rate the slide/shock covariations after having been exposed to them, we had Ss do these ratings in lieu of exposure to them. On the last page of the questionnaire, Ss rated their degree of snake fear, their degree of fear of damaged and exposed electric outlets, and jotted down what they thought was the purpose of the (imagined) covariation experiment. The Ss completed the Thought Experiment questionnaire in a group testing context. Instructions were as follows.

Thought Experiment

This brief questionnaire concerns how people perceive experiments in psychology. You will first be asked to read a description of an experiment, and then to imagine yourself as a S in the experiment.

Description of the Experiment

"In this experiment, you'll be asked to sit in a comfortable reclining chair and view a series of slides that will be projected on a screen in the laboratory. There will be three categories of slides: pictures of flowers, pictures of snakes, and pictures of mushrooms. Any given slide will be followed by one of three possible outcomes. You will either hear a neutral tone, or you'll feel a harmless shock on your forearm, or you'll experience nothing. (Before we start the actual experiment, we will ask you to select a level of shock that is definitely uncomfortable, but not painful.) Pay close attention to what is happening because your task is to determine whether or not there is a relationship between any category of slide and any of the outcomes following the slide. Once again, focus on whether there is a relationship between different categories of slides and the three outcomes."

Imagine that you are about to participate in this experiment. Please answer the following questions as if you were about to participate in this experiment.
Subjects then completed the nine scales corresponding to each of the slide/outcome combinations. An example is as follows:

What percentage of the flower slides will be followed by SHOCK?

Data analysis

Replicating Tomarken et al.'s (1989) data analytic strategy, we conducted three sets of planned comparisons. The first two sets were four within-group contrasts conducted within the high- and low-fear groups, respectively. These contrasts tested the difference between Ss' snake-shock predictions and the four relevant comparison predictions: snake-tone, snake-nothing, mushroom-shock and flower-shock. The third set comprised a comparison between the snake-shock predictions of the high- and low-fear groups. To control for experiment-wise error, we used a Dunn–Bonferroni approach for each of the four comparisons of each within-fear-group set (i.e. alpha = 0.05/4 = 0.0125). All tests were two-tailed.

Results and Discussion

As depicted in Fig. 1, high-fear Ss' expectations of the covariation between snake slides and shock were significantly greater than their expectations of the covariation between snake slides and nonaversive outcomes (snake/shock vs snake/tone, and snake/shock vs snake/nothing, ts(23) = 6.48 and 6.56, respectively, Ps < 0.0001). High-fear Ss also predicted the covariation between snake and shock to be greater than the covariation between mushroom and shock, t(23) = 5.16, P < 0.0001, and between flower and shock, t(23) = 10.03, P < 0.0001. Moreover, the between-groups planned comparison indicated that high-fear Ss', snake/shock predictions were significantly greater than those of low-fear Ss', t(38) = 2.83, P < 0.007.

Low-fear Ss tended to exhibit less bias than high-fear Ss. Their predictions of the covariation between snake and shock were greater than their snake/nothing, t(15) = 2.42, P < 0.03, and mushroom/shock predictions, t(15) = 2.13, P < 0.05. These effects, however, are nonsignificant under the Dunn–Bonferroni correction (i.e. Ps > 0.0125). Low-fear Ss did not have significantly different covariation predictions for snake/shock vs snake/tone, snake/shock vs flower/shock (both Ps > 0.05).

Fig. 1. Mean pre-experimental estimates of the conditional probability of outcomes given slide categories in Study 1.
The pattern of predicted probability estimates in the high-fear group is virtually identical to that reported by Tomarken et al.'s (1989, Experiment 1) high-fear Ss, and the pattern in the low-fear group is nearly identical to that reported by their low-fear Ss. The only difference was that Tomarken et al.'s low-fear Ss provided estimates of the fear-relevant/shock covariation that were significantly higher than the flower/shock and the fear-relevant/nothing covariations, whereas our low-fear Ss did not.

Study 1 implies that Ss may begin illusory correlation experiments with expectations about what stimuli are likely to be associated with what outcomes. Our findings raise the possibility that pre-experimental expectancy biases may contribute substantially to observed postexperimental covariation estimates.

Unlike Tomarken et al.'s Ss, ours did not directly participate in a series of illusory correlation trials, they did not view slides of potentially fearful stimuli, they did not experience shocks, and they did not participate in individual laboratory sessions. Nevertheless, despite these procedural differences, our Ss generated a pattern of probability estimates that was strikingly similar to that generated by Ss who have undergone a series of random slide/shock pairings (Tomarken et al., 1989). Because our Ss generated a pattern of probability estimates virtually identical to that generated by Ss who have actually undergone an illusory correlation procedure, we conclude that biased covariation estimates might be at least partly attributable to pre-experimental expectancy biases, and not arise solely from biased on-line processing.

Indeed, if anything, our results suggest that snake-fearful Ss begin illusory correlation experiments with biases that are even higher than those they report postexperimentally. For example, our snake-fearful Ss gave a mean probability estimate for fear-relevant/shock that was approx. 75%, whereas Tomarken et al.'s (1989, Experiment 1) fearful Ss gave an estimate that was approx. 55% when the veridical probability was 33%. Taken together, these findings imply that exposure to random phylogenetic fear-relevant stimuli/shock pairings attenuates but fails to eliminate pre-experimental expectancy biases.

STUDY 2

Study 1 suggests that inflated estimates of the association between phylogenetic fear-relevant stimuli and shock may precede exposure to random slide/outcome pairings. Study 2 was procedurally identical to Study 1 except that we replaced phylogenetic fear-relevant stimuli with ontogenetic fear-relevant stimuli (i.e. damaged and exposed electric outlets).

Method

Subjects

The Ss were 44 Harvard University Extension students who expressed either high (n = 24) or low (n = 20) fear of damaged and exposed electric outlets on a 7-point Likert Scale that ranged from 0 ("none") to 6 ("terror"). The high-fear group (58% female) had a mean age of 29.7 yr (SD = 6.9) and a mean damaged and exposed electric outlets-fear score of 4.5 (SD = 0.7). The low-fear group (55% female) had a mean age of 29.3 yr (SD = 7.2) and a mean damaged and exposed electric outlets-fear score of 0.8 (SD = 0.8).

Materials

The Thought Questionnaire was identical to the one in Study 1, except that damaged and exposed electric outlets replaced snakes as the fear-relevant slide category.

Results and Discussion

As depicted in Fig. 2, high-fear Ss' predictions of the covariation between electric outlet slides and shock were significantly greater than their predictions of the covariation between electric outlet slides and nonaversive outcomes (electric outlet/shock vs electric outlet/tone, and electric outlet/shock vs electric outlet/nothing, ts(23) = 4.88 and 7.57, respectively, Ps < 0.0001). High-fear Ss also predicted the covariation between electric outlet and shock to be greater than the covariation
between mushroom and shock, $t(23) = 5.59$, $P < 0.0001$, and between flower and shock, $t(23) = 5.77$, $P < 0.0001$. High- and low-fear Ss, however, did not differ in their predictions for electric outlet/shock, $t(42) < 1$.

Low-fear Ss displayed a pattern of covariation predictions similar to those of high-fear Ss. Low-fear Ss' predictions of the covariation between electric outlet slides and shock were significantly greater than their predictions of the covariation between electric outlet slides and nonaversive outcomes (electric outlet/shock vs electric outlet/tone, and electric outlet/shock vs electric outlet/nothing, $t(19) = 5.10$ and $4.73$, respectively, $Ps < 0.0001$). Low-fear Ss also predicted the covariation between electric outlet and shock to be greater than the covariation between mushroom and shock, $t(19) = 5.19$, $P < 0.0001$, and between flower and shock, $t(19) = 4.32$, $P < 0.0001$.

These findings imply that Ss pre-experimentally expect ontogenetic fear-relevant stimuli to be strongly associated with aversive outcomes. Such biases, however, are not reported postexperimentally after Ss have undergone an illusory correlation procedure involving shocks and slides of damaged and exposed electric outlets (Sutton et al., 1991). Taken together, these studies suggest that random slide/outcome pairings readily disconfirm previous expectations that slides of outlets are likely to be frequently paired with shock.

**GENERAL DISCUSSION**

The present studies suggest that Ss may begin illusory correlation experiments with expectations that fear-relevant stimuli will be paired with shock more than with neutral outcomes, and that fear-relevant stimuli will be paired with shock more than will fear-irrelevant stimuli. This expectancy bias is apparent for ontogenetic as well as for phylogenetic fear-relevant stimuli, and is confined largely to Ss fearful of the relevant stimuli. Previous illusory correlation research indicates that Ss overestimate the association between phylogenetic stimuli and shock (Tomarken et al., 1989), but do not overestimate the association between ontogenetic fear-relevant stimuli and shock (Sutton et al., 1991). Taken together, these findings suggest that random slide/outcome pairings are highly effective for eliminating pre-experimental biases associated with ontogenetic fear-relevant stimuli, but are relatively ineffective for eliminating pre-experimental biases associated
with phylogenetic stimuli. Mineka (1991) has also suggested that a relative insensitivity to disconfirmation may contribute to covariation biases associated with phylogenetic fear-relevant stimuli.

REFERENCES


