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EXPLORATION OF SOME MECHANISMS INVOLVED IN BLINKING TO VISUAL SEXUAL STIMULI

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This experiment (*a*) tested the hypothesis that visual sexual stimuli would increase the rate of blinking and (*b*) explored some possible mechanisms involved in the relationship between such stimuli and the blinking response. To explore these mechanisms, a conditioning experiment was run using 40 *S*s, 20 of whom were conditioned with the use of sex pictures and the rest with the use of landscape scenes as the UCS. An auditory stimulus was used as CS for 10 *S*s of each group; a visual stimulus was used as CS for the remaining *S*s. The sexual pictures elicited significantly more blinks than the landscapes, and both visual and auditory CS elicited more blinks when conditioned to the sexual pictures than when they were conditioned to the landscapes. The number of blinks elicited by the visual CS was not significantly different from that elicited by the auditory CS when both stimuli were conditioned to the sexual pictures. These results suggested that (*a*) the effect of the sexual pictures on arousal level is a critical factor in producing an increased blink rate and (*b*) the sensory modality of the arousing stimulus is not critical. It is possible, however, that the latter might have only been due to the number of acquisition trials used.

Previous studies suggest that human blink rate may be increased by presenting visual sexual stimuli. Three hypotheses may be advanced to explain how such stimuli may have this effect:

1. The *arousal hypothesis* states that sexual stimuli, whether visual or nonvisual, have the effect of increasing level of arousal (general, sexual, and/or anxiety arousal) and it is this effect of sexual stimuli which in turn increases blink rate. Studies relevant to this hypothesis are available. Lindsley (1951) concluded from numerous studies that general emotional arousal or excitement increases blinking. Other studies suggest a positive relationship between anxiety level and blink rate. Scores on a measure of maladjustment correlated significantly with blink rate (Meyer, Bahrick, & Fitts, 1953); stressful words evoked significantly higher rates than nonstressful words in a free association test (Doehring, 1957). Blink rate can be increased by inducing tension in parts of the body; therefore, if anxiety and muscular tension are assumed to be correlated, then anxiety arousal may be expected to be accompanied by increased blink rate (King & Michaels, 1957; Martin, 1958; Peak, 1942). The eyeblink response is also known to condition faster among anxious than among nonanxious *S*s (Franks, 1958; Runquist & Ross, 1959; Spence, 1954).

2. The *coping hypothesis* states that for a sexual stimulus to influence blinking, it has to be visual and anxiety-producing. When the sex stimulus is visual and anxiety-producing, blinking may be used to cope with the aroused anxiety. When confronted with such a stimulus, closing the eyes reduces the anxiety aroused by visual stimulation. However, keeping the eyes closed in the presence of the stimulus will also be anxiety-producing because it prevents effective dealing with the environment in general and with threats in it in particular. Hence, one tends to open one's eyes subsequently to reduce anxiety also. When confronted with a visual anxiety-stimulus, a series of "closing-and-then-opening" coping responses might appear in the form of blinking. On the other hand, when the anxiety stimulus is nonvisual, the response of closing the eyes can not effi-

ciently reduce anxiety. Therefore, "coping by blinking" should not take place.

3. The *arousal + coping hypothesis* states that stimuli which increase the level of (general, sexual, and/or anxiety) arousal in turn increase blinking but visual stimuli which arouse anxiety will elicit more blinks than will stimuli of other sense modalities that arouse the same amount of anxiety. This hypothesis assumes that blinking to visual sexual stimuli is a function of both arousal level and coping.

This experiment was designed to determine which of these three hypotheses could explain most adequately how visual sexual stimuli increase blink rate.

METHOD

In order to have a crucial test of the hypotheses it is necessary that the visual arousing stimulus and the nonvisual arousing stimulus produce the same level of arousal. A conditioning experiment was therefore run wherein a visual and an auditory CS were associated with the same arousing UCS, using an equal number of trials and an equal CS-UCS interval.

Subjects and Experimental Design

Forty (40) *Ss* were used, all of whom were male college (Yale) undergraduates. For 20 of them the UCS used in conditioning were pictures of female nudes and for the rest, landscape scenes. For half of each group, an auditory stimulus (buzzer) was used as CS; for the remaining members of each group, the CS was a visual stimulus projected on a screen. Thus, altogether, there were 4 groups of 10 *Ss* each that may be arranged in a 2 by 2 design: (*a*) *Vis-sex* group: visual CS, sex UCS, (*b*) *Aud-sex* group: auditory CS, sex UCS; (*c*) *Vis-land* group: visual CS, landscape UCS; and (*d*) *Aud-land* group: auditory CS, landscape UCS.

Stimuli

The UCS to evoke arousal in this experiment were five black-and-white slides of female nudes. In four slides the pubic hair was visible, thus making them quite different from pictures in model magazines with which *Ss* might be familiar. The exception was that of a girl whose breasts were bare but who was clad from the waist down with a popular movie actor standing behind her. All UCS were projected onto a screen about 15 feet from the *Ss*. There was no independent evidence that these pictures increased the level of general, sexual, and/or anxiety arousal of *Ss*. However, they probably had an effect on *Ss'* arousal level considering that young male college students generally find sexual pictures to be "interesting," and the visible pubic hair very probably made the pictures all the more "interesting" because they were not common, and the fact that *Ss* did not expect the experiment to involve such slides. It is not also unlikely that the content of the pictures had the more specific effect of increasing sexual arousal, an effect which would likely be accompanied also by some anxiety (feelings of uncertainty, awkwardness, embarrassment, self-consciousness, or guilt) because the situation was one in which it was not socially proper to respond sexually (*S* was participating in a scientific experiment and he knew his reactions were being observed and recorded by strangers).

The neutral nonarousal UCS were five landscape scenes, one of which was in black and white and the other four in color.[1] There was also no independent evidence that the landscape scenes did not increase arousal level.

The auditory CS was delivered by a buzzer with an intensity approximately equal to that of an ordinary inter-office communication buzzer. The visual CS was a red rectangle, approximately 3 by 4 feet in area, projected on the screen about 15 feet away.

Procedure

Ss were successively assigned to the various experimental groups according to the order in which they signed up for the experiment. They were told on the sign-up sheet that the experiment concerned visual perception. They were run one at a time during early evening.

As each *S* reported for the experiment, he was met outside the experimental room by the first author who invited him inside. When *S* indicated he was ready for the experiment, he was asked to sit on a designated chair and the following instructions were given him:

> This is not a test. This is only a study of what the eye selects to see. This will be a very easy and simple experiment. I shall project some pictures on that wall and I will just ask you to look at that part (*E* points to screen) all the time and to keep on looking until I tell you the experiment is over. Then after all the pictures have been projected, I'll just ask you some questions. O. K.?

After these instructions, the conditioned stimulus to be used was desensitized by presenting it five times alone and without being paired with a UCS. Each CS presentation during desensitization was of 15 seconds duration and a 5-, 10-, or 15-second interval between desensitization trials was randomly assigned.

[1] The number of blinks to the black and white landscape picture was not significantly different from the number of blinks to any of the colored ones. This suggests that the obtained differences between blinks to sexual and landscape UCS were not to color only.

Conditioning was begun in the sixth trial. From this trial on, a UCS was always delivered 2 seconds after the termination of the CS. This was done for 10 consecutive conditioning trials, in each of which the duration of stimulus presentation was 15 seconds for the CS (just as during the desensitization phase of the experiment) and 30 seconds for the UCS. Timing was accomplished on a watch with a sweep-second hand. A 5-, 10-, or 15-second interval was randomly assigned between conditioning trials. The CS and UCS used for any given *S* depended on the group to which he was assigned.

The order of presenting the five sexual UCS to the Vis-sex and Aud-sex groups was the same. Similarly, the order of presenting the five landscape UCS to the Vis-land and Aud-land groups was the same. Since there were 10 conditioning trials and there were only five UCS of a type, *E* re-presented the five UCS in the last five conditioning trials in the same order in which they were presented in the first five conditioning trials.

Recording of Blinks

The frequency of blinking was recorded during each stimulus presentation. Twenty-five (25) records of blinks were thus taken from each *S*, 5 for each trial during desensitization and 10 for each CS and UCS presentation during conditioning.

For 38 *S*s, two experimenters (E_1 and E_n) simultaneously but independently observed *S* and recorded on a form each blink they saw him make; for the remaining 2 *S*s (one *S* in Aud-land and another *S* in Vis-land, only E_2 recorded his observations. E_1 was the senior author. E_n was an assistant who did not know the purpose of the study and therefore would not likely know the expected relationship between the experimental conditions and the measures of behavior being taken. E_1 observed from a distance of about 4 feet at about 30° laterally from *S*'s right and E_n from about 5 feet at about 45° from *S*'s left. Two persons were used as E_2 (E_{2a} and E_{2b}).

To check the reliability of the observers, blink counts made by E_{2a} and E_{2b} on a random sample of 50 CS presentations and on another random sample of 50 UCS presentations were correlated with those made by E_1. E_1 correlated .81 and .69 with E_{2a} and E_{2b} respectively, on the sampled 15-second CS presentations and .70 and .66, respectively, on the sampled 30-second UCS presentations.

Although these correlations were not very high, the means of blinks counted by E_1 for the sampled CS and UCS trials were both significantly fewer than the corresponding counts of either E_{2a} or E_{2b}. It might, therefore, be that E_1 systematically counted less than he should have counted, a likely result of a response to counter probable bias in recording and the fact that, unlike E_n, he was also busy attending to the projection of the stimuli onto the screen. E_1's significantly lower count seems to imply that he would not likely be the source of a recorded increase in blink rates. Hence, it was decided that *S*'s score on any given trial be the average of the two observers' counts on that trial (exceptions were the two *S*s for whom only E_n's observations were available). The resulting averages were then used as the bases for all the statistical computations in the present report.

Predictions

The three hypotheses being tested predict different types of results. If the arousal hypothesis holds, then stimuli which produce the same level of arousal will elicit the same number of blinks regardless of their modality. In this experiment, therefore, this hypothesis predicts that the red color conditioned to the sexual pictures will elicit the same number of blinks as the buzzer conditioned to these pictures.

If the coping hypothesis holds, on the other hand, then increased blink rate will be produced by a visual anxiety-producing stimulus but not by an anxiety-stimulus of another modality. According to this hypothesis, therefore, the red color conditioned to be sexual pictures (assumed to be anxiety-producing) will produce increased blink rate but the non-visual stimulus (buzzer) conditioned to the same pictures will not produce increased blink rate.

The third hypothesis, the arousal + coping hypothesis, assumes that both the arousal hypothesis and the coping hypothesis are partly valid. Since the third hypothesis assumes that arousal per se increases blink rate, it predicts that even an auditory stimulus (buzzer) conditioned to the sexual pictures will elicit more blinks than it did before. This prediction is not shared by the coping hypothesis. However, since this hypothesis also assumes that stimulation by a visual anxiety-stimulus can be reduced by blinking, it also predicts that a visual CS (red color) conditioned to the sex pictures will elicit more blinks than an auditory CS (buzzer) conditioned to an equal degree to the same stimulus. This prediction is not shared by the arousal hypothesis.

All three hypotheses predict that sex pictures will elicit more blinks than landscape pictures and that a CS conditioned to the former type of pictures will elicit more blinks than a CS conditioned to the latter type.

RESULTS

Baseline of Blink Rate

Each *S*'s baseline was taken as his mean number of blinks during the five CS presentations during desensitization. The average blinks in the Vis-sex, Aud-sex, Vis-land, and Aud-land groups were 1.99, 2.54, 3.45, and 2.18, respectively. A two-way analysis of variance of the main design shows that at the

beginning of the experiment (*a*) the blink rates of the groups exposed to the sex and the landscape UCS were not significantly different from each other ($F<1.00$) and (*b*) the blink-eliciting power of the visual CS was not significantly different for that of the auditory CS ($F<1.00$).

Blinking to the UCS

The mean number of blinks across 10 UCS presentations of the Vis-sex, Aud-sex, Vis-land, and Aud-land groups were 13.68, 12.40, 6.45, and 7.77 blinks, respectively. Analysis of variance of the number of blinks to the UCS showed that variance associated with the UCS was significant ($F = 9.59$, $df = 1/36$, $p < .005$). The sexual UCS elicited significantly more blinks than the landscape UCS and this difference is independent of the sense modality of the preceding CS.

The average number of blinks elicited during each UCS trial by the sex and landscape stimuli is shown in Figure 1. The curves suggest that the

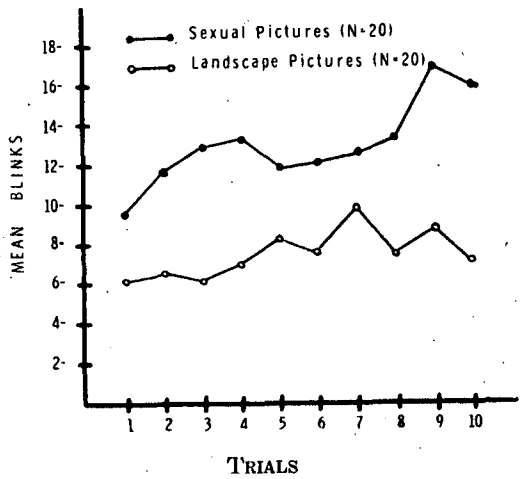

FIGURE 1. MEAN NUMBER OF BLINKS TO EACH UCS PRESENTATION

sexual UCS elicited more blinks with continued presentations, this being more marked than for the landscape UCS. An analysis of the trends of the means over the five successive pictures used in conditioning showed a UCS x Order-of-Pictures interaction that approaches significance ($F = 2.04$, $df = 4/152$, $p < .10$), indicating a slight tendency for the sexual pictures to elicit more blinks with more trials. This analysis was based on the mean blinks on each of the five UCS pictures instead of the means over the 10 UCS trials because, were the latter used, the presumed cumulative effect of presenting one stimulus after another would be confounded by an effect due to repeating the series of five pictures used in the first five trials.

Effects of Conditioning

Table 1 gives the mean increases ($\triangle M$) in the number of blinks to the CS as a result of conditioning. Each *S*'s $\triangle$ was taken by subtracting his mean number of blinks during desensitization from his mean number of blinks during conditioning. It was found that *S*s blinked significantly more to a CS after it was paired with the sexual pictures ($t = 5.85$, $p < .001$). However, they also blinked significantly more to a CS after it was paired with

TABLE 1

MEAN INCREASE IN NUMBER OF BLINKS TO THE CS ($\triangle M$) FROM DESENSITIZATION TO CONDITIONING TRIALS

Groups	$\triangle M$	s$\triangle M$	t	p
Vis-sex	6.59	1.66	3.98	.002
Aud-sex	4.37	.82	5.35	<.001
Vis-land	1.11	.48	2.28	.025
Aud-land	1.02	.48	2.13	<.040
All sex *S*s	5.48	.94	5.85	<.001
All landscape *S*s	1.02	.32	3.21	<.002

the landscape pictures ($t = 3.21$, $p < .002$). Thus, there was conditioning for both sexual and landscape UCS.

Using a logarithmic transformation[2] of each *S*'s $\triangle$, an analysis of variance showed significantly more conditioning with the sexual UCS than with the landscape UCS ($F = 24.76$, $df = 1/36$, $p < .001$).

Conditioning to the Auditory Sex-Associated CS

Contrary to a very specific prediction of the coping hypothesis (namely, that there would be no conditioning in the auditory CS paired with the sex UCS), Table 1 shows that conditioning effects in fact occurred in the Aud-sex group

[2] Logarithmic transformation was used to homogenize within—group variances because of the tendency of the cells' standard deviations to increase with the magnitude of the cell means.

($t = 5.35$, $p < .001$). Although significant conditioning also occurred when the auditory CS was paired with the landscape pictures (Aud-land group), significantly more conditioning took place when the auditory CS was paired with the sexual pictures ($t = 4.50$, $p < .001$).

Visual vs. Auditory CS Conditioned to the Sex UCS

Although the analysis of variance showed that the only significant conditioning effects were due to the kind of UCS used, a comparison of the Δ means in the Vis-sex and Aud-sex groups was still made because it was called for in this experiment. Using a pooled error term, the t test showed that, contrary to a prediction of the arousad + coping hypothesis, the sex-conditioned visual CS did not elicit significantly more blinks than the sex-conditioned auditory CS ($t = 1.27$).

However, when the learning curves were drawn, the sex-conditioned visual CS seemed to show a faster rate of conditioning than the sex-conditioned auditory CS (Figure 2). Corresponding data for the Vis-land and Aud-land

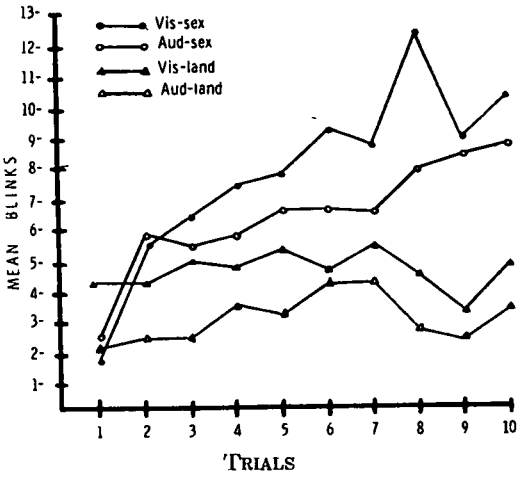

FIGURE 2. MEAN NUMBER OF BLINKS TO EACH CS PRESENTATION DURING CONDITIONING.

groups are included in this figure although they are not used in this analysis. The trends of the means over the 10 conditioning trials for the *Vis-sex* and the *Aud-sex* groups show a Modality-of-CS x Trials interaction that approaches significance ($F = 1.80$, $df = 9/162$, $p < .10$.), signifying a slight tendency for the sex-conditioned visual CS to elicit more blinks with more trials than the sex-conditioned auditory CS.

DISCUSSION

Assuming that the sexual pictures produced more arousal than the landscape pictures did, the most plausible explanation for the findings is that the increased arousal produced by the sexual pictures is the critical factor responsible for producing an increase in blink rate (arousal hypothesis). All predictions derived from this hypothesis were borne out by the results. On the other hand, one prediction of the coping hypothesis and one of the arousal + coping hypothesis were not borne out. The coping hypothesis predicted that there would be no conditioning of the blinking response to the buzzer when paired with the sexual pictures; the results show that there was conditioning. The arousal + coping hypothesis predicted that the sex-conditioned visual CS would elicit more blinks than the sex-conditioned auditory CS; the results show that, while the difference was in the predicted direction, it did not reach significance. The incidental finding that the landscape pictures were also effective UCS in conditioning the blinking response can also be explained in terms of the arousal hypothesis. Such stimuli may not be intrinsically arousing but they probably also have arousal effects when they are presented to college volunteers in a psychological experiment.

Although the results support the arousal hypothesis, the hypothesis that a visual anxiety-producing stimulus will lead to increased blink rate precisely because it has visual components that can be avoided by eye closure (arousal + coping hypothesis) has not been completely ruled out. First of all, there is the possibility that no difference was found between the visual and the auditory sex-conditioned CSs because the blink responses were taken only during the first 10 acquisition trials whereas more than 10 such trials might be needed to bring the blinking rates to these CSs to their respective asymptotes.

The learning curves of the Vis-sex and the Aud-sex groups in Figure 2 in fact suggest that the asymptotes had not been reached by the tenth acquisition trial. Both curves, but specially that for the Vis-sex condition, were obviously still rising. In spite of only 10 acquisition trials and although the Vis-sex and the Aud-sex groups started on the same level, the sex-conditioned visual CS already tended to elicit more blinks as the experiment proceeded ($p < .10$). This suggests that it might be premature to conclude that visual and non-visual sex-conditioned stimuli have the same effects on blinking. The arousal + coping hypothesis is not ruled out by the present results. More conditioning trials should be used in future replication of this experiment in order to provide a more rigorous test of this hypothesis.

Another possible reason why the visual sex-conditioned stimulus was not more effective than the auditory sex-conditioned stimulus is that an auditory stimulus might be easier to condition than a visual stimulus, as Pavlov believed (1960). Pavlov found that a variety of auditory CSs elicited more conditioned responses than a visual CS (intermittent flashing of light) and that the auditory component of a compound stimulus obscured the effect of the visual component. However, his experiments failed to establish that an auditory stimulus is easier to condition than a visual stimulus since his experimental controls were inadequate and since he actually failed to get more conditioned responses with some of his auditory CSs consistently.

In any case, the conditionability of visual and auditory stimuli is crucial to the interpretation of the present research. If auditory stimuli are in fact easier to condition than visual stimuli, as Pavlov believed, the absence of a difference in the blinks to the CS between the Vis-sex and the Aud-sex groups might only be due to a difference in the rate of conditionability of the stimuli rather than due to the nature of the mechanism relating visual sexual stimuli and blinking. Therefore, to test more adequately the hypotheses in this study, it would be necessary to equate empirically the conditionability of the CSs to be used.

REFERENCES

DOEHRING, D. G. Relations between manifest auxiety and rate of eyeblink in a stress situation. *USN School for Aviation Medical Research Report*, 1957, Project NM 13-1-99, Subtask 1, Report 6.

FRANKS, C. M. Effects of amobarbital sodium and desamphetanine sulfate on the conditioning of eye blink response. *Journal of Comparative and Physiological Psychology*, 1958, **51**, 220-222.

KANFER, F. Verbal rate, eyeblink, and content in structured psychiatric interview. *Journal of Abnormal and Social Psychology*, 1960, **61**, 341-348.

KING, D. & MICHELS, K. Muscular tension and the human blink rate. *Journal of Experimental Psychology*, 1957, **53**, 113-116.

LINDSLEY, D. Emotions. In S. S. Stevens (Ed.), *Handbook of experimental psychology*. New York: John Wiley & Sons, 1951, 473-516.

MARTIN, I. Blink rate and muscle tension. *Journal of Mental Science*, 1958, **104**, 123-132.

MEYER, D. R., BAHRICK, H. P., & FITTS, P. M. Incentive anxiety and the human blink rate. *Journal of Experimental Psychology*, 1953, **45**, 183-187.

PAVLOV, I. *Conditioned reflexes*. New York: Dover Publications Inc., 1960.

PEAK, H. Dr. Courts on the influence of muscular tension on the lid reflex. *Journal of Experimental Psychology*, 1942, **30**, 515-517.

RUNQUIST, W. N. & ROSS, D. Relations between physiological measure of emotionality and performance in eyelid conditioning. *Journal of Experimental Psychology*, 1959, **57**, 329-332.

SPENCE, K. W. Relations of electric shock and anxiety to level of performance in eyelid conditioning. *Journal of Experimental Psychology*, 1954, **48**, 404-408.