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EPINEPHRINE, CHLORPROMAZINE, AND AMUSEMENT[1]

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In their study of cognitive and physiological determinants of emotional states, Schachter and Singer (1962) have demonstrated that cognitive processes play a major role in the development of emotional states. Given a common state of physiological arousal, subjects can be readily induced into states of euphoria or of anger by means of cognitive manipulations. To what extent the state of physiological arousal is a necessary component of an emotional experience is not, however, completely clear in that study.

The technique employed by Schachter and Singer (1962) to produce a state of physiological arousal was simply the injection of the sympathomimetic amine, epinephrine. With slight exceptions, this agent provokes a pattern of physiological activation which is a virtual replica of the state produced by active discharge of the sympathetic nervous system. In experimental situations designed to make subjects euphoric, those subjects who received injections of epinephrine were, on a variety of indices, somewhat more euphoric than subjects who received a placebo injection. Similarly, in situations designed to make subjects angry and irritated, those who received epinephrine were somewhat angrier than subjects who received placebo. In both sets of conditions, however, these differences between epinephrine and placebo subjects were significant, at best, at borderline levels of statistical significance.

Assuming, for the moment, that physiological arousal is a necessary component of emotional states, one of the factors that might account for this failure to find larger differences between epinephrine and placebo subjects seems reasonably apparent. The experimental situations employed were fairly effective. The injection of placebo does not, of course, prevent the subject from self-arousal of the sympathetic system, and indeed there is considerable evidence (Woodworth & Schlosberg, 1958) that the arousal of an emotional state is accompanied by general excitation of the sympathetic nervous system.

A test of the proposition at stake, then, would require comparison of subjects who have received injections of epinephrine with subjects who, to some extent, are rendered incapable of self-activation of the sympathetic nervous system. Thanks to a class of drugs known generally as autonomic blocking agents, such blockade is, to some degree, possible. If the proposition that a state of sympathetic discharge is a necessary component of an emotional experience is correct, it should be anticipated that whatever emotional state is experimentally manipulated, it should be most intensely experienced by subjects who have received epinephrine, next by placebo subjects, and least of all by subjects who have received injections of an autonomic blocking agent.

PROCEDURE

In order to conceal the purposes of the study and the nature of the injection, the experiment was cast in the framework of a study of the effects of vitamins on vision. As soon as a subject arrived, he was taken to a private room and told by the experimenter:

> I've asked you to come today to take part in an experiment concerning the effects of vitamins on the visual processes. We know a great deal about vision, but only night vision has been studied in relation to nutrition. Our experiment is concerned with the effects of suproxin on vision. Suproxin is a high concentrate vitamin C derivative. If you agree to take part in the experiment, we will give you an injection of suproxin and then subject your retina to about 15 minutes of

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continuous black and white stimulation. This is simpler than it sounds; we'll just have you watch a black and white movie. After the movie, we'll give you a series of visual tests.

The injection itself is harmless and will be administered by our staff doctor. It may sting a little at first, as most injections do, but after this you will feel nothing and will have no side effects. We know that some people dislike getting injections, and if you take part in the experiment, we want it to be your own decision. Would you like to? [All subjects agreed to take part.]

This much said, the experimenter gave the subject a test of visual acuity and of color vision, took the subject's pulse and left the room. Shortly thereafter, the doctor arrived, gave the subject a quick ophthalmoscopic examination, then gave him an injection and informed him that the experimenter would be back for him shortly "in order to take you and some other subjects who have also received shots of suproxin into the projection room."

Injections

There were three forms of suproxin administered—epinephrine, placebo, and chlorpromazine.

1. Epinephrine: Subjects in this condition received a subcutaneous injection of ½ cubic centimeter of a 1:1000 solution of Winthrop Laboratory's Suprarenin.

2. Placebo: Subjects in this condition received a subcutaneous injection of ½ cubic centimeter of saline solution.

3. Chlorpromazine: Subjects in this condition received an intramuscular injection of a solution consisting of 1 cubic centimeter (25 milligrams) of Smith, Kline, and French Thorazine and 1 cubic centimeter of saline solution.

The choice of chlorpromazine as a blocking agent was dictated by considerations of safety, ease of administration, and known duration of effect. Ideally, one would have wished for a blocking agent whose mechanism and effect was precisely and solely the reverse of that of epinephrine—a peripherally acting agent which would prevent the excitation of sympathetically innervated structures. Though it is certainly possible to approach this ideal more closely with agents other than chlorpromazine, such drugs tend to be dangerous, or difficult to administer, or of short duration.

Chlorpromazine is known to act as a sympathetic depressant. It has a moderate hypotensive effect, with a slight compensatory increase in heart rate. It has mild adrenergic blocking activity for it reverses the pressor effects of small doses of epinephrine and depresses responses of the nictitating membrane to preganglionic stimulation. Killam (1959) summarizes what is known and supposed about the mechanism of action of chlorpromazine as follows:

> Autonomic effects in general may be attributed to a mild peripheral adrenergic blocking activity and probably to central depression of sympathetic centers, possibly in the hypothalamus (p. 27).

Popularly, of course, the compound is known as a "tranquilizer."

It is known that chlorpromazine has effects other than the sympatholytic effect of interest to us. For purposes of experimental purity this is unfortunate but inevitable in this sort of research. It is clear, however, that the three conditions do differ in the degree of manipulated sympathetic activation.

Subjects

Subjects were male college students taking classes in introductory psychology at the University of Minnesota. Some 90% of the students in these classes volunteer for a subject pool, for they receive two extra points on their final exam for every hour that they serve as experimental subjects. The records of all potential subjects were cleared with the Student Health Service in order to insure that no harmful effects would result from injections of either epinephrine or chlorpromazine.

Each experimental group was made up of three subjects—one from each of the injection conditions. Their appointments were staggered slightly so as to insure sufficient time for the particular drug to be absorbed. Thus, the chlorpromazine subject received his injection about 15 minutes before the movie began. Pretests had revealed that, with this dosage and mode of administration, about this time interval was required for the onset of sympathetic effects. Placebo subjects were injected 5–10 minutes before onset of the movie. Epinephrine subjects were injected immediately before the movie so that at most 3–4 minutes went by between the time they were injected and the beginning of the film. Pretests had shown that the effects of epinephrine began within 3–5 minutes of injection. It was, of course, basic to the experimental design that these effects begin only after the movie had started.

Film

Rather than the more complicated devices employed in the Schachter and Singer (1962) experiment, an emotion inducing film was used as a means of manipulating the cognitive component of emotional states. In deciding on the type of film, two extremes seemed possible—a horror, fright, or anxiety provoking film or a comic, amusement provoking film. Since it is a common stereotype that adrenalin makes one nervous and that the tranquilizer, chlorpromazine, makes one tranquil and mildly euphoric, the predicted pattern of results with a horror film would be subject to alternative interpretation. It was deliberately decided, then, to use a comedy. If our hypothesis is correct, it should be anticipated that epinephrine subjects would find the film somewhat funnier than placebo subjects who, in turn, would be more amused than chlorpromazine subjects.

The film chosen was a 14-minute 40-second

excerpt from a Jack Carson movie called *The Good Humor Man*. This excerpt is a self-contained, comprehensible episode involving a slapstick chase scene.

The projection room was deliberately arranged so that the subjects could neither see nor hear one another. Facing the screen were three theatre-type seats separated from one another by large, heavy partitions. In a further attempt to maintain the independence of the subjects, the sound volume of the projector was turned up so as to mask any sounds made by the subjects.

Measurement

Observation. During the showing of the movie an observer, who had been introduced as an assistant who would help administer the visual tests, systematically scanned the subjects and recorded their reactions to the film. He observed each subject once every 10 seconds, so that over the course of the film 88 units of each subject's behavior were categorized. The observer simply recorded each subject's reaction to the film according to the following scheme.

1. Neutral: Straight-faced watching of film with no indication of amusement.
2. Smile.
3. Grin: A smile with teeth showing.
4. Laugh: A smile or grin accompanied by bodily movements usually associated with laughter, e.g., shaking shoulders, moving head, etc.
5. Big laugh: Belly laugh—a laugh accompanied by violent body movement such as doubling up, throwing up hands, etc.

In a minute by minute comparison, two independent observers agreed in their categorization of 90% of the 528 units recorded in six different reliability trials. Lumping Categories 2 through 5 together, the two observers agreed on 93% of the units jointly recorded.

The observer, of course, never knew which subject had received which injection.

Evaluation of the film. The moment the movie ended the lights were turned on and the experimenter proceeded:

> Before beginning the visual tests, we want your eyes to recover somewhat from the constant stimulation they've just received. The rate of neuro-limnal recovery under conditions of perfectly normal lighting and coloring is of major interest to us. The recovery will have begun in about 12 minutes, and after that time, Dr. Mena will give you the more precise visual examination.
>
> In the meantime, I'd like to ask your help. As I told you, we need about 15 minutes of retinal stimulation, for which purpose we use a movie. Obviously, it doesn't matter at all to us which movie we use, so long as it is black and white. We can use one movie just as easily as another, but we do want to use a film that you like. I'm sure that you can see the necessity of using a film which our subjects will like. Of course, the only way to find out if you like it is to ask you. We're just beginning this experiment and will have many more subjects like you. Since you are one of the first groups, it will be a big help if you will give us your personal reactions to the film. If you like it, we'll keep it and if you don't like it, we can just as easily get another. If you'll use these mimeographed questionnaires, it will make it easier for us.

The experimenter then handed out a questionnaire whose chief items, for present purposes, were the following:

1. How funny did you find this film?

Extremely dull (1)	Very dull (2)	Somewhat dull (3)	Mildly funny (4)	Very funny (5)	Extremely funny (6)

2. All in all, how much did you enjoy this film?

Disliked it intensely (1)	Disliked it very much (2)	Disliked it a little (3)	Enjoyed it a little (4)	Enjoyed it very much (5)	Enjoyed it enormously (6)

The figures in brackets represent the values used in computing the means presented in later tables.

3. Would you recommend that we should show this particular film to our future subjects?

(3) —— strongly recommend keeping this film.
(2) —— moderately recommend keeping this film.
(1) —— recommend you get another film.

Physical condition. In order to check on whether or not the drugs were having the desired effect on the subject's internal state, after the subjects had evaluated the film, the experimenter continued with the following spiel:

> Before we begin the eye tests, we need a bit more information about you. Earlier studies on the visual processes have shown that a person's physical and emotional states influence the visual process. Because of this it is necessary to know how you feel physically and emotionally at this time. We know, for example, that certain states such as hunger, or fatigue, or boredom, do have a noticeable effect on these processes. Naturally, we have

to know these things about you in order to interpret the results we will obtain from each of you, and the only way we can find out such things is to ask you.

A bit more on this line and the experimenter then handed round a questionnaire whose chief items were the following:

A. For evaluation of the effects of epinephrine:

1. Have you experienced any palpitation (consciousness of your own heartbeat) during the last half hour or so?

Not at all	A slight amount	A moderate amount	An intense amount
(0)	(1)	(2)	(3)

2. Have you felt any tremor (involuntary shaking of the hands, arms, or legs) during the last half hour or so?

Not at all	A slight amount	A moderate amount	An intense amount
(0)	(1)	(2)	(3)

B. For evaluation of the effects of chlorpromazine: Any direct measure (such as blood pressure) of the effects of the chlorpromazine injection on each subject was pretty much out of the question owing to limitations of time and personnel. It is known, however, that chlorpromazine does have somewhat of a dehydrating effect. As some indication that within the experimental time interval the chlorpromazine had been absorbed, the following questions were asked:

1. Does your mouth feel dry?

Not at all dry	A little dry	Somewhat dry	Very dry	Extremely dry
(0)	(1)	(2)	(3)	(4)

2. Does your nose feel stuffy?

Not at all stuffy	A little stuffy	Somewhat stuffy	Very stuffy	Extremely stuffy
(0)	(1)	(2)	(3)	(4)

Film Detail Questionnaire

Since it is known that chlorpromazine produces drowsiness, it seemed possible that experimental differences might be due to the fact that subjects had simply not watched the film. In order to check on this, a 10-item multiple-choice test concerned with small details of the film was administered. This test was rationalized to the subjects as a means of measuring the amount of time they had watched the movie, therefore, the amount of retinal stimulation received. Presumably the more they had watched the screen the more details they would remember.

Following this test the purpose of the experiment was disclosed, the deception was explained in detail, and the subjects were sworn to secrecy. Finally, the subjects filled out a brief questionnaire concerned with their past experiences with adrenalin and tranquilizers and with their suspicion, if any, of the experiment.

RESULTS

Physical Effects of the Injections

Evaluating, first, the effects of the injections, it can be seen in Table 1 that there are good indications that epinephrine has produced the required pattern of sympathetic activation. On self-reports of palpitation and tremor, subjects in the epinephrine condition report considerably more disturbance than subjects in either the placebo or chlorpromazine condition. On pulse measures, epinephrine subjects increase significantly when compared with placebo subjects. A subject's pulse was measured immediately before the injection and shortly after the movie. Pulse increased for some 63% of the epinephrine subjects and for 28% of the placebo subjects.

As to the effects of chlorpromazine, it can be seen in Table 1 that subjects in this condition report considerably more nose stuffiness and mouth dryness than subjects in the placebo or epinephrine conditions. This may be taken as indirect evidence that within the time limits of the experiment, chlorpromazine was taking effect. The increase in pulse rate (61% of chlorpromazine subjects increase) is a standard reaction to chlorpromazine and appears to be compensatory for the decreased blood pressure caused by this agent. It should be noted, however, that unlike epinephrine subjects the chlorpromazine subjects were unaware of this increased heart rate, for on the palpitation scale they are quite similar to subjects in the placebo condition.

Six subjects (included in Table 1) in the epinephrine condition were unaffected by the injection. They reported virtually no palpitation or tremor and their pulses were not markedly affected. Since for these subjects the necessary experimental state was not produced, they are not included in any further presentation of data.

TABLE 1

PHYSICAL EFFECTS OF THE INJECTIONS

Condition	N	Pulse		Palpitation	Tremor	Mouth dry	Nose stuffy
		Pre-injection	Post-injection				
Epinephrine	44	81.4	87.3	2.00	1.86	0.72	0.39
Placebo	42	78.7	75.5	0.30	0.12	0.30	0.68
Chlorpromazine	46	81.4	86.0	0.52	0.26	1.12	2.16
p value							
Epinephrine versus Placebo				<.001	<.001	<.01	*ns*
Epinephrine versus Chlorpromazine				<.001	<.001	.07	<.001
Placebo versus Chlorpromazine				*ns*	*ns*	<.001	<.001

Effects of Drowsiness

It is known that chlorpromazine produces drowsiness, a state which in this experimental context might mean that the subjects paid less attention to the movie. Differences between chlorpromazine subjects and those in the other two conditions in reaction to the film could then be due to differential attention rather than to the factors presumably being tested. In order to check for this, the film details questionnaire, described earlier, was administered shortly after the movie. The results of this questionnaire are presented in Table 2 where the figures represent the mean number of correct answers in each of the conditions. It can be immediately seen that the three conditions are virtually identical. None of these figures is significantly different from one another and any differences in reaction to the film cannot, then, be attributed to differences in attention.

Overt Reactions to the Film

The observation record provides a continuous record of each subject's reaction to the film. As an overall index of amusement, the number of units in which a subject's behavior was recorded in the categories Smile, Grin, Laugh, and Big Laugh are summed together. The means of this amusement index are presented in Table 3. The larger the figure, the more amusement was manifest. Differences are in the anticipated direction. Epinephrine subjects gave indications of greater amusement than did placebo subjects who, in turn, were more amused than chlorpromazine subjects. The *U* test was used to test for significance of differences since the variance in the epinephrine condition was significantly greater than that in either the placebo or chlorpromazine condition. The means of both the epinephrine and the placebo conditions are significantly greater than the mean of the chlorpromazine condition.

Though the trend is clearly in the predicted direction, epinephrine and placebo subjects do not differ significantly in this overall index. The difference between these two groups, however, becomes apparent when we examine strong reactions to the film. Considering just the categories Laugh and Big Laugh, as indicating strong reactions to the film, we find an average of 4.84 such units among the epinephrine subjects and of only 1.83 such units among placebo subjects. This difference is significant at better than the .05 level of significance. Epinephrine subjects tend to be openly amused at the film, placebo subjects to be quietly amused. Some 16% of epinephrine subjects reacted at some point with belly laughs while not a single placebo subject did so. It should be noted that this is much the state of affairs one would expect from the disguised injection of epinephrine

TABLE 2

MEAN NUMBER OF CORRECT ANSWERS ON THE FILM DETAILS QUESTIONNAIRE

Condition	N[a]	Mean number correct
Epinephrine	38	9.29
Placebo	41	9.15
Chlorpromazine	45	9.38

[a] One subject in the placebo and one in the chlorpromazine condition did not answer this questionnaire.

TABLE 3

THE EFFECTS OF EPINEPHRINE, PLACEBO, AND CHLORPROMAZINE ON AMUSEMENT

Condition	N	Mean amusement index
Epinephrine	38	17.79
Placebo	42	14.31
Chlorpromazine	46	10.41
p value		
Epinephrine versus Placebo		*ns*
Epinephrine versus Chlorpromazine		.01
Placebo versus Chlorpromazine		.05

—a manipulation which, as Schachter and Singer (1962) have suggested, creates a bodily state "in search of" an appropriate cognition. Certainly laughter can be considered a more appropriate accompaniment to the state of sympathetic arousal than can quietly smiling.

It would appear, then, that degree of overt amusement is directly related to the degree of manipulated sympathetic activation.

Evaluation of the Film

Responses to the postmovie questionnaire in which the subjects evaluated the film are presented in Table 4. The column heading Funny includes answers to the questions "How funny did you find this film?"; the heading Enjoy includes answers to the question "All in all, how much did you enjoy the film?"; and the heading Recommend presents answers to the question, "Would you recommend that we show this particular film to our future subjects?"

For all three questions, the trend is in precisely the same direction, epinephrine subjects like the film slightly more than do placebo subjects who like it more than do chlorpromazine subjects. On all questions, however, the differences between conditions are small and, at best, significant at only borderline probability levels.

TABLE 4

EVALUATION OF THE FILM

Condition	N	Funny	Enjoy	Recommend
Epinephrine	38	4.09	3.99	2.04
Placebo	42	4.01	3.95	1.93
Chlorpromazine	46	3.85	3.85	1.85

The fact that between-condition differences are large on the behavioral measure and quite small on the attitude scales administered after the film is an intriguing one. The most reasonable explanation comes from the subjects themselves. For example, after the experiment an epinephrine subject said,

> I just couldn't understand why I was laughing during the movie. Usually, I hate Jack Carson and this kind of nonsense and that's the way I checked the scales.

For this subject, then, his long time preferences determined his answers to the questions whereas his immediate bodily state seems to have determined his reaction while watching the movie. If this is widespread, it should be anticipated that there will be relatively little relationship between past preferences and overt behavior in the epinephrine condition and a considerably stronger relationship in the placebo condition. For chlorpromazine, too, one should anticipate slight relationship between past preferences and behavior. No matter what the long time feeling about such films the immediate reaction to the movie should be restrained owing to lack of sympathetic activity. However, as pointed out earlier, chlorpromazine is a weak blocker and, most reasonably, one should expect a somewhat weaker relationship with this drug than with the placebo.

TABLE 5

RELATIONSHIP BETWEEN LAUGHTER AND PREVIOUS ATTITUDE TOWARD SLAPSTICK FILMS

Attitude to slapstick	Epinephrine		Placebo		Chlorpromazine	
	N[a]	Laugh index	N[a]	Laugh index	N[a]	Laugh index
Dislike	25	15.12	29	10.52	29	7.34
Like	12	21.75	12	23.25	16	14.69
t		1.18		3.40		2.04
p		*ns*		.001		.05

[a] One subject in each condition did not answer the question concerned with general attitude to such films.

As a measure of general attitude toward the sort of film shown, at the time that they were evaluating the film the subjects also answered the question, "In general, how well

do you like this kind of slapstick film?" by checking one of five points along a scale ranging from "Slapstick is the kind of film I like least" to "Slapstick is my favorite kind of film." The relationship of attitude to this sort of film to reactions to this particular film in each of the drug conditions is presented in Table 5. The subjects are divided into two groups—those who dislike slapstick and those who like it as much or more than they do other kinds of films. The entries in the table are the mean laugh indices for each of the breakdowns.

It is evident that there is a very strong relationship between general attitude toward such films and laughter in the placebo condition, a considerably weaker relationship in the chlorpromazine condition, and the weakest relationship of all in the epinephrine condition.

DISCUSSION

The overall pattern of experimental results of this study and the Schachter and Singer (1962) experiment gives consistent support to a general formulation of emotion as a function of a state of physiological arousal and of an appropriate cognition. The fact that the epinephrine-placebo difference in this study, though in the proper direction, was not larger must be considered within the context of other relevant studies. As noted earlier, Schachter and Singer obtained similar results in their tests of the effects of epinephrine on euphoria and anger. In their attempt to account for their results, they identify two factors which could attenuate the differences between subjects injected with epinephrine and those receiving a placebo. One of these factors—the self-arousal of placebo subjects—has been tested in the present study. The second factor they identify is what they call the "self-informing" tendency of epinephrine subjects. To understand this notion will require a brief review of the formulation proposed by Schachter (1959) who has suggested that an emotion be considered a joint function of a state of physiological arousal and of a cognition appropriate to this state. Given a state of physiological arousal for which an individual has no immediate explanation, he will "label" this state and describe his feelings in terms of the cognitions available to him. Given a state of arousal for which an individual has a completely appropriate explanation (e.g., "I feel this way because I have just received an injection of adrenalin.") no evaluative needs will arise and he is unlikely to label his feelings in terms of the alternative cognitions available. These propositions are strongly supported in the Schachter-Singer study where subjects, injected with epinephrine and told precisely what they would feel and why, were considerably less emotional (either angry or euphoric) than were subjects injected with epinephrine and told simply that they would experience no side effects. Inevitably, however, some of the subjects in this latter condition were self-informed; that is, on their own, they attributed their states of arousal to the injection. Consistent with expectations, such "self-informed" subjects proved to be considerably less emotional than subjects in the same condition who were not self-informed. To the extent, however, that this self-informing tendency operates, the differences between placebo and epinephrine conditions will, then, be attenuated. There is little question that such a tendency also operated in the present study and we suggest, of course, that this is one of the chief factors limiting the magnitude of differences between the epinephrine and the placebo conditions. Such a self-informing tendency will probably operate in any experiment on humans which employs an injection technique.

In order to make the epinephrine-placebo comparison under conditions which would rule out the operation of any "self-informing" tendency, two experiments were conducted on rats. In one of these, Singer (1961) demonstrated that under fear inducing conditions, rats injected with epinephrine were considerably more frightened than rats injected with a placebo. In another study, Latané and Schachter (1962) demonstrated that rats injected with epinephrine were notably more capable of avoidance learning than were rats injected with a placebo. Viewed together, this series of experiments on rats and humans give clear support to the hypothesis that "emotionality" is, in part, a function of degree of sympathetic excitation.

The identification of the "self-informing" tendency does permit us to consider one alternative interpretation of the results of the experiment presented in this paper. One might consider that the effects of the several injections have been to vary "level of activation" in the sense employed by Lindsley (1951) and Woodworth and Schlosberg (1958). This would imply that no matter what the state or activity, epinephrine subjects would react more extremely than either placebo or chlorpromazine subjects. If correct, this would negate the cognitive component of this formulation of emotion. It must be remembered, however, that this experiment was planned hand in hand with the Schachter and Singer (1962) study. In this prior study the "epinephrine informed" conditions were deliberately built into the experiment to test for this possibility. Subjects who were injected with epinephrine and told precisely what they would feel and why did not "catch" the induced emotional state at all. It seems safe to generalize from these results to the present study and conclude that the level of activation notion alone cannot explain the results of these two studies.

SUMMARY

An experiment is described which was designed to test the proposition that "emotionality" is, in part, a function of the degree of excitation of the sympathetic nervous system. The degree of sympathetic activation was manipulated by injections of (*a*) the sympathomimetic agent—epinephrine, (*b*) a placebo, and (*c*) the sympatholytic drug—chlorpromazine. The effects of these drugs on amusement were tested by exposing subjects to a slapstick film. Epinephrine subjects were more amused than were placebo subjects who, in turn, were more amused than chlorpromazine subjects.

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