NON-SPECIFIC AROUSAL AND SOCIAL FACILITATION

by

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ABSTRACT

The Hull-Spence model of general drive was tested as it applies to social facilitation effects. 60 subjects participated in complex problem-solving tasks in a 2 x 2 experimental design with home-like and laboratory condition as two levels of the Setting factor and alone and audience condition as two levels of the Evaluation factor. The laboratory condition represented a higher state of nonsocial arousal than the home-like condition. The test of drive summation of Hull-Spence theory is derived from the audience conditions. The assumption of drive summation is validated only when performance is better in the home-like setting than in the laboratory. The results revealed non-significant differences in performance in the two different arousing settings. Furthermore in all four conditions no correspondence was found between increase in drive as measured by heartrate and release of the dominant response. Thus the applicability of the Hull-Spence theory of general drive as employed by Zajonc is questioned.

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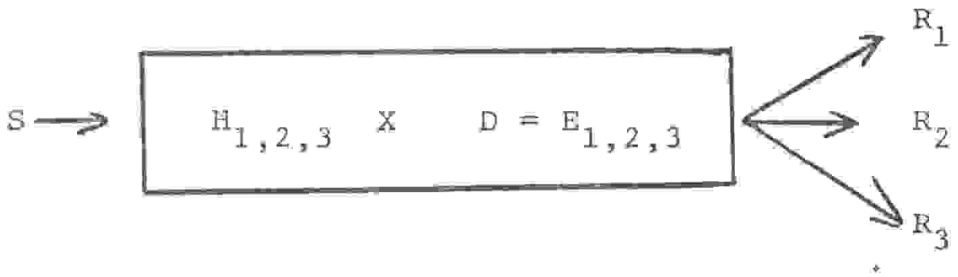
J.G.

Numerous observations and experiments (e.g. Triplett, 1897, Meumann, 1904, Travis, 1925, Dashiell, 1930, Pessin, 1933, Allport, 1924, Wapner and Alper, 1952) have reported various influences the presence of an audience can have on people. Performance on a task in front of an audience was sometimes facilitated, whereas learning of the task was impaired in front of the same audience. Zajonc (1965) was able to reconcile these seemingly contradictory findings by postulating that the presence of an audience increases the general drive level of the subject and facilitates in a given task the release of dominant responses. A dominant response is defined as a response, correct or incorrect, which has the highest probability of being emitted in any given situation. In the learning phase of a novel task, the dominant response is usually the incorrect one, such that more mistakes are made in the presence of an audience which is postulated to give rise to a greater general drive level in the learning subject than when the subject is alone. In the performance phase of the learned task, the dominant response is the correct one, such that performance is enhanced in the audience condition compared to the alone

condition.

In the construction of his theory of social facilitation effects, Zajonc drew heavily on the Hull-Spence general drive theory. The essence of this theory can be reflected in one discursive equation:-



The symbols S and R are observable events, the symbols inside the box are hypothetical constructs which intervene in eliciting the particular response (R_1) having the highest probability of occurrence following stimulus situation (S). The equation within the box predicts the exitatory potential (E_1) for the particular response (R_1) as a multiplicative function of the habit strength (H_1) underlying the response and the general drive level (D). The habit strength is directly dependent on previous learning trials where the particular stimulus situation and the particular response occurred together. All kinds of different needs or environmental conditions are acting on the

organism in the very moment of responding and hence create a very unique situational general drive level. The particular components contributing to any drive level are interchangeable and can be substituted for each other. That means the same overt response R_1 can be evoked under any equally strong general drive level regardless which drive components contributed to its strength.

For any stimulus there exists generally one response which has the highest probability of occurrence. This response is the dominant response. Because of ongoing oscillatary processes, it is sometimes possible that a response is elicited which is placed lower in the response hierarchy of response generalization. With increasing drive however, the excitatory potential for the dominant response becomes relatively much stronger than the competing excitatory potentials, so that its probability of occurrence increases even more.

Extensive research conducted by Spence (1956) has shown arousal to increase the probability of release of the dominant response in subjects' performance on a task. Different arousal groups were groups with high or low scores on Taylor's Manifest Anxiety Scale. High anxiety subjects were

found to learn worse but perform better on a complex task than low anxiety subjects.

Most of the recent social facilitation studies are logical replications of Hull and Spences' original experiments. The presence or nonpresence of an audience was substituted for the original high or low scores of test anxiety as measured by the MAS (Taylor Manifest Anxiety Scale). If an increase in dominant responses was observed, it was generally concluded that an increase in the subject's general drive level accounted for these effects, exactly in line with the Hull-Spence predictions.

In order to prove that the mere presence of an audience increases the general drive level in the subject, Zajonc relied on some physiological animal studies (Mason and Brady, 1957) in which actual changes in the hydrocortisone level in rats were observed to depend on the presence or nonpresence of an audience. Hydrocortisone production is generally found in rats under stress conditions (Thiessen, 1964). This finding is in line with some later studies by Latane (1972) who measured higher heartrate in rats in the presence of other rats than when they were alone. Zajonc

limited his prediction of generalized arousal to the mere presence of an audience as being a sufficient arousal condition. He defined the notion of a 'mere' presence in a recent unpublished paper as such :

> "When we speak of 'mere' presence in the context of social facilitation, we must mean performance effects that are associated with the presence of others can be obtained even though all other factors and processes that one commonly associates with the presence of others are eliminated."

The rapidly growing research literature spawned by this 'mere presence' notion yielded results in line with the Zajonc hypothesis as well as contrary to it.

Zajonc and Sales (1968) tested the mere presence hypothesis by assessing the performance of subjects on a pseudo-recognition task in front of an audience and in an alone condition. In the pseudo-recognition task the subject must identify words which are flashed so rapidly on the screen that correct identification of the words is quite impossible. In previous learning trials certain words had been established as either dominant or

subordinate responses. It was shown that the subjects responded in the audience condition with significantly more dominant responses than in the alone condition. This mere presence of the audience was taken as a condition sufficient to increase the subject's arousal level.

Further support for Zajonc's theory was found in a study using cockroach subjects undertaken by Zajonc, Heingartner, and Herman (1969). These researchers used a method of presenting a merely present audience of cockroaches to performing cockroaches. The cockroach audience was placed in glass compartments along the runways travelled by the performing cockroaches which were thus given a continuous view of the audience. The cockroach subjects in the simple task condition had to run a straight alley away from a light source towards a dark bottle serving as a goal from noxious stimulation. The cockroaches in the complex task condition in front of the ever present audience had to run a cross maze, i.e., to make one turn in order to escape from the aversive light source to the dark bottle. In the simple runway, cockroaches in the audience condition performed better than cockroaches alone. In the complex maze, however, performance

was better in the alone condition. Thus it seemed that the presence of an audience facilitated the simple task, but impaired performance in the complex task.

While the above cited experiments were able to detect social facilitation effects due to the presence of spectators, there is a growing concern over the meaning of 'mere' presence as used by Zajonc. Cottrell, Wack, Sekerak and Rittle (1968) for instance suggested that the traditional audience used in social facilitation experiments may not be 'merely' present. In order to test this idea the quality of presence was manipulated. One audience consisted of spectators as traditionally used, watching quietly the performing subjects. Another audience type consisted of blindfolded confederates who were introduced as subjects for another experiment where they had to be dark-adapted. Both audience conditions were compared to the alone condition. The results were such that no differences were found between the alone and the blindfolded audience conditions, but significantly more dominant responses were evoked in the spectator condition than in the alone or blindfolded conditions. This finding suggested that an audience composed of

spectators was not really passive after all.

Cottrell expanded on the audience notion and proposed that an audience is effective only when it is able to evaluate or reinforce the subject's behavior. For social facilitation effects to occur, the subject must be able to anticipate the negative, neutral, or positive outcome of his performance. Anticipation is based on previous experience in similar conditions. The audience thus becomes a learned source of drive for the subject. Henchy and Glass (1968) took up Cottrell's idea that evaluation is the crucial variable and designed an experiment varying the perceived evaluative characteristics of the audience. Besides an alone condition, three audience conditions were used. In the first condition, the audience consisted of two 'experts' who would evaluate the subjects' performance afterwards. In the second condition the audience was two passive student observers. In the third condition subjects actually worked alone but were told that their performance would be recorded for later evaluation (generalized audience). The results confirmed Cottrell's hypothesis, i.e., significantly more dominant responses were released in the evaluative conditions than in the alone or

passive observer conditions. The most interesting of these results was the significant facilitation effect in the condition where an audience was not present but where the subjects performed under the anticipation of later evaluation of their recorded performance. The fact that this alone condition showed much more facilitation effects than the passive spectator condition gave particularly strong support for Cottrell.

Despite these differences between the Cottrell and Zajonc viewpoints on the meaning of an audience effect on the social facilitation phenomenon, both draw on the Hull-Spence theory of general drive level in their predictions. If an increase in dominant responses was observed, it is generally concluded that an increase in the subject's general drive level accounted for these effects as predicted by the Hull-Spence theory. In fact, very few studies have directly manipulated drive in their study of social facilitation effects. Most of these studies used scores on anxiety tests as indicator of the level of arousal in their experimental subjects. Quarter and Marcus (1971) for example divided their subjects into two experimental groups, one with high scores on the Achievement Anxiety Test (AAS) and the

other with low scores on the same test. They hypothesized along the lines of Zajonc's theory of drive level an interaction of the test anxiety variable with the audience variable where the dependent variable was performance on a digit span test, i.e., the probability of release of the dominant response was expected to be higher for the high anxiety group in front of an audience than for the low anxiety group, while no difference was expected between the two anxiety groups in the alone condition. The audience condition only was expected to induce greater stress in the high anxiety group than in the low anxiety group. No such interaction was found to be significant in the results of the study which led the authors to call for a re-examination of the validity of increased drive as a mediating variable for the audience effect in social facilitation phenomena.

In another study by Martens (1969), subjects were divided into high and low anxiety groups on the Taylor Manifest Anxiety Test. The high anxiety subjects were found to learn and perform better in the audience condition than in the alone condition. This finding is not entirely consistent with Zajonc's theory which would expect

the high anxiety group to learn worse than the low anxiety group on the novel task in front of an audience. Other studies have come up with different results from those obtained by Martens (e.g. Cox, 1966, 1968, Ganzer, 1968). Cox in his studies found the presence of an audience to impair the learning and performance phases of high and medium anxiety subjects, but not of low anxiety subjects. It should be noted too that these results are also not completely in line with the Zajonc hypothesis in that low anxiety groups were found to perform better on the learned task in front of an audience than the high anxiety group.

Martens attributed the discrepancies between his study and those by Cox and Ganzer to differences in the anxiety scales used and complexity of tasks involved. In any case, the inconsistencies in the results of the above mentioned studies seem to point to the inadequacy of the anxiety tests as a good indicator of drive level in the experimental subjects. The difficulty with those studies employing the MAS or AAS as a basis for drive manipulation is to create the proper drive inducing situation which would meet the various specifications within the applicability of the particular anxiety

scale. But even if all requirements in terms of proper instructions, sampling of subjects, and choice of the right task are met, the disappointing results with these tests suggest that:

> "a more generalised anxiety scale such as the MAS does not intervene with the presence of an audience to produce differences in learning and performance on a complex motor task." (Martens, 1969, p. 259)

A footnote in the above mentioned study by Quarter and Marcus (1961) filed a similar complaint of the AAS as an anxiety arousal indicator:

> "Over the past year, a number of experiments by different researchers at the Ontario Institute for Studies in Education used the AAS to discriminate between high anxiety and low anxiety subjects and failed to obtain predicted performance differences."
>
> (Quarter and Marcus, 1971, p. 103)

If there have been few experiments which attempted to manipulate the drive level in social facilitation processes, there have been even fewer that gave a more direct measure of general drive level in subjects by using physiological

detectors of general arousal. Most social facilitation studies have assumed an increase in the drive level of its subjects whenever an increase in release of the dominant response occurred. The few studies that bothered to check up on whether there was an actual corresponding increase in subjects' physiological arousal included those by Martens (1969), and Henchy and Glass (1968).

Martens used the palmar sweat index as one of his dependent variables in his 2 X 2 factorial design with low and high anxiety on the MAS as one independent factor and presence and nonpresence of an audience as another factor. No differences in palmar sweating was detected between the low and high anxiety subjects although there was a significant difference in performance between these two anxiety groups. One is thus led to question the validity of the general drive notion in elicitation of audience effects. The study by Henchy and Glass measured the skin conductance and heartrate of subjects in the alone condition and audience conditions in a one factor experiment. Differences in performance on a pseudorecognition task were found between the alone condition and audience conditions but no differences in behavioral

arousal were detected. Again it appears as if autonomic arousal cannot be used as a mediating factor in the interpretation of social facilitation effects.

Although the above studies have attempted to prove the utility of the drive concept in the production of social facilitation effects, it has still not been proved if the additive and multiplicative assumptions of the Hull-Spence general drive model are really valid for the social facilitation context. Because the general drive model is additively composed of several contributing drive components, additional increase beyond the increase due to the presence of an audience should further increase the probability of occurrence of the dominant response. The experimental manipulation of increasing the subject's drive level by some additional non-social drive should clarify the question if the general drive model is a complete explanatory scheme for social facilitation phenomena.

The present study is designed to investigate this particular issue. A 2 X 2 factorial design is used with the audience and alone conditions as levels of one factor (Evaluation factor) and the home-like environment and laboratory

environment in which the task was performed as the other factor (Setting factor). The rationale of the study assumes a familiar environment like the home to have a low general arousal effect on the subject and an unfamiliar setting like a psychological laboratory to have a higher general arousal effect on the subject. A pilot study prior to the experiment did indeed detect a significantly higher measure of heartrate in subjects in the laboratory than in the home. Thus the present study has an advantage over the previous studies (e.g. Cox, 1966, 1968, Ganzer, 1968, Martens, 1969, Quarter and Marcus, 1971) in that it has more confidence in the a-priori difference in the directly measureable arousal level of subjects in the two environmental settings. Previous studies have only used indirect and unreliable measures of drive level in subjects as determined by their scores on anxiety tests, and whatever physiological differences in the subjects have been obtained in a completely post hoc fashion. The resulting performance of the subjects on a complex task in front of an evaluative audience or in an alone condition, in the home-like environment (low arousal) or in the laboratory (high arousal) should yield an indication of how the general drive

theory relates to social facilitation effects.

Validation of the Hull-Spence general drive equation would require a significant main effect to be obtained for both the Setting factor and the Evaluation factor. According to the general arousal hypothesis of Zajonc, both the high arousal setting and the evaluative audience condition would cause more interference with performance on a complex problem solving task, here defined as one in which dominant responses are incorrect, relative to the low arousal setting and the alone condition respectively.

In order to test the additive and multiplicative assumptions of the Hull-Spence general drive theory, particular attention is focussed on differences in subject performance in the audience condition between the high arousal environment and the low arousal environment. The evaluative threat provided by the evaluative audience might be identical in both conditions, but the arousal inducing effect of the two environmental settings however is different. Because of the additive law of general arousal as employed by Zajonc, this difference between the arousing effect of the two environments would result in different

probabilities of release of the dominant response in the two environmental settings. Because recent studies (Cottrell, 1968, Cottrell, Rittle, Wack, 1968, Cottrell, Wack, Sekarak, Rittle, 1967, Henchy and Glass, 1968, Martens, 1969, Quarter and Marcus, 1961) have emphasized so dramatically the importance of the awareness of evaluative threat in the elicitation of social facilitation effects, the present study is particularly concerned to observe whether the influence of this evaluative threat could be so great as to cause a breakdown in the summation law of drive level. This would be confirmed if no difference in subject performance can be detected in the audience condition between the high and low arousal environments. Differences in arousal between the two environmental settings may become so minute when compared to the overriding strong arousal effects stemming from the ongoing human interaction (awareness of evaluation from the audience) that the Hull-Spence theory of drive level may not be seen to be entirely applicable to the interpretation of social facilitation phenomena.

METHOD

Design

A 2 x 2 factorial design was used. The two levels for the first factor, the Setting factor, was a home-like setting and the laboratory setting. The two levels of the second factor, the Evaluation factor, were the alone condition and the audience condition. The main dependent variables were a measure of the subjects general arousal level (heart rate) and their performance on three complex tasks in the four experimental conditions. In addition five other dependent measures of the general arousal of the subjects were used. These were ratings on four-self-report scales of general activation and a rating by the confederate in the audience condition of the subjects' nervousness.

Subjects

Sixty subjects were drawn from a pool of undergraduate female students attending Summer School at the University of Victoria. Since Kaplan (1969) found a strong interaction of subject performance with the degree of exposure of the subject to psychological experiments, only subjects who had never participated in any psychological

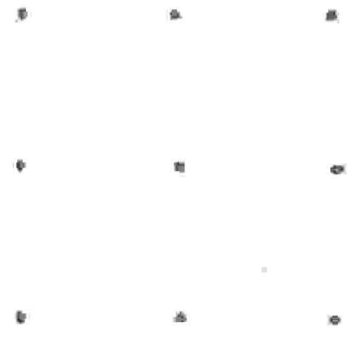
experiment were chosen. The home-like setting condition was carried out on subjects living in residence rooms on the University campus while attending Summer School. Time of day was counter balanced equally in all four conditions. Fifteen subjects were randomly assigned to each experimental condition.

Task

A particular type of behavioral set task was employed as in a social facilitation study by Goerl, Pakula and Pulton (unpublished 1973) which yielded excellent results in line with Cottrell's research. The dominant response was defined as the inability to break out of the behavioral set.

Three complex problems were presented in random order, each stated on one page of a six page booklet. The written instructions were the same as used by Maier (1950) in problem solving experiments. The problems are given below:

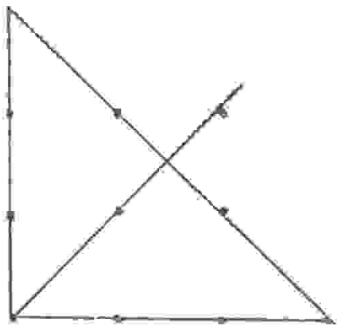
1. The Nine Dot Problem



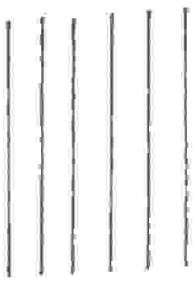
The instructions to this problem were as follows:

> "Connect the dots by drawing four connected straight lines. You may not take the pencil off the paper, and you may not retrace any lines."

This problem represents a negative perceptual set. The dominant response is to perceive the dots as outlining a square. The problem is solved only when the subject leaves the implicit boundary of this square and draws the lines outside the area bounded by the dots.



2. The Six Matches Problem

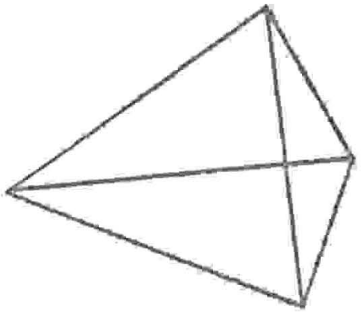


Six matches were attached with cellophane tape to the page. The instructions were as follows:

> "Build four equal side triangles where the

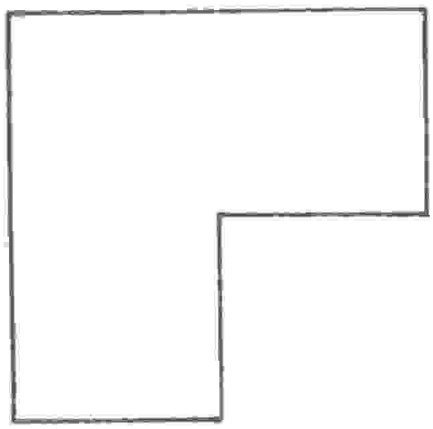
sides are equal to the length of one matchstick.

The dominant response tendency is to remain in two dimensions. The problem can only be solved when the subject recognizes that he can use the third dimension.

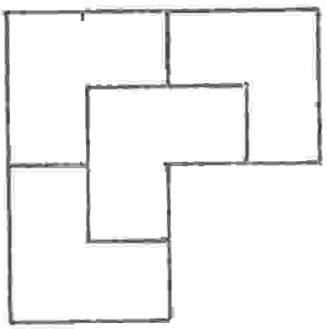


3. The Farmer Problem

"Once there lived a farmer with four sons. The sons were very jealous of each other and always suspected the father of showing favouritism toward one or the other. So when the time came for him to retire the farmer was faced with a problem. He had an odd shaped piece of land (without buildings) which he decided to divide equally among his sons. He asks you to divide the piece of land shown below into four parts equal in SIZE and SHAPE, with none left over. Show how you would do this in the following diagram."



The subject's tendency is to divide the figure into triangles or some other equal sided figures which do not lead to a solution of the problem.



Thayer's Activation-Deactivation Adjective Check List (AD-ACL)

The additional measure of the hypothetical concept anxiety or general arousal is a relatively new measure devised by Thayer (1967). In several validation studies Thayer (1967) introduced a self report measure of activation and claimed to have found better reliability and validity in his measure than any single of the traditional measures (GSR, heart rate, finger blood volume, etc.). This

Activation-Deactivation Adjective Check List (AD-ACL) is composed of four orthogonal factoranalytical dimensions representing different points on the arousal continuum. These factors made up of certain mood reflecting adjectives correlated highly with physiological measures in conditions representing a continuum of arousal ranging from near sleepiness to taking an important examination. Thayer proposed that each set of adjectives (composing one factor) can be used independently.

The present study planned to employ all four factors named the General Activation (GA), High Activation (HA), General Deactivation (GD) and Deactivation-Sleep (DS) factors. The adjectives used in the four factors are:

HA - clutched up, jittery, stirred up, fearful, intense

GA - lively, active, full of pep, energetic, peppy, vigorous, activated

GD - at rest, still, leisurely, quiescent, quiet, calm, placid

DS - sleepy, tired, drowsy

The twenty-two adjectives were presented in random order to the subjects, each printed on a 2 x 3 card. The answers were to be written on the second page of the booklet, where all adjectives were listed

again in random order. Each adjective was to be rated on a four point scale (vv = definitely feel, v = slightly feel, ? = do not know, no = I disagree.)

Booklet

Each booklet consisted of six pages. The Thayer scales were placed at the beginning page, followed up by an instruction page to the three problems. These three problems were arranged in mixed order on the next three pages. Each problem was stated on one page. The subjects were also instructed to indicate if they already knew the solution to any of the problems. A complete booklet is presented in Appendix A.

Procedure

Pilot Study

A pilot study was run in order to validate the assumption that the two environmental settings were actually different in terms of general arousal induced in the subject. Arousal was predicted to be higher in the laboratory than in the home-like setting. The pulse of 24 subjects was measured, 15 in the home-like setting and 9 in the laboratory condition. The time of the day was counterbalanced for each condition. Subjects in the laboratory

condition were asked to wait while seated for five minutes outside the laboratory in order to prevent contamination of the heartrate measurement due to physical activity (walking). The difference of the means between the home-like and the laboratory condition was highly significant. ($t = 2.3612$, $df = 23$, $p < 0.025$) Thus the choice of these two environmental settings as independent factor of different arousal was taken as justified.

The Experiment

The experiment in the laboratory condition took place in the Neuropsychological Laboratory of the Psychology Department. The room was about 12 feet x 15 feet in size. As it was practiced in the pilot study, the subject was asked to wait while seated outside of the laboratory in order to prevent contamination of the heartrate measurement due to physical activity (walking). The subject was brought into the laboratory and told:

"This is our psychological laboratory. Please take a seat over there."

The subject was seated on a desk in the upper third of the room, facing the entrance. The one-way mirror was at her right. In the audience condition

the confederate was present when the subject entered the laboratory. The confederate was introduced to the subject with the following introduction:

> "This is Miss Mitchell, she is a graduate student in the Psychology Department and she is going to watch this experiment and evaluate your performance."

The booklet and the set of cards were handed over to the subject. She was asked to read the instructions to the Thayer Scales as well as the instructions to the three problems and to ask, if necessary, clarifying questions. After the experimenter had made sure that the subject understood what she was supposed to do, the pulse measurement was taken. The pulse was measured on the right hand wrist in usual medical procedure over a 15 seconds period as timed by a normal wristwatch with a large second hand. Only two out of the 60 subjects commented on the pulse measurement while it was being taken. However neither of the two subjects demanded to know the purpose of the pulse measurement, and consequently none was given them.

The performance of the subject was well visible to the confederate who remained seated on the opposite side of the desk, four feet away from

the subject. The confederate had been instructed not to make eye contact with nor talk or respond verbally to the subject during the experiment, but to watch attentively and quietly the performance of the subject. According to Mehrabian (1971), permanently looking away after initial short eye contacts codes "channel closed" and may increase the threat of refusal or evaluation felt by the subject. The confederate rated the subjects' perceived nervousness during the experiment on a five point scale (1 = entirely calm, to 5 = hyperactive, sweating, extreme agitation).

In the home-like setting condition the experimenter arrived with the confederate at the subject's home. The confederate was seated again at a distance of four feet from the performing subject. There was no other audience in the room. The introduction of the confederate to the subject was identical to that given in the laboratory. In both alone conditions, the subjects were entirely alone in the room when they were working on the problems. In all four conditions, the experimenter left the room as soon as the short instruction to the self explanatory booklet was given and the pulse measurement of the subject was taken. After

20 minutes the experimenter reentered the room and the experiment was terminated. All subjects were debriefed about the experiment and the rationale of the study and generally found the experiment enjoyable and challenging.

RESULTS

Scoring

The subjects were given a score of 1 for each correctly solved problem and 0 for an incorrect or unsolved solution to the problem. The final performance score for each subject was a total of all three problems. This scoring was the same for problems known beforehand. This was felt to be justified as a χ^2 statistic of problems known and not known in all four experimental conditions was not found to be significant ($\chi^2 = 1.3$, df = 3, $\chi^2_{0.0053} = 7.84$).

Multivariate F-tests

A 2 x 2 multivariate analysis of variance utilizing Wilk's Lambda criterion as a test statistic yielded one discriminant function for the Environment factor which was significant at less than the 0.01 level ($F = 3.207$, df = 6/51, $p < 0.01$). The amount of between group variance accounted for by the discriminant function was given by the square of Roy's criterion (=(0.523 or 0.274) x 100). The amount of variance accounted for by the Setting factor was therefore 27.4%. The only dependent variable loading significantly on the discriminant

TABLE 1

Multivariate analysis of variance Table, Test of Setting.

Multivariate test of significance using Wilks Lambda criterion.

Test of roots	F	DFHYP	DFERR	P less than	R
1 through 1	3.207	6.000	51.000	0.01	0.523

Univariate F-Tests

Variable	F(1,56)	Mean SQ	P less than	SDFC
1 (Performance)	0.788	0.600	0.379	0.277
2 (Heartrate)	18.301	1972.280	0.001	-0.929
3 (Gen. Activation)	0.320	10.417	0.574	-0.161
4 (High Activation)	0.371	4.817	0.545	-0.090
5 (Gen. Deactivation)	0.982	30.817	0.326	-0.348
6 (Deactivation - Sleep)	0.009	0.067	0.925	-0.024

function was the heartrate variable ($F = 18.301$, $df = 1/56$, $p < 0.001$). The overall F's for the Evaluation factor and the Evaluation by Setting interaction factor were not found to be significant. The mean results for all dependent variables are presented in Tables 2 - 8.

In order for the significance of the subject nervousness dependent variable to be determined, a multivariate analysis of variance was carried out on the Setting factor for only the audience level of the Evaluation factor since no measures were taken in the alone condition. The obtained multivariate F ratio is significant ($F = 3.638$, $df = 6/51$, $p < 0.01$) but the nervousness dependent variable was not found to load significantly on the discriminant function obtained for the Setting factor. The significant multivariate F ratio is due to the highly significant heartrate variable loading on the discriminant function ($F = 15.183$, $df = 1/28$, $p < 0.001$).

Table 2

Mean number of problems solved.

Evaluation	Setting: Homelike	Setting: Laboratory	
Alone	1.2	0.733	0.966
Audience	0.400	0.467	0.433
	0.8	0.6	

Table 3

Mean Heartrate

Evaluation	Setting: Homelike	Setting: Laboratory	
Alone	72.267	84.267	78.267
Audience	72.800	83.733	78.267
	72.533	84.000	

Table 4

Mean General Activation

Setting

Evaluation	Homelike	Laboratory	
Alone	14.4	16.4	15.4
Audience	16.9	16.6	16.75
	15.65	16.5	

Table 5

Mean High Activation

Setting

Evaluation	Homelike	Laboratory	
Alone	9.9	9.2	9.55
Audience	9.5	9.1	9.3
	9.7	9.15	

Table 6

Mean General Deactivation

Evaluation	Setting: Homelike	Setting: Laboratory	
Alone	15.9	16.8	16.35
	15.9	17.9	16.9
	15.9	17.35	

Table 7

Mean Deactivation - Sleep

Evaluation	Setting: Homelike	Setting: Laboratory	
Alone	5.3	5.1	5.2
Audience	5.2	5.2	5.2
	5.25	5.15	

Table 8

Mean Subject Nervousness as rated by the confederate.

		Setting: Homelike	Setting: Laboratory	
Evaluation	Alone	no measure	no measure	
	Audience	2.27	2.27	2.27
		2.27	2.27	

DISCUSSION

The results of the present study, with particular reference to the dependent variables heartrate and performance, do not confirm Zajonc's theory or the expectations of general drive theory. The only significant main effect was found for the Setting factor, and the only dependent variable loading significantly on the discriminant function for this Setting factor was the heartrate variable. The mean heartrate measure for the home-like setting and the laboratory setting were respectively 72.50 and 84.00 beats per minute. Thus as indicated by the pilot study, there was an actual difference in general arousal stemming from the 'mere' physical setting of the test situation for both the alone and audience conditions. The nonsignificance of the dependent variable performance on the same discriminant function indicated no difference in performance between the home-like setting and the laboratory setting for both the alone and the audience conditions. Zajonc would have predicted a difference in performance between the home-like setting and the laboratory setting if there was a corresponding difference in general arousal in the two settings. As can be seen, a difference in

arousal as measured by heartrate was indeed found between the two settings, but there was no corresponding significant difference in performance in the two settings. This finding is therefore contrary to that expected by Zajonc. Confidence in the assumed correspondence between an increase in drive and an increase in probability of release of the dominant response is thus considerably undermined by this finding.

This study did not detect significant performance differences between the evaluation and nonevaluation conditions. This is a surprising finding considering the fact that practically all previous research has shown difference in subject performance between evaluation and nonevaluation groups. The overall F test for the Evaluation factor in this study was not found to be significant by MANOVA. This difference in results between the present study and previous studies which found a significant main effect for the Evaluation factor may be due to the different statistical analyses used for interpretation of the data. Most previous studies have carried out univariate analyses of variance (ANOVA) on their data, even in cases where more than one dependent measure were taken on the

same subjects. This study on the other hand made use of a multivariate test statistic (Wilk's Lambda) to test for the significance of the discriminant function which differentiated between the evaluation and nonevaluation groups when all the dependent measures were taken into consideration. It is only when the overall F test in the MANOVA is significant that it is usual for unbiased conclusions to be made about the significance of each of the dependent variables on the discriminant function. One possible exception however, occurs when the dependent measures are not intercorrelated. According to Hummel and Sligo (1971, p. 50) inferences based upon multiple univariate tests are not biased when the dependent measures are orthogonal. In the case of the performance and heartrate measures in this study the correlation was found to be $r = -0.030$.

Based then upon this statistical consideration and upon the previously mentioned fact that demonstrations of social facilitation have in the past resulted from univariate analyses even when more than one dependent measure were used, it was decided to proceed with a post hoc analysis of variance on both of the principle dependent measures in this study, namely task performance

and heartrate.

The results using this univariate analysis revealed a significant performance difference between the alone condition and the evaluative audience condition (see Tables 9, 10). This significance in performance confirms the well established finding in social facilitation research that the presence of an evaluative audience increases the release of the dominant response. This analysis did not yield a significant difference in performance for the setting factor.

A post hoc univariate analysis of variance was also run on the other important dependent variable, the heartrate variable, but the F-value for the Evaluation factor was not found to be significant (identical means of 78.00 heartbeats per minute were calculated for both the alone condition and the evaluative audience condition). This coincides with the results of the MANOVA and is consistent with the results of Henchy and Glass (1969) who kept a continuous record of the heartrate and skin conductance of their subjects throughout the experiment, but found no difference in autonomic activity between the subjects in the alone condition and those in the evaluative audience conditions

Table 9

Analysis of variance table

with heartrate as dependent measure

Source	DF	SS	MS	F	Prob.
Subj.	59	8011.73			
B1 (Setting)	1	1972.27	1972.27	18.300	0.000074
B2 (Evaluation)	1	0.0	0.0	0.000	1.000000
B12 (Setting x Evaluation)	1	4.27	4.27	0.040	0.84002
EB12 (error)	56	6035.20	107.77		

Table 10

Analysis of variance table

with performance as dependent measure.

Source	DF	SS	MS	F	Prob.
Subj.	59	48.60			
B1 (Setting)	1	0.60	0.60	0.787	0.378632
B2 (Evaluation)	1	4.27	4.27	5.600	0.021445
B12 (Setting x Evaluation)	1	1.07	1.07	1.400	0.241595
EB12 (error)	56	42.67	0.76		

although significant differences in performance were obtained.

The results of the post hoc ANOVA are slightly different from the MANOVA results. The heartrate dependent variable shows again the significant difference on the Setting factor but not on the Evaluation factor. The performance dependent variable however reveals now a significant difference on the Evaluation factor but not on the Setting factor. These findings are consistent with the low heartrate - performance correlation illustrating the orthogonality of these two dependent variables. The important additional contribution of the post hoc ANOVA was to demonstrate that the dependent variables were actually a function of the experimental manipulation.

The significant ANOVA finding for performance clearly implies that the performance dependent variable was not too restricted to detect a social facilitation effect. We would have to have concluded this as a possibility if this post hoc analysis had failed and thus could proceed to no further inference. The pattern of results as obtained by the ANOVA now may be taken as evidence that arousal as measured by heartrate is unrelated

to social effects upon performance. This conclusion is directly contrary to that expected from the Hull-Spence model as employed by Zajonc.

It was stated in the Introduction that a primary interest of the present study is to look for differences in subject performance between the low arousal and high arousal Setting conditions in the audience level in order for the additive assumption of the Hull-Spence drive construct to be valid for the interpretation of social facilitation effects. The results are such that a significant difference in heartrate was found between the two Settings but no corresponding significant difference was found for the performance measure. Respectively six and seven problems on the average were solved in the low and high arousal Settings in the audience condition. Thus when the perceived evaluative threat from an audience is assumed to be a constant in both Setting conditions, an increase in nonsocial arousal in subjects does not exert additional influence on subject performance. It can thus be considered that the additive drive construct in the Hull-Spence equation can not be directly applied to social facilitation processes.

Thayer's scales and confederate rating of subject arousal

None of Thayer's scales were significant on the univariate test of the multivariate test statistics obtained for the experimental factors. Their loadings on both discriminant functions for the Setting factor and the Evaluation factor show them to correlate very poorly with heartrate. This study therefore fails to confirm the validity of the scales as a good measure of autonomic state of arousal as found by Thayer. The actual correlations of the four scales, High Activation, General Activation, General Deactivation, and Deactivation-Sleep with the heartrate measures were respectively 0.086, -0.072, 0.018, and -0.075.

The dependent variable, subject nervousness as perceived by the confederate in the audience condition, was not found to be significant on the discriminant function obtained for the Setting factor. This may be due to the difficulty in assessment of nervousness in people on a simple scale. This is particularly so when there are no validated criteria for perception of nervousness in others. The insignificance of the correlation between this measure of perceived nervousness and

heartrate in the two environmental settings further proves the point of the unreliability of one's perception of nervousness in others even when actual physiological differences were detectable in these judged subjects.

Tasks

The cognitive set tasks seemed to discriminate between evaluation conditions and to reflect social facilitation effects. This conclusion is drawn from a pattern in performance between the evaluation and nonevaluation conditions similar to most previous social facilitation research (e.g. Zajonc, 1966, 1969, and Cottrell, 1968). Subjects in the alone condition across the two environmental settings solved significantly more problems than subjects in the audience condition according to the analysis of variance. The dominant tendency of the subjects did seem to be inability to break out of the cognitive set inherent in these problems. This confirms the results of Goerl, Pakula, and Pulton (1973) who employed a similar type of cognitive set tasks in their social facilitation study which also found a significant difference in performance between their evaluation and nonevaluation groups.

CONCLUSION

The findings in the present study are contrary to Zajonc's explanatory concept of general drive and the additive assumption of the drive concept in giving rise to social facilitation effects. While there was a difference in general arousal as measured by heartrate between the two settings, there was no difference found in their performance.

How may we account for these findings? It is possible that heartrate and general autonomic activity is not an adequate measure of general drive particularly when we consider that Henchy and Glass (1969) could not detect a difference in heartrate and skin conductance in their subjects between the evaluation and the nonevaluation conditions even with a continuous check on these two autonomic arousal measures throughout the experiment. This consideration gains further support by the findings of Martens (1969) who observed a difference in palmar sweating between the evaluation and nonevaluation condition but no difference between the high and low anxiety groups.

Hence there still remains the problem to

qualify the Hull-Spence model as used by Zajonc and to specify the kind of arousal other than autonomic activity which might play a part in this social facilitation process. The present research results indicate that social facilitation, contrary to Zajonc, is not mediated by arousal as it is usually measured. The little evidence from research results allows us but to speculate on these alternatives. We have shown however, that the relationship between arousal and social facilitation is not unqualifiedly simple as Zajonc's usual statement of it implies.

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APPENDIX A

A COMPLETED QUESTIONAIRE

These adjectives express different moods. Go through the set of adjectives and indicate on the four-point scales how precisely they reflect your momentaneous state of mind. Circle your answers.

For example:	strongly agree	(vv)	v	?	no
	slightly agree	vv	(v)	?	no
	I dont know	vv	v	(?)	no
	I disagree	vv	v	?	(no)

List of Adjectives

quiet	(vv)	v	?	no
lively	vv	(v)	?	no
placid	vv	v	?	(no)
at rest	(vv)	v	?	no
clutched up	vv	v	?	(no)
still	(vv)	v	?	no
full of pep	vv	v	?	(no)
stirred up	vv	v	?	(no)
vigorous	vv	(v)	?	no
tired	vv	v	?	(no)
activated	vv	(v)	?	no
intense	vv	v	?	(no)
peppy	vv	(v)	?	no
leisurely	(vv)	v	?	no
sleepy	vv	v	?	(no)
jittery	vv	v	?	(no)
quiescent	(vv)	v	?	no
fearful	vv	v	?	(no)
active	vv	(v)	?	no
calm	(vv)	v	?	no
energetic	vv	(v)	?	no
drowsy	vv	v	?	(no)

GA 19

4

25

3

1, 76 4 = scale

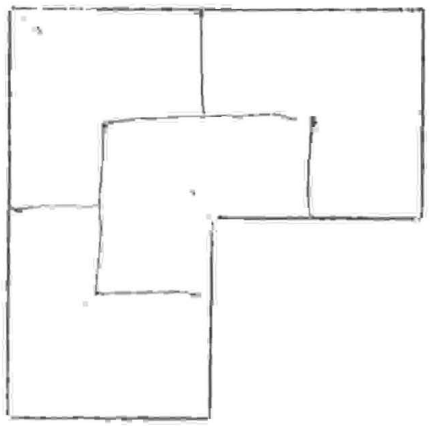
2 15

no

On each of the following three pages you will find one problem. Please read precisely the instructions to each problem and then try to solve it. You can make use of whatever available space you may find in the booklet. Please indicate if you already know beforehand the solution to any problem but give the solution anyway.

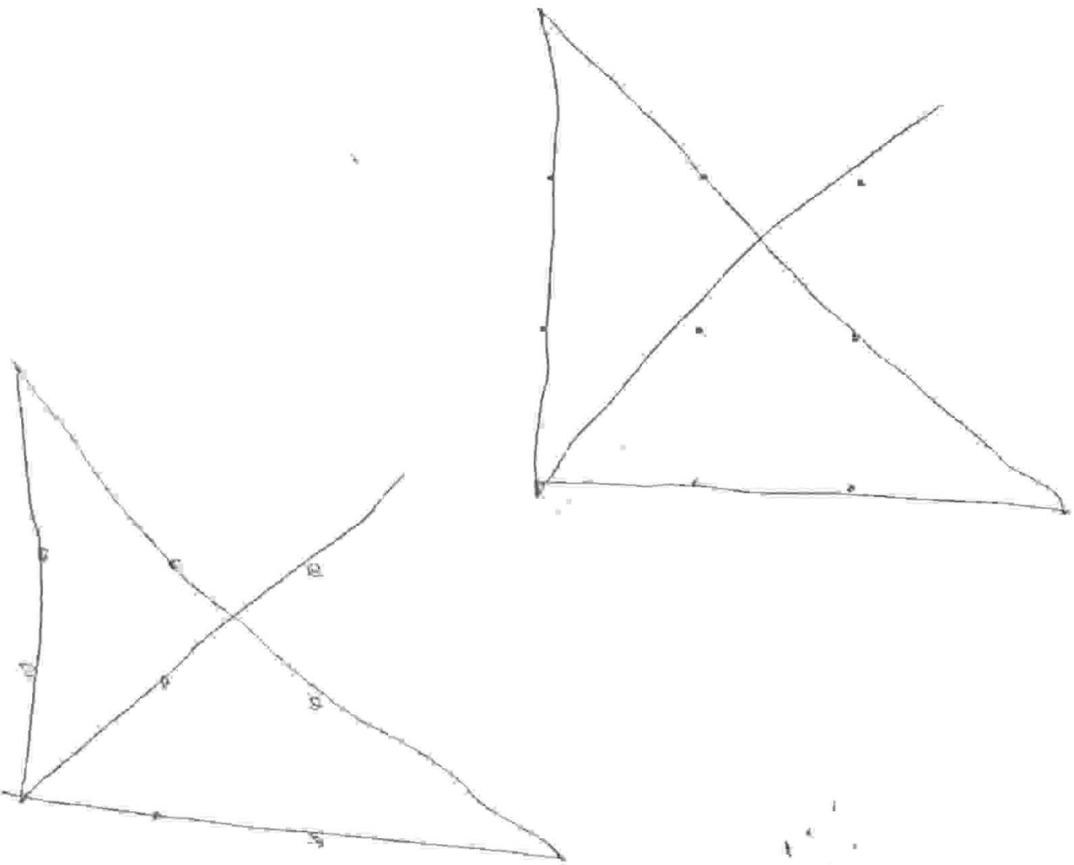
You are given 20 minutes to solve all the problems.

Once there lived a farmer with four sons. The sons were very jealous of each other and always suspected the father of showing favoritism toward one or the other. So when the time came for him to retire the farmer was faced with a problem. He had an odd shaped piece of land (without buildings) which he decided to divide equally among his sons. He asks you to divide the piece of land shown below into four parts equal in SIZE and SHAPE, with none left over. Show how you would do this in the following diagram.



I know the problem: yes (no)

Connect the dots by drawing four connected straight lines. You may not take the pencil off the paper, and you may not retrace any lines.



I know the problem: yes (no)

Build four equal side triangles where the sides are equal to the length of one matchstick.

I know the problem: yes no

APPENDIX B

LISTING OF RAW DATA

201	0	76	20	8	13	5	2		
203	0	84	19	5	19	5	4		
204	0	76	7	9	20	10	3		
205	1	64	23	7	18	3	2		
206	1	80	24	9	10	3	1	1	
207	0	72	14	10	28	8	2	2	
208	0	68	13	13	15	6	2		
209	0	90	10	14	14	9	3		
210	0	88	11	10	19	3	2		
211	2	76	7	5	10	3	2	1	
212	1	72	12	7	14	3	1		
213	0	76	13	12	21	3	4		
214	0	72	26	12	10	5	3		
215	0	90	13	6	20	9	2		
101	0	96	11	5	20	3			
102	0	112	13	14	08	07			
103	0	084	13	05	25	09			
104	0	094	14	08	17	09			
105	1	84	20	13	15	3		1	
106	1	104	24	12	18	03			
107	1	072	21	19	08	06			
108	0	072	11	05	24	09			
109	2	096	17	08	25	06			
110	0	088	23	09	16	03			
111	0	84	17	11	11	3			
112	1	72	10	7	15	10			
113	1	69	11	5	18	4		1	
114	3	97	13	12	13	3			
115	1	72	21	8	14	3			
201	3	75	12	8	27	8	2		
202	0	75	7	5	24	5	3		
203	0	92	13	10	11	9	3	1	
204	0	88	14	7	19	12	1		
205	1	92	15	5	23	4	1		
206	1	96	13	7	21	5	2		
207	0	120	23	9	10	3	2		
208	0	96	25	13	14	5	2		
209	0	72	13	10	18	6	3		
210	0	84	7	11	15	3	3		
211	0	96	11	11	13	9	1	2	
212	1	78	25	7	10	3	2		
213	1	76	19	14	11	8	3	1	
214	0	84	21	9	20	3	2		
215	0	76	19	5	25	3	4		

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