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ABSTRACT

R. Martens' hypothesis that an audience acts as a stimulus to elicit arousal or drive in the performance of an individual, which in turn enhances the emission of the dominant habit, is reexamined. Where incorrect responses are dominant, learning of a novel task will be inhibited, or at least improvement will not be as rapid as for individuals performing alone. Uncomplicated motor learning tasks were used, in a partial replication of Marten's procedures, to examine the effect of the following four conditions: audience present/videotape present; audience present/videotape absent; audience absent/videotape present; and audience absent/videotape absent. Results indicated that in the initial stages of motor learning subjects performing before an audience were more variable in their performance than subjects performing without an audience. Subjects reported the presence of an audience provided greater arousal, and in some cases this arousal was shown to be positively correlated to their performance scores. Overall, the findings indicated that audience effects account for only a small portion of variance in motor behavior. (JD)

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Social Facilitation During the Initial Stage of Motor Learning: A Re-examination of Martens' Audience Study

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Running head: Social Facilitation

Abstract

This study partially replicated Martens' (1969a) social facilitation study of motor behavior. His very robust performance findings provided impressive confirmation for Zajonc's hypothesis, and his arousal findings have since been used as evidence for a nonlearned-drive basis for social facilitation. The present study also extended Martens' investigation by examining the separate and combined effects of an audience and videotape camera. The effects due to the presence of the audience and camera were not additive; instead, the audience detrimentally effected subjects' performance consistency and the camera resulted in more trials over ± 30 msec after the performance criteria had been attained. Martens' most robust findings for constant error were not replicated, nor were some of his physiological arousal findings. His pattern of constant error results over all trials is atypical of known learning strategies that subjects use to reduce error over successive trials. Overall, our findings are in accord with most social facilitation studies of motor behavior where the audience effects account for only a very small portion of the variance.

Social Facilitation During the Initial Stage of Motor Learning: A Re-examination of Martens' Audience Study

The performance of individuals alone compared to their performance in the presence of an audience has been a pervasive social psychological issue which Zajonc (1965) and later Cottrell (1972) called social facilitation. Based on a post hoc analysis of previous social facilitation studies, Zajonc employed constructs borrowed from Hullian drive theory to formulate a social facilitation hypothesis. This hypothesis maintains that an audience acts as a stimulus to elicit arousal or drive, which in turn enhances the emission of the dominant habit. Where incorrect responses are dominant, learning of a novel task will be inhibited, or at least improvement will not be as rapid as for individuals performing alone. During the later stages of learning (dominant responses mainly correct) increases in arousal should improve performance.

Perhaps the most impressive support for Zajonc's hypothesis initially came from Martens' (1968) doctoral dissertation research which was later reported in the Journal of Personality and Social Psychology, the Journal of Experimental Social Psychology, and Research Quarterly (Martens, 1969a, b, c). Unlike the early tests with verbal tasks (e.g., Zajonc & Sales, 1966), Martens' support for the hypothesis was the most comprehensive because corroborative evidence for physiological arousal was provided for both initial and later stages of motor learning. In addition, some of Martens' audience effects[2] were much stronger (^{2} = 13-15%) than those typically achieved with verbal tasks (^{2} = 2-5%). With few exceptions, more recent studies of audience effects on motor behavior have shown small, and often inconsistent, audience effects (see Landers

& McCullagh, 1976 for a review). Considering the pre-existing Martens' results, the weaker findings reported by contemporary investigators have generally been attributed to methodological inadequacies in providing audiences of sufficient size to elicit arousal, and to not specifying a priori the habit strength on the motor task employed. As a result, Martens' (1969a, b, c,) research has been consistently cited as major evidence for Zajonc's hypothesis and has been used as a prototype for social facilitation research on motor behavior.

In the psychology literature (Weiss & Miller, 1971; Zajonc, Note 3), the theoretical significance attached to the pattern of the physiological responses displayed by subjects in Martens' alone and audience conditions have received greater attention than the robustness of Martens' performance findings. Zajonc (Note 3) uses the elevated palmar sweating found by Martens (1969a, b, c) to argue that the drive level produced by an audience is not an aversive drive, like pain and frustration. These aversive drives are learned and are generally subject to habituation effects over successive trials. Martens (1969a, b, c) offers the only physiological evidence which shows an enduring pattern over 15 trials without any trace of habituation. More recent evidence, however, does not support Zajonc's (Note 3) innately acquired drive interpretation. For example, Cohen and Davis' (1973) data clearly show habituation of palmar sweating over the course of learning trials. They also found results that were directionally opposite those found by Martens. In the Cohen and Davis study palmar sweating in the presence of an audience actually decreased from a pre-experimental basal state, whereas increases were noted in Martens' experiment. Such disparate palmar sweating results are also evident in other audience studies (e.g., Farst & Most, 1973). There does not appear to be a simple resolution for these discrepancies. Such a resolution is needed, though, to clarify whether the drive of social facilitation is a learned aversive drive (Cottrell, 1972; Weiss & Miller, 1971) or an innately acquired drive (Zajonc, Note 3).

The interpretations by Zajonc and other investigators are reasonable extrapolations from Martens' (1969a, b, c) research reports. Unfortunately, important experimental details were omitted in Martens' articles. The complete experimental protocol (Martens, 1968) clearly indicates that while subjects were observed by an evaluative audience, they could also see themselves on a videotape monitor. They were told that their performance would be videotaped and later shown to evaluative others. Subjects in this audience/videotape condition were compared to a group performing alone. It is therefore impossible to attribute Martens' performance and arousal findings solely to a "passive" audience. The nature of this highly evaluative experimental treatment may account for Martens' unusually robust performance findings accompanied by heightened arousal, unaffected by habituation. This interpretation is supported by the findings of Cohen and Davis (1973). They concluded that their video-camera condition, compared to a "hypothetical audience" condition (behind a one-way mirror), showed stronger "set effects" and was very reactive in maintaining subjects' initial arousal level.

Although Cohen and Davis (1973) examined the separate effects of a hypothetical audience and video-camera, the combined effects relative to an alone-control condition have not been examined in the motor behavior literature. The purpose of the present study therefore was to replicate Martens' procedures[3] and to examine the effect of the following four

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treatment conditions. audience present/videotape present, audience present, videotape present, and audience absent/videotape absent (i.e., alone control condition). Only the initial stages of learning were investigated when it became obvious that our employment of Martens' "learning criterion" did not produce responses of sufficient habit strength to be considered well learned (See discussion of Table 2 results).

Method

Subjects and Design

Right-handed males (N=60) were recruited from various physical education basic-instructional classes and student centers at The Pennsylvania State University. They ranged in age from 18 to 25 years.

The basic design was a 2 x 2 (audience x videotape) factorial[1] encompassing the presence or absence of the audience and presence or absence of the videotape. Subjects were randomly assigned to the four treatment conditions with the restriction that there be 15 subjects in each condition. According to our a priori calculations using Martens (1968) distribution, this number of subjects provided sufficient statistical power (p 45) to test Zajonc's social facilitation hypothesis for the audience (N=30) and no-audience conditions (N=30).

Apparatus

A coincident-timing task, which had similar dimensions to the Schmidt and Hubbard apparatus (Schmidt, 1969) employed by Martens (1968), was used. This task, called a Bassin Anticipation Timer (Lafayette, Model #50575), consisted of a 90 in. (231 cm) -long runway containing a series of small stroboscopic lamps that produced an illusion of motion at 5.86 ft./sec (175.80 cm/sec) in a sagittal plane toward the midline of the seated subject. This speed provided the same 1.5-sec preview time used by Martens. The subject's task was to time the movement of a cursor (with a pointer attached) across a 2-ft. (60 cm) trackway so the pointer would pass directly over the lamp nearest the subject (coincident point) just as it was illuminated. Unlike the Martens' (1968) study, weights were not attached to the handle since Schmidt (1969) has shown load effects were not significant for moderate-speed cursor movements.

The dimensions of the cursor trackway were the same as used by Martens (1968). It consisted of a 5 in. (12.67 cm) -long handle mounted on a ball-bearing assembly which surrounded a .5 in. (1.27 cm) stainless steel rod. The tip of the 6-in. (15.2 cm) pointer slid across a second stainless steel rod slightly below and parallel to the other rod. With his right hand, the subject slid the cursor from right to left across the trackway. As the cursor passed the coincident point it depressed a microswitch stopping the msec timer.

A Sony Video Camera (Model AVC-3210) and Sony Transistor Video Monitor (Model CVM 950) were used to simulate the videotaping of the subject's performance. The camera was located approximately 84 in. (331 cm) from and to the right of the subject, while the monitor was located approximately 54 in. (137 cm) in front of the subject, beside the apparatus. Behind a partition was a storage case, which when the latch was opened, made a sound similar to the record switch on the videotape machine.

Arousal Measures

The palmar sweat print technique, developed by Sutarman and Thompson (1952), was used to detect changes in autonomic arousal levels over the period of time the subject was being tested. A black solution, containing a moisture reactant, was thinly applied forming a plastic mold which could be removed with Scotch "Magic" transparent tape. The number of active palmar sweat glands in the left hand, third finger were counted for each print taken. Harrison and MacKinnon's (1966) Palmar Sweat Index (PSI) was used and is defined as the number of glands secreting sweat in a 3-mm-square area around the central whorl of a fingertip. For counting the number of active sweat glands the interrater reliability between two independent raters was r = +.98. The PSI scores were expressed as change scores for all subjects. For each subject, the better, more easily readable, of the two basal-print counts was subtracted from all subsequent print counts to control for individual differences.

As in previous experiments (Martens & Landers, 1970; Vachon & Marchant, Note 2), there was a problem in this experiment with obtaining consistency in successive sweat prints under standard conditions. PSI prints were missing as a result of inconsistent application of the solution. Subjects with at least two readable experimental prints and one basal print were therefore used in a 2 x 2 (audience x prints) analysis. This resulted in six subjects in the audience condition and 15 in the no-audience condition.

In addition, Thayer's (1967) Activation-Deactivation Adjective Check List (ACL) was used to determine potential increases in arousal (activation) Thayer's scale is an objective self-report measure of transient levels of activation, and has been shown to possess some degree of construct validity (Dermer & Berscheid, 1972). Subjects were required to describe, on a 4-point scale, their immediate feelings toward 49 adjectives. These adjectives comprised four subscales of activation: General Activation, High Activation, General Deactivation, and Deactivation-sleep. The subscales of most importance for the present investigation were those of High Activation and General Deactivation.

Procedures

As the subjects entered the laboratory, they were seated in the outer room and given an informed consent form to read and sign. Basal sweat prints were taken at 5 and 12 min after their arrival. The subjects were given the ACL to complete in the time interval between sweat print measures. After the second print, the subject was taken into the testing room where he listened to audiotaped instructions and was given a few practices moving the cursor across the trackway (without runway lamps illuminated). Each subject was told he was to try to reach an undisclosed "learning criterion". The actual criterion was a total absolute error score for three consecutive trials of 90 msec or less. Subjects in the audience absent/videotape absent condition (only the experimenter present) began the experimental trials immediately. The subjects were given knowledge of results after each trial in msecs early or late. All subjects received at least 15 trials. Those failing to attain the "learning criterion" by Trial 15 were given additional trials until it was achieved. Once they achieved the learning criterion the experiment was discontinued, subjects were debriefed, and cautioned not to discuss the true nature of the experiment with other students.

After instructions, subjects in the audience, videotape, and audience/videotape conditions were given audiotaped explanations for the presence of the audience, videotape, or both audience and videotape. As in Martens' (1968) study, the subjects were told that a group of individuals were asked to observe them "learn the task". They were also told that these observers had been "watching several other individuals and they would like to see how you learn this task compared to those others" (see Martens, 1968, p. 46). The audience, which ranged from 5-9 members (M = 6-7), had been instructed in their role as passive, nonresponsive spectators. The audience was seated approximately 84-96 ins. (210-240 cm) to the left of the subject. In the videotape-present condition, the subject was told that he was being videotaped, and that the tape would be shown to a group of physical educators who were going to compare the way he learned the task to the way others learned it (see Martens, 1968, p. 45). The camera was turned on and the subject saw himself on the monitor. In actuality, the subject was not being videotaped in any condition, and this was explained to him during debriefing. Once these additional instructions were given, the experimental procedure was identical to the alone condition.

Palmar sweat prints were taken every fifth trial up to and including Trial 15. The ACL was again completed after Trial 10.

Results

Performance Errors

Subjects' error scores were grouped into successive blocks of five trials. Constant error, variable error and total error were analyzed in a 2 x 2 x 3 (audience x videotape x trial blocks) analysis of variance with repeated measures on the last factor. The means and standard deviations for these measures are contained in Table 1.

Insert Table 1 about here

For Constant error (CE), subjects' responses were on the average early, with those in the audience-present conditions (M = -9.92) deviating more than those in the audience-absent conditions (M = -6.09). With the videotape present, subjects were slightly closer to the coincident point by .87 msec than subjects with the videotape absent. The analysis of variance of the CE data showed that audience, videotape, blocks-of-trials and the interactions of these factors were nonsignificant, p's .15.

The means for subjects variable error (VE) in the audience-present and audience-absent conditions were 62.11 and 50.29, respectively. The audience, therefore, had the effect of making subjects more inconsistent in their performance from one trial to the next. This main effect, $F(1,56)=4.68$, p .04, as well as the blocks of trials main effect, $F(2,112)=11.05$, p .002, were significant. Post hoc analysis (Newman-Keuls) of the simple effects for the trial-blocks effect showed that subjects were most inconsistent on Block 1, but became less variable on Blocks 2 and 3 (See Table 1). Subjects in the videotape-present conditions (M = 57.12) were slightly more inconsistent than those in the videotape-absent conditions (M = 55.88). This main effect as well as all interactions were nonsignificant, Fs 1.00.

A subject's total error score (E) for each trial was $E = VE^2 + CE^2$. The results of the ANOVA revealed that the videotape main effect and all two- and three-way interactions were nonsignificant, ps .05. Only the trial blocks main effect, F (2,112)= 15.19, p .01, and the audience main effect, F (1,56)= 4.05, p .05, were significant. The total error results essentially reflected the VE findings of greater error among subjects performing before an audience, and greater error on Block 1 compared to Blocks 2 and 3.

Trials to Criterion

The number of trials needed to attain the 90-msec learning criterion was subjected to a 2 x 2 (audience x videotape) ANOVA. These means and standard deviations are contained in Table 2. Although subjects with the audience present averaged 2.73 more trials-to-criterion than those with an audience absent, this small difference was not significant, F (1,56)=1.18, p .05. The videotape main effect and the audience/videotape interaction were also nonsignificant, F's 1.00.

During testing it became apparent that the performance of many subjects, who had already achieved the learning criterion, deteriorated on subsequent trials. This was examined by tallying the number of trials over ±30 msec after the criterion was achieved (See Table 2). Of the 60 subjects, 37 had one or more trials above ±30 msec. These post-criterion trials over ±30 msec were analyzed for this subsample in an audience x videotape ANOVA (unweighted means solution). There were eight subjects each in the audience-present/videotape-present and audience-present conditions, nine in the videotape-present condition, and 12 in the videotape-absent/audience-absent condition. The effect of the audience was small for both levels of videotape and failed significance, F (1,33)=1.58, p .05. On the other hand, the videotape main effect was significant, F(1,33)=6.23, p .05. After the learning criterion was attained, subjects having the videotape present had more trials over ±.30 msec than subjects in the videotape-absent condition. The audience/videotape interaction was nonsignificant, F 1.00.

Insert Table 2 about here

Arousal Measures

The pre-experimental (basal) scores for the PSI and activation-deactivation scales were compared for each treatment condition prior to subjects actual exposure to the experimental conditions. In all comparisons there were no significant arousal differences (Fs 1.00) indicating that subjects were essentially equal during the pre-experimental period.

Thayer's ACL. The basal ACL scores were subtracted from scores obtained in the experimental situation (after Trial 10) for both the activation and deactivation subscales. High scores were indicative of greater activation (or greater deactivation) in the experimental situation. The activation and deactivation scores were each analyzed in a 2 x 2 (audience x videotape) ANOVA.

On the activation scale the means for subjects performing with and without an audience were 2.97 (activated) and .93 (calm), respectively. The difference was statistically significant, F (1,56)=4.80, p .05. The videotape main effect and audience/videotape interaction was not significant.

The deactivation subscale yielded a different pattern of results. There were negligible differences between audience and no-audience conditions, *F* 1.00. However, subjects in the videotape conditions were less deactivated from the basal to experimental situation (*M*= 1.87) than subjects in the videotape-absent condition (*M*= 4.27), *F* (1,56)= 4.25, *p* .05. The audience x videotape interaction was nonsignificant, *F* 1.00.

Palmar sweat prints. Nearly all of the 21 subjects, referred to previously, decreased their rate of palmar sweating from the basal period to the experimental situation. The rate of decrease was less for subjects in the audience condition (-2.01) than for subjects in the no-audience condition (-13.81). These differences, however, were not statistically significant, *F* (1,19) 1.00. A greater decrease from basal scores was evident when subjects first began performing (*M*= -13.78), but this trials main effect and the audience x trials interaction were nonsignificant (*Fs* 1.00).

Correlations between arousal and performance measures. To determine the covariation between arousal measures and the CE and VE performance measures, product-moment correlation coefficients were calculated for the various treatment conditons (See Table 3). Since the direction of the performance scores in relation to the target was not of importance for this analysis, the particular arousal measure was correlated to the subject's mean E score. Also included in Table 3 are correlations between PSI and total error measures derived from data presented in Martens (1968). In each case, high palmar sweating was generally associated with a greater deviation from the target. This pattern was significantly correlated for the PSI measure in Martens' combined treatments and approached statistical significance for the videotape condition (VE) in the present study. These correlations accounted for between 2% and 46% of the variance.

The correlations between activation- and deactivation- ACL subscales and E scores showed the same relationship as the PSI findings. Higher reported activation (or lower deactivation) resulted in greater E, but only a few of the correlations were significant.

Insert Table 3 about here

Discussion

The results of the present experiment replicate Martens' findings in providing support for Zajonc's prediction for the initial stages of motor learning. Subjects performing before an audience were more variable in their performance compared to subjects performing without an audience. Evidence for the arousal mechanism underlying Zajonc's social facilitation hypothesis was indicated in the present study by subjects in the presence of an audience having greater self-reported arousal, and in some treatments this arousal was shown to be positively correlated to their performance scores. It is clear from the performance results of this study, as well as Martens' study, that the audience effect for the variable error component accounts for a very small portion of the variance (= 2%). This relatively small effect is in accord with most of the audience literature where the audience has been a group of passive observers.

This study did not replicate the CE data reported by Martens (1968, 1969a). Where his audience effects were most robust, our study failed to find any differences whatsoever. These differences could, of course, be due to slight variations in apparatus (e.g., slide and cursor assembly) and samples employed.[4] It is difficult to explain, however, why these factors could systematically produce such dramatically different distributions. Martens' data shows a very small MS_b error term (19.2), large learning effects over trial blocks, and essentially negative deviations from the coincident point on 88% of all trials. Our data from this study and our two pilot studies demonstrate a large MS_b error term (5543.48), no learning over trial blocks, and "bracketing" around the coincident point with approximately an equal number of positive and negative deviations. The constant error distribution found in our study is consistent with other coincident-timing studies (e.g., Christina & Buffan, 1976; Schmidt, 1969), whereas the distribution reported by Martens is unique in the motor learning literature. Martens' distribution is quite discrepant even when we compare the data from Schmidt's (1969) study which employed the same apparatus[5] and conditions that Martens used with his alone group (See Figure 1). The bracketing evident in this study, and many other coincident-timing studies (e.g., Christina & Buffan, 1976; Schmidt, 1969), is indicative of subjects strategy to correct error based on knowledge of results from previous trials. A more plausible explanation for the atypical constant error distribution obtained by Martens is that there may have been some systematic bias in his measurement of error magnitude.

Insert Figure 1 about here

Figure 1 also reveals that even with 15 trials there is still considerable variation about the zero point. Our data, and a re-examination of Martens' findings, suggest that consistent performance at or below the criterion level (i.e., correct-dominant response) was not achieved. Instead, it appears that the subjects were still in the initial stages of learning where the incorrect response was dominant. This conclusion calls into question the findings Martens reported for the later stages of motor learning (Martens' "performance phase"). Although audience effects were found for this phase of skill learning, it would be very difficult to maintain that they were a result of a change in habit strength once the criterion was supposedly attained. As Cottrell (1972, pp. 207-208) has pointed out, there is a problem in identifying the dominant habit in this type of sequentially organized response. This could possibly be due to the lack of floor effects without which it is impossible to know with assurance when a .50 probability of correctly responding has been achieved. It is quite apparent that predictions concerning social facilitation are only meaningful on certain kinds of motor tasks. Since Martens' research reports, social facilitation investigators (Carron & Bennett, 1976; Landers, Brawley, & Hale, 1978) have identified some motor tasks where drive theory predictions can be tested.

Considering the audience and videotape conditions in the present study, the audience had the greater effect upon performance, although the videotape condition did affect performance after the criterion was attained. It is interesting that the audience and videotape conditions, when combined, did not interact to produce greater arousal increments and performance decrements in this treatment condition. This finding is in agreement with the problem-solving performance results of Laughlin and Wong-McCarthy (1975).

There is also some indication in the present study and Martens' study that physiological arousal may be the underlying mechanism for the obtained audience effects. As Geen and Gange (1977) point out, "most of the experiments that have been conducted to date to test the drive theory of social facilitation have been derived from the Hullian notion of irrelevant drive, and have not involved any assumptions concerning possible underlying physiological mechanisms" (p. 1273). From the PSI and self-report ACL correlations with performance measures, it appears that arousal is inversely related to performance quality during the initial stage of learning. This is supported primarily from correlations between arousal and performance measures when the treatments were combined. In other instances, the Ns were too small for meaningful statistical comparisons, but at least these correlations showed that the direction of the relationship was consistent (See Table 3). It appears that these arousal measures may be tapping the same mechanism underlying performance. The tendency for positive correlations between arousal and performance measures is consistent with drive theory predictions. It also provides some support for arousal-activation theorists who have equated drive with physiological activity.

The findings of the present study were consistent with the results of other studies (Cohen & Davis, 1973; Karst & Most, 1973) showing a decrease in palmar sweating from the basal to experimental situation. Martens' results showed an increase in palmar sweating during this same period, and this increase remained stable over trials. This difference is surprising since comparable experimental conditions were employed. Our only departure from Martens' procedures was in using approximately two fewer audience members. The size of the audience, however, has not been shown to be linearly related to arousal and motor performance measures (Landers & McCullagh, 1976; Wankel, 1977). From the results of this and other audience studies, it is unlikely that these disparate palmar sweat findings depend on whether the audience is physically present or remote (Geen & Gange, 1977). Nor is it likely due to subjects' focus on the stressful environment versus their own thoughts and feelings (Martens, 1969b). The bidirectionality of the PSI under comparable experimental conditions may be due to the inherent unreliability in applying the solution or to other potential problems with this measure. This technique might be improved further by using Harris, Polk and Willis' (1972) modifications of the PSI. One important modification is the incorporation of twice the amount of coloidal graphite in the chemical solution to provide the sharpest possible contrast. By incorporating this and other modifications of the PSI technique (Harris et al., 1972), greater clarity should be achieved without resorting to less desirable procedures. In addition to Harris et al.'s modifications, other measures of palmar sweating are now available that circumvent many of the problems encountered with the PSI (Harris et al., 1972; Strahan, Todd, & Inglis, 1974).

On the other hand, the decreases in sweating may, as Cohen and Davis (1973) suggest, indicate that subjects reduce their initial levels of apprehension once they become familiar with the experimental procedures. Cohen and Davis' (1973) results support a learned-drive interpretation of audience effects in that learned drives show habituation effects over trials. Due to the problems mentioned earlier, our nonsignificant PSI results must be regarded with caution. They were, however, supportive of Cohen and Davis' (1973) interpretation and were not at all supportive of a pattern that Zajonc (Note 3) maintains would reflect an innate drive.

It is important to consider the Martens' study in historical perspective. Zajonc's (1965) social facilitation hypothesis, followed closely by Martens impressive support for it, captured the attention of many social psychologists and lured them to this seemingly fertile field of investigation. In hindsight, it now appears that much of this initial enthusiasm was unwarranted. Despite claims to the contrary (Cottrell, 1972; Zajonc, 1965, Note 3), there was no clear support in the social facilitation literature prior to 1965 that audience effects produced significant performance decrements during subjects' initial learning of a novel task (see Landers & McCullagh 1976, pp. 133-135, for a review). It is true that since 1965 audience effects consistent with a drive theory interpretation of social facilitation are found with some degree of regularity. It is also true that Zajonc', drive theory analysis still provides a more parsimonious explanation than alternative explanations based on current cognitive views of behavior (Geen & Gange, 1977). In the past decade the focus has been on explaining, as simply as possible, statistically reliable findings rather than determining their predictive significance. At best, audience effects from laboratory experiments on motor behavior appear to be quite small (accounting for 1-3% of the variance), almost to the extent of being of trivial predictive significance.

Melton (1947) and Bilodeau (Note 1) arrived at this same conclusion after testing hundreds of Air Force cadets in coaction and alone conditions. For motor skills, it appears that at the present time these social variables do not constitute an important source of variance even when highly evaluative audiences are employed and motor tasks that control for subjects' dominant-task response are used. It also suggests why numerous investigators have had difficulty corroborating such small, but statistically reliable, audience and coaction results with physiological and self-report measures of arousal. The inherent inter- and intrasubject variability on the arousal measures may be too great to detect the very subtle effects due to a passive audience.

It might be profitable to redirect research on motor behavior to examine social situations together with selected individual personality characteristics known to be affected by arousal. This interactional approach has met with some success in the few social facilitation studies employing it (e.g., Cox, 1968). This approach may complicate the basic simplicity (or oversimplicity) of Zajonc's hypothesis, but it may also enable us to go beyond the negligible social facilitation effects that are characteristically produced by the exclusive use of passive audiences and coactors.

Author Notes

1. Appreciation is extended to Robert W. Christina, Albert V. Carron, Rainer Martens, and Donna M. Landers for providing helpful suggestions on an early draft of this manuscript.

2. Martens (1968) found these substantial differences with measures of and absolute error, which were defined as the difference between the times of arrival of the target and the pointer to the coincident point, with and without regard to sign, respectively. In addition to these measures, Martens (1969a) found the typically small audience effects (^{2}= 2%) for an intravariance measure, which was actually the standard deviation of each subject's scores for each block of five trials. This measure, called variable error (VE), together with constant error (CE) and a total error (E) composite of VE and CE were also employed in the present study.

3. There were two basic departures from Martens' procedures: the audience contained two fewer members; and subjects were not selected on extreme scores on the Manifest Anxiety Scale. This latter departure appeared justified since Martens reported that neither the anxiety main effect nor the anxiety by audience interaction was significant for CE and VE measures.

4. Power is, of course, dependent on the way the data is distributed. Our failure to replicate Martens' CE distribution also resulted in our having considerably less statistical power than estimated from Martens' (1968) data. Where we were able to replicate Martens' VE distribution, the power of our study was comparable to that in

Martens' study. Thus, the lower power was a result of the type of CE distribution we obtained, and not in itself the reason for finding nonsignificant differences between audience present and absent conditions.

5. According to Martens (1968), the only modifications that he made ~~on~~ the apparatus used by Schmidt (1969) was in the electrical circuitry employed for starting and stopping a msec timer.

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Table 1

Means and Standard Deviations for Constant, Variable, and Total Error (msec) Under Different Conditions of Audience, Videotape and Blocks of Trials

Blocks of Trials	Audience Present/ Videotape Present			Audience Present			Videotape Present			Audience Absent/ Videotape Absent		
	CE	VE	E	CE	VE	E	CE	VE	E	CE	VE	E
1	-13.32[a] (82.75)[b]	86.90 (57.31)	114.24 (40.60)	6.41 (40.03)	73.83 (45.63)	86.35 (47.80)	7.16 (45.99)	63.41 (27.54)	77.82 (39.51)	-13.41 (89.37)	64.95 (48.46)	96.51 (59.06)
2	-3.45 (51.80)	54.89 (21.89)	73.42 (30.58)	-16.83 (30.48)	52.00 (20.85)	61.82 (26.53)	-7.91 (45.59)	42.99 (19.72)	59.41 (19.64)	-6.85 (45.96)	44.95 (20.31)	62.38 (25.32)
3	-20.01 (47.29)	50.68 (33.98)	70.12 (29.08)	-12.31 (41.17)	57.91 (33.41)	71.27 (25.49)	-8.16 (20.40)	44.00 (13.64)	49.60 (13.37)	-7.49 (26.34)	41.48 (21.59)	50.10 (18.81)

[a]Negative sign indicates subjects' response was early.

[b]Values in parentheses are standard deviations.

Table 2

Means and Standard Deviations for Trials-to-Criterion Measures

Measures	Audience Present/ Videotape Present	Audience Present	Videotape Present	Audience Absent/ Videotape Absent	All Groups
Trials to Criterion (.90 msec)					
Martens' Study	16.8 (9.01)[a]			10.00 (8.46)	13.40 (7.89)
Present Study	12.87 (11.53)	13.20 (10.09)	10.20 (8.65)	10.40 (8.34)	11.67 (9.00)
Trials ± .30 msec After Criterion Attainment					
Martens' Study	3.00 (1.41)			2.97 (2.09)	2.98 (1.91)
Present Study	5.13 (2.53)	3.50 (1.41)	4.33 (1.58)	2.92 (1.88)	3.86 (1.67)

[a]Values in parentheses are standard deviations.

Table 3

Correlations Between Arousal and Total Error Measures for

Martens' Study and the Present Study

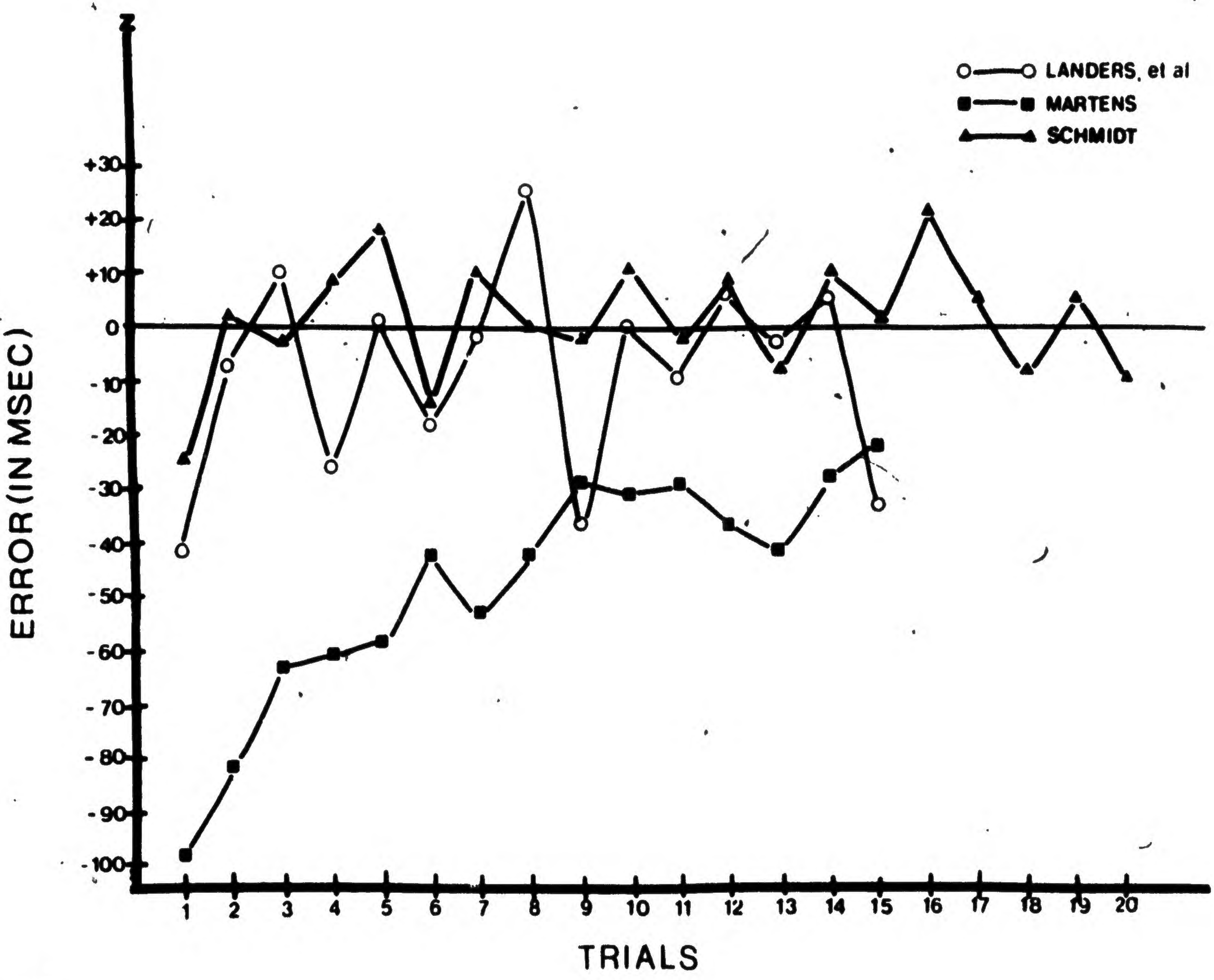
Arousal Measures	Audience Present/ Videotape Present		Audience Present		Videotape Present		Audience Absent/ Videotape Present		All Conditions	
	N	r	N	r	N	r	N	r	N	r
Martens Study PSI	24	.13	-	-	-	-	24	.15	48	.30**
Present Study										
PSI	6	.18[a]	-	-	6	.68*	9	.49	21	.31
High Activation	15	.35	15	.25	15	.33	15	.32	60	.26**
Deactivation	15	-.36	15	.14	15	-.16	15	-.56**	60	-.23**

[a]The Audience and audience/videotape conditions were combined for this correlation.

*$p < .10$
**$p < .05$

Figure Captions

Figure 1. Mean constant error scores for subjects in "alone" conditions in the present study compared to Martens' and Schmidt's studies.



LANDERS, et al
MARTENS
SCHMIDT
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ERROR (IN MSEC)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
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17
18
19
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TRIALS