
Effects of a Supportive Audience on a Handgrip Squeezing Task in Adults

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ABSTRACT

International Journal of Exercise Science 9(1): 4-15, 2016. The role of social facilitation by way of audience effect in select exercise-related variables during an isometric handgrip task was assessed using a mixed design. Fifty three moderately active participants ($M_{\text{age}} = 21.76 \pm 5.27$) were recruited from the Midwestern United States. Participants were randomly assigned to one of two groups: supportive audience or control. Audience members provided positive verbal encouragement to participants in the experimental condition throughout the task performance. Participants in the control group performed the task in the absence of an audience and did not receive any verbal encouragement. Participants provided anxiety ratings pre- and post-task using the State-trait anxiety inventory for adults (STAI). Participants' ratings of perceived exertion (RPE) and heart rate (HR) were monitored and assessed at 30-second intervals. Upon task completion, sustained effort in the form of time on task was recorded in seconds. A repeated measures analysis of variance (RM ANOVA) revealed that there was a time effect within groups of HR = (F(2.64, 131.85) = 189.3, p < 0.001) and within groups of RPE = (F(2.97, 139.42) = 2189.43 p < 0.001). An independent sample T-test revealed significant differences in HR at 0, 30 and 60 seconds between the groups. An independent sample T-test revealed no significant differences in anxiety and RPE between the groups. These results partially support the notion of social facilitation and may have implications for research and practice.

KEY WORDS: Social facilitation, anxiety, interactive others, RPE, endurance

INTRODUCTION

Social facilitation refers to the notion that the presence of others creates performance changes in either facilitative or debilitating ways. Triplett (52) originally observed that children improved fishing and cycling performance in the presence of others. Triplett (52) suggested that the presence

of others stimulates feelings of competition and leads to a desire to move faster. Later, Allport (1) expanded on Triplett's findings by observing college-age participants as they completed different mental tasks in the presence of others completing the same task. He found that in most situations, participants improved their performance. Although similar results had been observed by other researchers,

Allport (1) was the first to term this phenomenon as social facilitation.

Spectators are amongst important antecedents of social facilitation. Performance changes can be elicited by several different classifications of spectators including passive others, evaluative others, or interactive others (1, 15). Of those, passive others correspond to the individuals who are present and observe the performance with no interaction with the performer (41, 56). Evaluative others are those individuals judging the performance (31). Interactive others, also termed "audience" are those who watch the performance and interact with the performer (19, 27).

To further expand on the effects of others' presence on performance, Goffman (24) proposed that changes in performance could be due to the individuals' desire to please the observers. Indeed, the presence of others can change the drive, or arousal, in the participant (56) to promote a heightened desire to perform well while being evaluated (14). Presence of others may also lead to increased focus on task (17) or distraction from it (4), which can in turn impact performance.

Alternative approaches including the theories of drive (56) and evaluation (14) can also help explain the effect of social facilitation on task performance (50). As such, the presence of others increases the arousal, or drive, of the performer and elicits differential performance changes (56). Performers executing a new task typically experience poorer performance and those who execute a familiar task typically experience enhanced performance.

To that end, research indicated that there needs to be an evaluative component to the 'other' watching the performance in order to elicit enough change in arousal to impact performance (14).

Nonetheless, not all researchers have reported a social facilitation effect in motor task performance (10, 23). In an attempt to explain the inconsistencies, Strauss (50) ordered motor tasks in three categories including coordination tasks, conditioning tasks, and tasks involving both coordination and conditioning. To that end, coordination tasks included tasks that require participants to move in a synchronous motion, such as walking or driving (10, 48). Conditioning tasks included those that require high amounts of effort and low amounts of learning, such as running (55). Finally, tasks that involve both coordination and conditioning included those that are team-oriented, such as squash and gymnastics (21, 40). Based on the patterns that emerged from his observations, Strauss (50) proposed that, although the relationships were weak, coordination tasks were inhibited and conditioning tasks were facilitated by the presence of others, while tasks that involve both coordination and conditioning were not affected by social facilitation.

Moving from motor performance, research findings pertaining to social facilitation and sport performance are also equivocal. While some support the effect of social facilitation within the context of sport performance (27, 34, 40, 55), some do not (35, 51). For example, there is evidence to suggest that in the presence of an audience, gymnasts with low skill levels and gymnasts who are unaware that they are

going to perform in front of an audience improve performance relative to those with higher skill levels and those anticipating performing in front of an audience (40). On the other hand, evidence also suggests that squash players with high skill levels and squash players with low skill levels react similarly in the presence of an audience (21). Furthermore, recent research also argues that the presence of a supportive audience can lead to a fear of failure in athletes which may in turn cause them to choke under pressure (34, 56).

In addition to these results pertaining to the presence of others within the sport context, research attention has also been directed toward the presence of others within the exercise context. These results suggest that, at the presence of encouraging others, participants achieve greater peak hamstring and quadriceps torque (11, 39) and report lower ratings of perceived exertion (RPE) (3). The later is important in that RPE is a subjective measure of task difficulty and lower RPEs would imply participants' perception of lower levels of exercise difficulty. Consistent with these findings, relative to participants at the presence of encouraging others, participants at the presence of discouraging others report higher levels of task difficulty and lower levels of exercise-related enjoyment (31). Finally, relative to performing alone, at the presence of virtual competitive others, participants significantly increased effort expenditure during a cycling task (2, 13). However, these supportive findings aren't unequivocal considering others suggesting no significant effects of others' presence on participants' exercise behavior, exercise-related enjoyment levels, and RPE reports during a treadmill task (12).

The present study sought to further explore the effects of others' presence on a set of exercise-related variables. Considering that the presence of others can facilitate or debilitate exercise behavior (2, 3, 11, 12, 13, 31, 39), further studying this effect can help recommendations for its use as a means of facilitating exercise behavior and effort expenditure in general (18, 52). Specifically, the present study aimed to measure the effects of the presence of an interactive audience on participants' anxiety levels, RPE, time spent on task, and heart rate (HR) during a handgrip-squeezing task up to RPE-10.

Given the previous findings that attest to both the anxiety reducing and increasing effects of an audience (56), no *a priori* hypothesis was set for the potential impact of the audience on the participants' anxiety levels. Consistent with previous findings that participants report lower RPEs at the presence of others (3), it was expected that participants performing at the presence of an audience would report lower RPEs. Also in line with previous reports of increased effort output in the presence of others (11, 39), it was expected that the participants performing with the audience present would last longer on task. Finally, drawing upon previous work reporting increased effort expenditure at the presence of an audience (12), it was expected that the participants performing with the audience present would invest higher effort and consequently display higher HRs.

METHODS

Participants

Fifty three students (n=28 male; n=25 female) were recruited from a Midwestern

university to participate in this study. Participants were recruited through exercise science and wellness classes and by means of a university-wide recruitment e-mail. Participants' ages ranged from 18-46 ($M = 21.76 \pm 5.27$). Of the 53 participants, 45 ($n = 23$ male; $n = 22$ female) were Caucasian and 8 ($n = 5$ male; $n = 3$ female) were African-American. Participants exercised an average of 4 days ($M = 4.15 \pm 2.7$) per week (see Table 1a and 1b). Required sample size for repeated measures analysis of variance (RM ANOVA) within subject was determined by means of a power analysis using the G*Power 3.1 program (20). The required sample size for each group was determined as 26, and the total sample size was determined as 52.

Table 1a. Descriptive statistics for participants' ethnicities

	Caucasian	African-American	Total
Male	23	5	28
Female	22	3	25
Total	45	8	53

Table 1b. Descriptive statistics for participants' characteristics

	Mean	SD
Participants' Age	22	5.3
Weekly physical activity (Hours)	4.15	2.7

Inclusion criteria consisted of individuals who were 18 years of age or older who volunteered to participate in this study. Based on their answers to the demographic and health questionnaires (see Instruments), participants were excluded if they were participating in a performance sport (i.e., any sports involving potential crowd/fan presence and effects including football, baseball, and basketball at the varsity, junior varsity, or competitive club

levels), were diagnosed with an intellectual disability or had any pre-existing conditions that may prevent them from performing the handgrip squeezing task (i.e., cardiovascular and musculoskeletal conditions, carpal tunnel syndrome). The Institutional Review Board approved this study.

Protocol

Using a randomized block design which accounted for gender, participants were assigned to two conditions: audience group (AG) (i.e., experimental) or no audience group (NAG) (i.e., control). Participants in the AG performed in front of four audience members. Similar to previously validated protocols (19), audience members were instructed to create a positive audience environment by clapping, cheering, and offering positive, but non-task specific, motivational statements throughout the participants' performance. A total of nine individuals were trained in the proper procedure for the audience members in order to ensure the audience environment was uniform for each participant. Motivational statements included: "You look strong!", "A+ for you!", and "Fantastic!" Participants in the control condition performed the task with no audience present.

A calibrated Lafayette TM handgrip dynamometer Model 78010 (Lafayette Instrument Company, Lafayette, Indiana) was used to measure participants' handgrip capacity. For the purposes of this study, participants squeezed a hand bar that was connected to a spring, which moved a pointer on the face of the device. The testing anchors for the dynamometer ranged between 0-100 kg.

The demographic form included items gauging name, age, sex, number of days spent exercising, sport participation experience, height, weight, and prior use of a handgrip dynamometer.

The General health and life type questionnaire, GHLTQ, (9) included items of cardiovascular health, musculoskeletal conditions, general health history, family health history, and tobacco use. Participants answered items in a dichotomous (YES-NO) format. For the purpose of this study, three items were added to the questionnaire. These gauged the participant histories of carpal tunnel syndrome, musculoskeletal disease, and cognitive impairments and disabilities.

The State-trait anxiety inventory for adults, STAI, (47) was used as a measure of state (Y-Form 1) and trait (Y-Form 2) anxiety. Participants rated anxiety levels using a four point Likert scale with anchors ranging from 1 (*not at all*) to 4 (*very much so*). Positive emotions were reverse scored and scores on each Y-form were totaled. The STAI is a widely used measure of anxiety in social science research (26, 29).

The Rate of perceived exertion, RPE, scale helped gauge perceived exertion during task performance (RPE; 7). The scale is a 10-point category-ratio scale ranging from 0 (*nothing at all*) to 10 (*maximal*). RPE is a reliable measure of effort and possesses high intra-test ($r = .93$) and re-test ($r = .83-.94$) coefficients. The scale is also highly correlated with important physiological indices of exertion including heart rate (HR) and maximal oxygen uptake (VO_{2max}) (7, 8).

A Polar HR monitor was used to measure HR (Polar USA, Lake Success, New York). The HR monitor included a chest strap that made contact with the skin and recorded the electricity of the heart. The device then transmitted a signal to a watch that participants wore on their wrist. HR has been shown to be a reliable indicator of arousal levels (22).

Time to RPE-10 was recorded in seconds using a handheld stop watch by one investigator. Task completion corresponded to the moment when participants reached an RPE of 10 or were unable to maintain the level of task difficulty (30% of maximal volume contraction (MVC)).

This study consisted of two stages. During the initial stage, preliminary information was gathered and MVC for the squeezing task was computed in a quiet room with only the investigator present. At this stage, participants signed the informed consent form, completed the demographic questionnaire and GLTQ and STAI forms. Next, participants' MCV was determined. In order to determine MVC for the handgrip squeezing protocol, participants held the dynamometer in their dominant hand with their arm at the side of their body with their elbow flexed at a ninety degree angle. Participants squeezed the hand bar at maximal effort for one second on three consecutive attempts. A one-minute rest period was allowed in between each trial. The highest force of the three attempts was recorded as the participant's MVC. The investigator then calculated 30% of the participant's MVC prior to moving on to stage two (42, 43, 44).

The second stage of the study consisted of the experimental task. Both stages were completed consecutively with no more than five minutes between stages for all participants. For the purposes of the experimental task, within the testing room, participants in the NAG group were tested with no audience present and participants in the AG group were tested with the four member of the audience present. Audience environment remained the same for each participant in the audience group. If the participant was assigned to the AG, he or she began hearing quiet, positive statements as soon as he or she entered the room. For all participants, the investigator explained the task protocol and asked them to begin when they were ready. Once the task began, participants in the AG heard loud, positive statements and clapping, much like they were at an athletic event (19). For the purposes of the experimental task, participants were instructed to squeeze the handgrip dynamometer at 30% of their MVC until RPE 10. Participants did not watch the caliper reading. In cases where the participant did not hold the grip up to their 30% value, the investigator notified and instructed the participant to squeeze stronger. Task completion corresponded to the moment where participants could not maintain 30% of MVC for five consecutive seconds or reached an RPE of 10. Previous research investigating the effect of external stimuli on perceived exertion and task endurance have used identical task protocols (5, 44).

During task performance, HR and RPE were recorded at thirty second time intervals. Once participants reached task completion, the investigator recorded time to task completion in seconds. Following

task completion, participants completed a second STAI Y-Form 1, after which they were debriefed.

Statistical Analysis

A repeated measure analysis of variance (RM ANOVA) with time interval as within subject and condition as between subject factor was used to analyze the RPE and HR data. Paired sample T-test analysis were performed on the STAI scores to analyze the differences between the groups and pre-post task performance. In addition, an independent sample T-test was used to analyze the differences in time on task between the groups. PASW (SPSS) Statistics 18 package was used to run the RM ANOVA, One-Way ANOVA and T-test analysis in this study. For those analysis, the significance level, α , was considered 0.05

RESULTS

The descriptive statistics and the independent sample T-tests between the two groups showed no significant differences in age and physical activity levels between the audience (AG) and no audience (NAG) groups. Additionally, no significant difference was shown between the two group's MVCs. A significance difference was, however, shown between the two group's resting HR, $t(58) = 2.58$ ($p < 0.05$).

Independent sample T-tests analysis revealed significantly different state anxiety scores for both groups (AG_{pre-Y1} : 27.71 ± 8.44 ; AG_{post-Y2} : 38.5 ± 11.91 , $p < 0.001$ and NAG_{pre-Y1} : 26.37 ± 5.18 ; NAG_{post-Y1} : 34.26 ± 10.2 , $p < 0.05$) between pre- and post-task performance. These results indicate that task performance increased state anxiety

similarly in both groups. No state and trait anxiety means differences were observed between AG and NAG.

Due to high attrition rates around second 150 (N=36), Repeated Measure ANOVAs (RM ANOVA) were conducted up to second 150 for the two groups to analyze the time effect within each group, and independent sample T-tests were conducted for analyzing the between group differences. Table 2 illustrates results for time effect within each group. Analysis revealed differential RPEs in each group at 90, 120 and 150 seconds. Specifically, time on task and RPE increased linearly in both groups. However, no significant differences in RPEs were observed between the two groups (see Figure 1).

Table 2. Time effects on RPE within experimental and control groups by time interval.

	0-90 seconds		0 - 120 seconds		0 -150 seconds	
Audience	32	F(2.17, 123.56)	31	F(2.34, 126,37)	30	F(2.64, 131,85)
Non-Audience	27	=144.5 23*	25	=160.7 33*	22	=189.34 1**

Note: At each time interval, there was a significant difference in reported RPE within each audience and non-audience groups. **Indicates p <0.001.

Independent sample T-test analysis revealed that AG remained significantly longer on task relative to the NAG (AG: 197.92 ± 51.98; NAG: 163.15 ± 42.19, p < .05). Figure 2 illustrates the differences between groups in time on task upon task completion.

Due to high attrition rates around second 150 (N=36), a Repeated Measure ANOVA (RM ANOVA) was conducted up to second 150 for the two groups to analyze the time effect within each group, and independent

sample T-tests were conducted for analyzing the between group differences. Time effects were observed on both groups F(2.97, 139.42) = 2189.434. Participants' HR was different at each time point. Moreover, a mean HR difference was observed between the two groups. AG had significantly higher HR in average relative to NAG (M_{HR AG-NAG}= 10.219, p = .008). Figure 3 and Table 3 illustrate the mean HR difference between the groups.

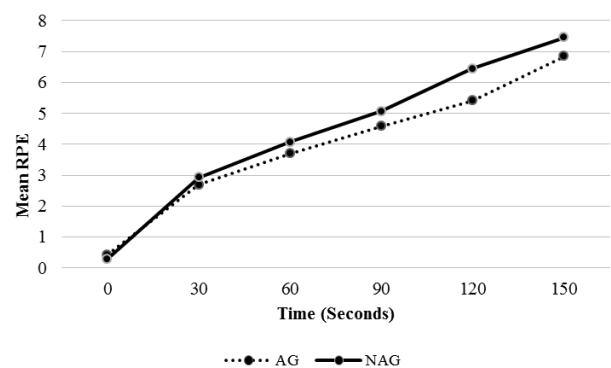


Figure 1. Mean RPE values per group by time interval. Error bars represent standard deviations.

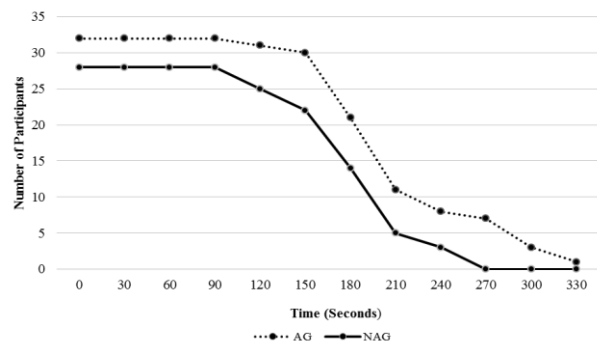


Figure 2. Time on task for the experimental and control conditions. Error bars represent standard deviations.

DISCUSSION

Main findings from this study indicated that participants who performed in the presence of an audience did not lower their RPEs. In fact, the present participants

increased their RPEs linearly as a result of time on task and the audience had no effect on these ratings. These results are not consistent with some findings that showed that participants report lower RPEs with an audience or other motivational stimuli (3, 42, 43). Nevertheless, these results are consistent with others that showed that participants did not report lower RPEs in the presence of an audience (12) or other external stimuli (5, 44).

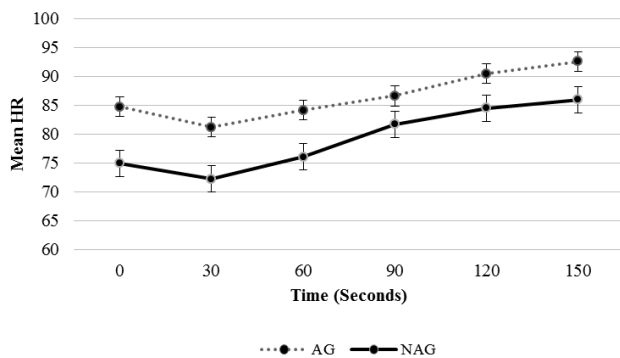


Figure 3. Mean HR differences for the experimental and control groups by time interval. Error bars represent standard deviations.

Table 3. Descriptive statistics for participants' mean HR values.

		N	Mean	SEM
0 Second	AG	32	.42*	.18
	NAG	28	.29*	.17
30 Second	AG	32	2.66	.29
	NAG	28	2.93	.26
60 Second	AG	32	3.70	.38
	NAG	28	4.07	.27
90 Second	AG	32	4.59	.43
	NAG	28	5.07	.34
120 Second	AG	31	5.42	.45
	NAG	25	6.44	.40
150 Second	AG	30	6.90	.44
	NAG	22	7.45	.42

Note: There was a significant difference between groups at resting HR (0 second), $t(58) = 2.58$ ($p < 0.05$).

The ergogenic impact of the audience on task performance shown in this study is in

line with the results of previous ones (19, 34, 56). Participants who performed in front of an audience remained on task longer than those performing the task with no audience present. Similar performance gains in the presence of others were also shown in strength (11, 39, 45) and endurance (13) tasks.

The results of this study also showed that participants performing in front of an audience displayed higher HRs relative to those performing with no audience present. In fact the participants performing in front of the audience started off with higher resting HRs relative to their counterparts performing with no audience present. It is known that the presence of others can change the arousal in participants (56) to promote a heightened desire to perform well (14). Previous work has also indicated that the presence of an audience can increase the body's physiological stress responses (53) amongst which HR is an indicator. Alternatively these participants may have also displayed higher HRs as a result of their longer time on task potentially due to a greater desire to perform well at the presence of others (14).

Lastly, the present results revealed that anxiety increased in both groups linearly throughout the performance of the task. However, the groups did not differ from each other in their pre- and post-task anxiety levels. Although, there was no *a priori* hypothesis for anxiety within the current study, these findings are in line with previous ones (46) suggesting that performance can increase state anxiety as opposed to non-performance. Drawing upon those, it is also interesting to note that participants in both groups reported

elevated anxiety; audience did not seem to have an effect on the anxiety results. Consequently, it is possible that although no participants reported playing performance sports, they may have still been conditioned to the presence of an audience in other ways including class presentations or art performances (6, 33, 47).

Taken together the results of the current study may help shed light on the role of social facilitation by way of an interactive audience during exercise in general, and specifically in exercise-related anxiety, RPE, time on task and HR. While further evidence is needed and no definite conclusion can be drawn, in the present study, having an interactive audience facilitated task performance and increased HR for the participants who performed in its presence. Drawing upon these results, no effect of the audience can be suggested for the anxiety levels or RPEs.

Some limitations should be acknowledged. First, due to the homogenous nature of the present sample, current results and conclusions may not be generalizable to the greater population. Second, no specific information on the age, gender, and if the participant knew an audience member was collected from the audience. Given that the make-up of the audience may have an effect on the performance of the participants, this information could prove beneficial. Third, although frequently used in previous research (5, 44), the handgrip-squeezing task used in this study may present low ecological validity in comparisons to other forms of physical activities (e.g., running, cycling). Fourth, different types of tasks may be

differentially affected by social facilitation (50). To that end, it is plausible that some of these participants experienced this task as a coordination task while others as a conditioning task. In other words, participants with no previous experience with the task may have focused more on its coordination aspects while those with some previous experience may have focused more on its conditioning aspects. Fifth, to prevent any bias the audience may introduce on the participants' responses, participants completed the second anxiety questionnaire about three minutes following task completion. Because the questionnaire gauged emotions immediately felt at task completion, completing it retrospectively may have failed to accurately capture the participants' "in the moment" experiences. Lastly, it is also plausible that the anxiety questionnaires may have primed the participants' awareness of their anxiety, which may have in turn impacted their second appraisal and rating of their anxiety.

In order to generalize results to greater populations, future investigations should consider using tasks with higher ecological validity (i.e., running or cycling tasks). Furthermore, the use of single-item anxiety measures in the course of the task performance could provide researchers with more accurate representation of the participants' experience throughout the task. Finally, adding a measure of motivation or including a qualitative component to those inquires could allow a better understanding of how social facilitation effects exercise behaviors.

The current results indicate that the presence of supportive others may help

increase time spent on exercise task and this is important to consider. To the extent that exercise has ample health benefits, any intervention to increase time spent exercising remains of high practical utility (38). Additionally, from a self-determination theory standpoint (16), the extra time spent on task may help individuals feel more competent while exercising, which can in turn increase motivation and adherence to exercise. Nevertheless, the validity of this proposition should be tested in upcoming research. Finally, when working with individuals who are trying to establish consistent and positive exercise behaviors, practitioners could benefit from using encouraging statements. To that end, group exercise settings and/or exercise buddy systems may also prove practical avenues to provide exercisers with audience-based scenarios.

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