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Rudimentary Physiological Effects of Mere Observation

JOHN T. CACIOPPO,
The Ohio State University

PATRICIA A. ROURKE, BEVERLY S. MARSHALL-GOODELL, LOUIS G. TASSINARY, AND ROBERT S. BARON
The University of Iowa

ABSTRACT

Complex social factors can influence physiological activity, behavior, and health, but little is known about how essential components of these factors (e.g., human association, observation) affect human physiology. To begin to address this issue, an experiment was conducted to contrast predictions from social facilitation, distraction/conflict, and physiological reactivity formulations regarding the physiological effects of *mere observation*. Skin conductance and heart rate were measured surreptitiously from 27 women during a period in which they believed that the experimenter was simply calibrating auditory and physiological recording equipment. Approximately half of the subjects were led to believe that they could be observed by the experimenter during this period, and the remainder were led to believe that they could not be observed. Following baseline recordings, a series of 10 orienting tones were presented. Predictions from the physiological reactivity formulation were supported: (a) no differences in basal levels of somatovisceral activity were found as a function of mere observation; (b) mere observation enhanced the skin conductance response to the initial orienting tone; and (c) these physiological differences were punctate, quickly dissipating and quickly habituating. Hence, mere observation has subtler physiological effects than thought previously. Implications are discussed regarding the possible mechanism underlying the stress-enhancing and stress-buffering effects of human association, and regarding the effects social and contextual factors may have in psychophysiological research. Results from an international survey, based on the responses of 57 authors of articles that have appeared in *Psychophysiology* since 1983, are reported to inform the latter discussion. Results suggest that, even when social factors in psychophysiological research are minimized or held constant within studies, subtle differences in the social context across studies within and across laboratories may contribute to the appearance that psychophysiological relationships are unreliable.

DESCRIPTORS: Mere observation, Social facilitation, Physiological reactivity, Electrodermal activity, Skin conductance response, Heart rate, Electromyogram, Orienting response, Social psychophysiology.

Complex social factors such as an individual's level of social support or position in a social hierarchy can moderate both the effects of emotional stimuli on physiological reactivity and disease, and the effects of physiological changes on behavior (e.g., Broadhead et al., 1983; Cacioppo, 1982; Haber & Barchas, 1984). It is unclear, however, how multifaceted social factors produce such effects because little is known about the physiological effects of elementary components of these social factors, such as mere presence or observation. The aim of the present study is to examine the physiological consequences of one of the simplest components of these complex social factors—being within the focus of attention of a conspecific, or "mere observation."

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Address requests for reprints and correspondence to: John T. Cacioppo, Department of Psychology, The Ohio State University, 1885 Neil Avenue Mall, Columbus, Ohio 43210-1222.

Assertions about the physiological effects of human association and observation are usually attributed to Zajonc's (1965, 1980) theory of social facilitation (e.g., see Gale & Baker, 1981). In seeking to understand how the presence of conspecifics affects behavior, Zajonc (1965) proposed that: (a) the presence of or observation by others, as spectators or as coactors, elevates nonspecific physiological arousal levels; (b) physiological arousal enhances the emission of dominant responses, resulting in a facilitation of simple task performances and an impairment of complex task performances; and (c) it is the presence of conspecifics that is the sufficient condition to bring about these effects. Zajonc (1980) elaborated upon this formulation by suggesting that mere presence increased physiological arousal levels due to the uncertainty created by a conspecific. This important formulation unified almost 70 years of disparate research on the behavioral effects of coaction and observation, but was admittedly speculative with regard to the postulated physiological mechanism and outcomes.

Indeed, although psychophysiological data have been cited as supporting Zajonc's theory, the focus of the formulation was on the behavioral rather than the physiological consequences of human association, and consequently the formulation does not offer a detailed treatment of the physiological bases or consequences of mere observation. For instance, the Hull-Spence drive theory upon which Zajonc's (1965) formulation is based does not make explicit predictions about physiological responses, and it is therefore unclear what if any physiological differentiation of social conditions would be inconsistent with this formulation. It is perhaps noteworthy, however, that Zajonc (1965) discussed the generally physiologically arousing effects of conspecifics, and among the studies Zajonc (1980) cited in support of his model was a study by Latane and Cappell (1972), who showed that heart rate over a 5-min period in rats who were in the company of another rat was higher than was heart rate in rats who were alone in an open-field situation. For these reasons, the clearest physiological prediction from Zajonc's theory appears to be that the simple presence of or observation by a conspecific elevates physiological arousal levels:

> The theory of social facilitation enunciated by Zajonc in 1965 is probably too well known to require extensive description. Briefly, it is that the presence of conspecific organisms, as either coactors or a passive audience, *produces an increment in general arousal,* which in turn serves as a drive that energizes dominant responses at the expense of subordinate ones in accordance with the familiar Hull-Spence equation, $E = D \times H$ (Geen & Gange, 1977, p. 1268, italics added).

Subsequent investigations of the impact of mere observation have focused much more on behavioral than physiological predictions. Most studies have not involved any physiological recording, and studies in which physiological measures *were* recorded have additionally required that subjects perform a task to enable the quantification of behavior under audience or no audience conditions (e.g., see reviews by Bond & Titus, 1983; Geen & Gange, 1977; Guerin, 1986). Consequently, the alternative formulations generated since Zajonc's proposal have either ignored the physiological component altogether or have embraced the suggestion that mere observation elevates general physiological arousal levels. One of the most influential of these, distraction/conflict theory (Baron, 1986; Baron, Moore, & Sanders, 1978; Groff, Baron, & Moore, 1983), posits that the presence of others *when performing a task* constitutes a distractor and, hence, creates attentional conflict, thereby increasing general physiological arousal and drive, which in turn produces either behavioral facilitation or behavioral impairment depending on the level of task difficulty. That is, according to Baron and his colleagues, drive is again a central concept but it, and the accompanying physiological activation, are thought to be attributable not to the mere presence of or observation by a conspecific, but rather to the attentional conflict created by audiences during a task (see Baron, 1986; Sanders, 1984). Groff et al. (1983), for instance, stated:

> If distraction-conflict theory is correct in assuming that attentional conflict mediates social facilitation, audiences should facilitate the vigor and speed of ergograph responding *only when paying attention to the audience conflicts with task demands* (p. 362).

Results have provided only partial support for these physiological predictions: measures of electrodermal activity reveal greater activation during a task under audience than under no-audience conditions, whereas heart rate and electromyographic activity have not been affected consistently by the presence of observers during the task (see Bond & Titus, 1983; Geen & Gange, 1977; Guerin, 1986; Moore & Baron, 1983). In reviewing this literature, Cacioppo and Petty (1986) noted that this pattern of physiological response is similar to that found in studies of mildly threatening or potentially punitive stimuli. Fowles (1980), for instance, summarized this latter literature as showing that:

> EDA responds to threatening stimuli, that this response is not attributable to somatic activity, and that—

at least in many cases—heart rate does not respond to these stimuli (p. 93).

Although the link between electrodermal activity and the punitive consequences of a stimulus is unlikely to be invariant (e.g., novel stimuli also elicit changes in electrodermal activity; see Cacioppo & Tassinary, in press), these parallels raise the possibility that a rudimentary effect of mere presence is to modulate the potential punitive consequences arising from intrusions on an organism's environment and, hence, influence physiological reactivity to signal stimuli. In the absence of a positive attachment, affiliation, or bond between the conspecifics—as has been the case in most research in this area—mere observation can be expected to heighten the potential punitive consequences arising from intrusions on the organism's environment and, hence, increase physiological reactivity to signal stimuli (see Cacioppo & Petty, 1986). Unpredictability, uncertainty (Zajonc, 1980), evaluation apprehension (Cottrell, Wack, Sekerak, & Rittle, 1968), and self-presentational concerns (Carver & Scheier, 1981) each may arise from observed performances, but it may be useful to view these divergent psychological reactions simply as exemplars of the various ways in which mere presence or observation can heighten the potential punitive consequences of actions or environmental changes. According to the physiological reactivity model, mere observation should increase the strength of excitatory responses to innocuous stimuli without necessarily increasing the level of general physiological arousal; moreover, this differential reactivity should dissipate quickly under observational conditions that prove not to constitute a threat (e.g., mere observation by a strange experimenter).

The present study was designed to contrast the physiological predictions made by social facilitation, distraction/conflict, and physiological reactivity formulations. This was done in a hierarchical fashion, with (a) the first hypothesis contrasting a prediction about physiological outcomes from Zajonc's social facilitation theory against a competing prediction derived from the distraction/conflict and physiological reactivity formulations; and (b) the second hypothesis contrasting a prediction from distraction/conflict against a competing prediction made by the physiological reactivity model.

Specifically, the first hypothesis focuses on the *basal* physiological activity exhibited by individuals who are alone or are merely being observed by a conspecific. If mere observation in the absence of task activity raises the general physiological arousal level of an organism, then differences in somatovisceral activity should be evident as a function of observation. On the other hand, if mere observation either (a) increases drive/arousal due to the attentional conflict others create when an individual is performing a task, or (b) simply enhances physiological reactivity, then the initial basal level of physiological activity should be comparable across "observed" and "unobserved" conditions. Examining basal levels of physiological activity therefore provides a simple but effective means of differentiating between the hypothesis from social facilitation theory that mere observation increases general physiological arousal levels and the prediction made by distraction/conflict and physiological reactivity formulations.

The second hypothesis, in contrast, focuses on the nature and magnitude of the physiological response evoked by the presentation of an innocuous orienting stimulus during a period in which subjects believed that the experimenter was calibrating auditory and physiological recording equipment. According to distraction-conflict theory, mere observation should enhance drive/arousal to the extent that subjects are engaged in a capacity-demanding task. If subjects are led to believe that they are simply sitting quietly well in advance of the initiation of any experimental task, then mere observation should not create attentional conflict with a task and, therefore, should not affect an individual's physiological reaction to an unexpected signal stimulus. If, however, mere observation enhances an organism's physiological reactivity, then the skin conductance response to the initial orienting stimulus should be greater in the "observed" than in the "unobserved" condition even when basal levels of peripheral physiological activity are comparable.

It is conceivable that subjects in the observed condition could be more absorbed in thought (e.g., about their being surveilled) than subjects in the unobserved condition, and consequently be in a state of relative "distraction" when the initial orienting stimulus is presented. It is important to note, therefore, that previous research on the orienting response has demonstrated that subjects who are distracted from or are intentionally inattentive to a stimulus show *smaller* rather than larger orienting responses (as measured by the skin conductance response) than do subjects who are either sitting idly or trying to attend to the stimulus (e.g., Iacono & Lykken, 1983; Michihiro, Muranaka, & Miyata, 1984). Hence, only the physiological reactivity model predicts that the orienting stimulus will evoke a *larger* skin conductance response under observed than under unobserved conditions; any other outcome could be interpreted as favoring the distraction/conflict model. The skin conductance

response to the initial orienting stimulus therefore provides a powerful means of distinguishing between the physiological predictions from the reactivity and distraction/conflict models.

In sum, subjects who were led to believe that they were either being observed or not during the calibration of auditory and physiological recording equipment were exposed to a series of innocuous auditory tones while skin conductance, heart rate, and electromyographic activity over the left and right *splenius capitius/semisplinalis coli* (neck) muscle region were monitored surreptitiously. The physiological responses before and to the first orienting stimulus were of primary interest for two reasons. First, these responses were sufficient to distinguish between the physiological predictions made by the social facilitation, distraction/conflict, and physiological reactivity formulations. Hence, the number of confirmatory statistical analyses could be restricted by this focus. Second, it appeared conceivable that subjects might become suspicious once it became clear that an entire sequence of auditory stimuli, rather than a single calibration tone, was being presented. Nevertheless, subjects were exposed to a series of 10 orienting stimuli, rather than to a single tone, because: (a) the presentation of these additional stimuli followed and, therefore, could not interfere with the specific theoretical hypotheses being tested; (b) the inclusion of these additional tones allowed exploratory analyses of habituation and dishabituation to be performed; and (c) their inclusion should facilitate meaningful comparisons of the present results with those obtained in previous research (e.g., see review by Dawson, Schell, & Filion, in press).

Method

Subjects

Twenty-seven healthy females, aged 18–35 years, were recruited to serve as subjects. Subjects were paid $6.00 for their participation. All subjects were tested by the second author, who was blind to the specific experimental hypothesis. Only females were tested to maintain same-sex pairings between the subject and the observer (the experimenter).

Apparatus

Physiological activity was monitored continuously on a Grass Model 7D polygraph and transmitted simultaneously to an IBM/PC-AT laboratory computer running ASYST. The physiological signals were digitized using 12-bit (0.2 μV/unit) A/D boards by Metrabyte Corporation. In addition to the following measures, a single ground electrode filled with high conductivity gel was attached to the right earlobe after cleaning the site with alcohol.

Skin conductance. Standard Beckman Ag/AgCl surface electrodes (8 mm internal diameter) were placed over the thenar and hypothenar eminances of the nonpreferred hand. Prior to the attachment of these electrodes using adhesive collars, the recording sites on the skin were washed using a nonabrasive soap, and the electrodes were filled with a .05 molar NaCl solution in a Unibase paste, as specified by Fowles et al. (1981). Skin conductance was measured using a Wheatstone bridge with a 0.5V applied voltage and was digitized and stored 20 times per second. Because electrodermal activity has been the most sensitive measure in previous research on mere observation (e.g., see Moore & Baron, 1983) and in studies of orienting (e.g., see Dawson et al., in press; Elaad & Ben-Shakhar, 1989), skin conductance served as the primary dependent measure in the present study.

Heart rate. Gold cup surface electrodes were placed over the upper-right collarbone and apex of the lower-left rib. These recording sites were cleaned using an abrasive soap and alcohol, and the gold cup electrodes were filled with a high conductivity gel (Med Associates). The electrodes were then attached using an approximately 3.8 $\times$ 3.8 cm piece of sponge with an adhesive backing. The threshold detector on the Grass 7P4 cardiotachometer was adjusted to detect the rising slope of each R-spike; the circuitry of the Schmitt trigger was modified so that the precise time each R-spike was detected could be recorded to the nearest .01 s.

Electromyographic activity. Standard Beckman Ag/AgCl surface electrodes (8 mm internal diameter) were placed over the left and right *splenius capitius/semisplinalis coli* (neck) muscle regions in an attempt to quantify postural components of the orienting response. Prior to the attachment of electrodes using adhesive collars, the recording sites were scrubbed with an abrasive soap, abraded with a needle, and cleaned with alcohol, and the electrodes were filled with a high conductivity gel. EMG recordings were bipolar with an interelectrode distance of approximately 5 cm (Davis, 1952). The EMG signals were relayed through Grass 7P3 wide-band AC preamplifiers, filtered using a 5–500 Hz passband (−3dB points), individually rectified, and summed using Grass integrators with 0.05-s time constants and thresholds adjusted to place the "zero signal" of each at less than 2% of full-scale deflection. Integrated EMG activity from each channel was digitized and stored 100 times per second.

Respiration. Respiration was measured for purposes of artifact detection using a Grass plethysmograph placed securely around the center of the torso.

Procedure

Following informed consent and the attachment of electrodes, subjects were seated in a comfortable chair in a private testing room. They were told that they would be allowed approximately 20 min to adapt to the laboratory while a same-sex experimenter calibrated the computer, audio equipment, and physiological recording instruments in an adjacent control room. Following an approximately 15-min adaptation period, the experimenter returned to the testing room and introduced the experimental manipulation. The

experimenter began by asking all subjects if they were comfortable and if they had any questions. The experimenter then told the subjects that the calibration was progressing smoothly, that there were a few more pieces of equipment to calibrate, that they might hear several tones during the calibration of the audio equipment, and that the experiment would not begin until the calibration of all of the equipment had been completed. Finally, the experimenter pointed to four panels covered with a sound-attenuating material and told the subject that these panels covered a one-way mirror. Subjects in the **unobserved condition** were told that one of the panels would be removed before the experiment began to allow the experimenter to watch the subject during the experiment. Subjects in the **observed condition** were told that one of the panels would be removed now to allow the experimenter to watch the subject while she completed the calibration and during the experiment.[1]

Approximately 90 s after the experimenter returned to the control room, subjects were exposed to a series of 80dB tones, each 2 s in duration with rise and fall times of 50 ms. The frequency of the first tone was modulated at a rate of 20 Hz by randomly selecting from a rectangular distribution of frequencies ranging from 80–560 Hz. This tone was then followed by an additional 7 similarly sculpted tones, a dishabituation tone generated from a rectangular distribution of frequencies ranging from 880–1360 Hz, and a final tone similar to the first 8 tones. A variable 53–58 s interstimulus interval was used. The series of orienting tones emanated from the left or right speaker located approximately 1 m behind the subject, with selected speaker determined randomly contingent on at least 4 tones emanating from each speaker.

Data Reduction

Basal electrodermal activity was defined as the mean skin conductance level observed during the 45 s immediately preceding the first tone, and basal heart rate was defined as the mean heart rate during this period. The phasic measure of evoked electrodermal activity was defined as the magnitude of the skin conductance response originating 1–4 s following the onset of each tone, and the phasic evoked heart rate response was defined as the second-by-second heart rate for the 4-s period following tone onset. Phasic skin conductance responses that were preceded from 1–3 s by a strong inhalation were excluded as artifacts. Finally, the tonic measure of evoked electrodermal activity was defined as the mean skin conductance level observed during the 25-s period (partitioned into two 10-s and one 5-s epochs) beginning 5 s following tone onset, and the measure of tonic heart rate was defined as the mean heart rate during these same three epochs. Finally, measures of mean EMG activity over the right and left neck muscle regions were quantified over the same periods as was heart rate, but manipulation checks revealed that subjects could not distinguish between tones emanating from the right or left speaker. The failure of the subjects to be able to discriminate the locus of the auditory tone rendered moot attempts to examine effects of observation on postural orientation to the signal stimulus. Consequently, the EMG measures of basal activity, but not EMG measures of postural orientation, were included in the analyses.

Results[2]

Did Basal Physiological Activity Differ as a Function of Observation?

The *a priori* contrast comparing observed and unobserved conditions revealed no significant difference in skin conductance level, heart rate, or

[1]The present paradigm differs from most previous research in several important respects. Mere observation was manipulated during the "calibration of the recording equipment" to ensure that subjects had no experimental task to perform. Although the absence of a task meant that performance data could not be collected, the physiological predictions made it possible to pit various explanations for the effects of mere observation against one another. Second, early pilot testing revealed that some subjects in "unobserved" conditions nevertheless felt as if they were being ogled through the "eyes of the polygraph." Subsequent pilot testing indicated that the present cover story regarding equipment calibration was effective in eliminating feelings of observation and suspicion. If our pilot testing is representative, then subjects in the "unobserved" condition in this study may have felt less a social presence than subjects in the "no audience" conditions in previous research. Third, the manipulation of observation was intentionally weaker in the present study than in previous research to identify the most rudimentary physiological effects of simply being observed. Specifically, the experimenter occasionally looking at the subject through a one-way mirror while purportedly calibrating the equipment constituted the only observation of subjects in the "observed condition"; and the subjects were reclined in a comfortable chair in such a way that they could tell a one-way mirror separated the testing and control rooms, but they could not see the experimenter, themselves, or any equipment in the mirror. Subjects in the unobserved condition were, of course, reclined in the same fashion, but no mirror was evident in the room.

[2]To maximize the power of the tests of the two theoretical hypotheses, one-tailed *a priori* contrasts were formed. Limited exploratory analyses using two-tailed tests were then conducted to investigate the effects of mere observation on habituation and dishabituation. An alpha level of $p<.05$ was used throughout, and the degrees of freedom for analyses involving repeated measures were corrected for violations of sphericity using the Huynh-Feldt procedure. The degrees of freedom of all tests involving missing data were adjusted to reflect the number of actual observations. Corrected degrees of freedom were rounded to the nearest whole number.

EMG activity during the baseline periods preceding the first tone, all F's<1. These results, which are also consistent with the palmar sweat and self-reported arousal data reported by Landers, Bauer, and Feltz (1978), suggest that mere observation is not sufficient to elevate general physiological arousal levels or to heighten basal levels of sympathetic dominance.

Did the Initial Tone Elicit an Orienting Response?

Before proceeding to the test of the second hypothesis, the skin conductance response and the heart rate response to the first tone were analyzed (irrespective of condition) as a manipulation check to determine if the tone was effective in evoking an orienting response. Results revealed the expected directional fractionation: a significant skin conductance response, $F(1/25)=4.14$, $p<.05$, and a decelerator heart rate response, $F(1/25)=11.43$, $p<.05$.

Did the Physiological Response to the First Tone Differ as a Function of Observation?

Cell means for the heart rate and skin conductance responses to the first tone are illustrated in Figure 1. The *a priori* contrast comparing observed and unobserved conditions provided support for the physiological reactivity hypothesis that skin conductance response magnitude would be larger in the observed than in the unobserved condition, $F(1/25)=3.31$, $p<.05$. There was no evidence for the decelerator heart rate response to be stronger in the observed than in the unobserved group, $F<1$. These results support the view that mere observation enhances physiological reactivity and are clearly inconsistent with the notion that distraction/conflict mediates such heightened reactivity.

Finally, analyses of tonic skin conductance, heart rate, and EMG activity during the half minute following the first tone provided additional data bearing on the hypothesis that mere observation leads to elevated physiological arousal. Results revealed a Condition (observed vs. unobserved) $\times$ Epoch (3 poststimulus periods) interaction on the measure of skin conductance level, $F(2/49)=5.19$, $p<.05$. The interaction revealed that the skin conductance level of subjects in the unobserved group was steady throughout this period ($\bar{X}$s = 3.49, 3.62, and 3.54 μS, respectively), whereas the skin conductance level of subjects in the observed group quickly recovered from the initially higher level following the first tone ($\bar{X}$s = 3.59, 3.45, and 3.25 μS, respectively).

In sum, analyses of the phasic and tonic physiological response to the first tone provided evidence for mere observation influencing the immediate physiological reactivity of subjects to innocuous signal stimuli (see Figure 1), but no evidence was found for the hypothesis that mere observation heightens general physiological arousal per se.

Exploratory Analyses: Physiological Responses During Habituation and Dishabituation Trials as a Function of Observation

Exploratory analyses of the physiological responses during the habituation and dishabituation trials as a function of observation were next conducted. Analyses of heart rate across the 8 habituation trials revealed only a significant main effect for trials, indicating that the decelerator heart rate response to the tone, which was comparable for observed and unobserved groups on Trial 1, habituated similarly across trials in the observed and unobserved conditions, $F(5/131)=3.43$, $p<.05$. A significant Condition $\times$ Trials interaction indicated that skin conductance response magnitude, which was larger on Trial 1 in the observed than in the unobserved condition, also habituated quickly across trials in both conditions, $F(7/175)=2.25$,

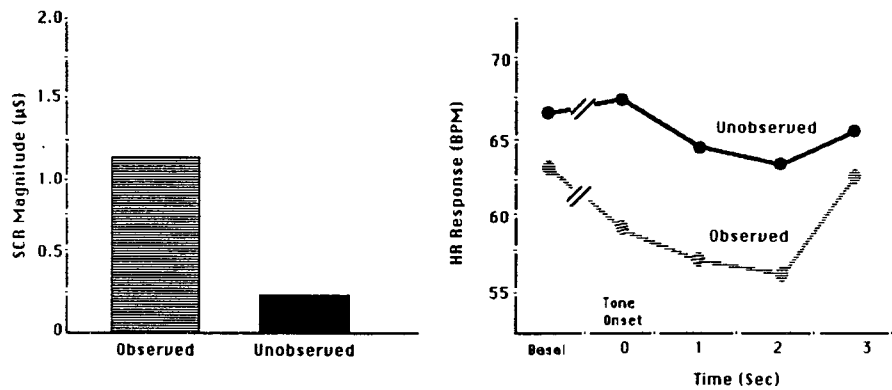

Figure 1. Phasic skin conductance and heart rate response.

$p<.05$. Finally, subjects in the observed and unobserved conditions exhibited equivalent skin conductance responses to the dishabituation tone, but a Condition × Epoch interaction indicated that the skin conductance level of subjects in the unobserved condition declined during the poststimulus period relative to the skin conductance level of subjects in the observed condition, $F(2/46)=14.79$, $p<.01$. That is, changes in skin conductance level differentiated the observed and unobserved groups once subjects had an opportunity to reflect on the possible meaning of the dishabituation tone. This effect, too, was short-term; no test on the final trial was significant. No other test was significant.

Discussion

Implications for Social Processes and Health

There are now over two dozen published experiments testing the behavioral and physiological effects of observation which have monitored autonomic or EMG activity as subjects performed some task under audience or no-audience conditions. Although these studies have revealed differences as a function of observation on measures of electrodermal activity (e.g., palmar sweat index, skin conductance), they have revealed no consistent effects on heart rate or EMG activity. Despite the task requirements in these studies and the nonuniform physiological effects of observation, the most common characterization in this literature is that mere observation leads to an increase in nonspecific physiological arousal (see reviews by Bond & Titus, 1983; Geen & Gange, 1977; Guerin, 1986; Moore & Baron, 1983). For instance, Landers et al. (1978) measured palmar sweat and self-reported arousal prior to and during a coincident-timing task; although they found no difference between audience and no-audience conditions on either measure during the baseline period (F's<1), they offered an interpretation only for the significant physiological differences observed during the task: observed subjects were more aroused physiologically than were unobserved subjects. In sum, theory and research on the physiological consequences of mere observation per se have not received much serious attention because: (a) subjects in these studies were required to perform tasks to allow a quantification of behavior, and (b) any evidence of an elevated physiological response in the observed, in contrast to unobserved, condition was treated as evidence of general physiological arousal.

In the present study, competing predictions from three theoretical formulations regarding the physiological effects of mere observation were contrasted using a comparatively mild manipulation of "observation" and the orienting-tone paradigm from psychophysiology. Specifically, Zajonc's (1965) theory makes a different prediction from the distraction/conflict and physiological reactivity models regarding the effects of observation on basal levels of physiological activity; and the latter two models make competing predictions regarding the magnitude of the skin conductance response evoked by an innocuous orienting stimulus prior to the onset of an explicit experimental task for the subject to perform. Results from the present study contradicted the prediction that simply being observed elevates physiological arousal levels in the absence of provocation or action and revealed instead that mere observation has subtler physiological effects than delineated in previous research on social facilitation. For instance, no differences in basal levels of somatovisceral activity were found as a function of mere observation; rather, mere observation enhanced the skin conductance response to the initial orienting tone, and these physiological differences were punctate, quickly dissipating, and quickly habituating. Even presentations of an innocuous stimulus did not produce general or prolonged elevations of physiological activity. Thus, consistent with ethological research showing that the presence of conspecifics in the face of uncertainty or scarce resources elevates the potential for nonreward or punishment (e.g., see Uetz, Kane, & Stratton, 1982), mere observation was found in the present study to elevate physiological reactivity to environmental changes. Together, these data provide the strongest support for the physiological reactivity formulation.

It is conceivable that both sympathetic and parasympathetic responses to signal stimuli might be affected by mere observation. Limited as they are, the heart rate data argue against an appreciable effect of mere observation on parasympathetic activity. Heart rate changes within the first couple of beats following a stimulus (e.g., see Figure 1) are mediated by changes in vagal input, whereas those developing over longer periods may be mediated by some combination of parasympathetic and sympathetic input (Koizumi, Terui, & Kollai, 1985; Somsen, Jennings, & van der Molen, 1988). Although a significant deceleratory heart rate was elicited by the tone, neither its onset, its magnitude, nor its habituation varied as a function of mere observation. We have replicated this deceleratory heart rate response using a 60dB tone in a study in which subjects in the observed condition were led to believe that a group of students (rather than the experimenter alone) were watching through a one-way mirror during the experiment. Again, however, the effects of observation on heart rate deceleration

did not approach significance. Hence, mere observation appears to operate in a somewhat selective and temporally defined manner through the sympathetic rather than the parasympathetic nervous system.

At the psychological level, uncertainty (Zajonc, 1980), evaluation apprehension (Cottrell et al., 1968), self-presentational concerns (Carver & Scheier, 1980), and distraction/conflict (Groff et al., 1983) may each constitute a sufficient but not a necessary explanation for the behavioral facilitation of simple task performance and the behavioral impairment of complex task performance as a function of the presence of another person. As we have noted, the manipulation of observation used in the present study is comparatively weak (see footnote 1) and may not be sufficient to produce behavioral impairment or facilitation. The present study nevertheless raises the possibility that each of these sufficient but unnecessary psychological explanations (e.g., evaluation apprehension, uncertainty) may be elements of a more general perception that the presence of the conspecific constitutes a potential threat to a valued resource (e.g., social approval, personal control over outcomes).

Note that although the perception that the presence of a conspecific constitutes a potential threat may be necessary for enhanced physiological reactivity and social facilitation effects on performance, we do not mean to suggest that a necessary consequence of mere observation or human association is to *enhance* physiological reactivity or social facilitation effects on performance. The physiological reactivity formulation predicts that human association can have either stress-enhancing or stress-buffering consequences, and it highlights conditions under which each outcome is expected. Briefly, the physiological reactivity model specifies that association with or observation by agents who can exercise fate control over valued resources (e.g., food, social approval) *increases* the magnitude of the excitatory input to particular target organs in response to environmental challenges, whereas human association that enhances a person's sense of fate control or reduces the likelihood of the loss of a valued resource *diminishes* this physiological reactivity to stressors (e.g., see Cacioppo & Petty, 1986, pp. 658–664). For instance, although the bulk of the social psychological research on mere presence and observation has focused on their activating properties (see Baron, 1986), studies by Kissel (1965), Schachter (1959), and Latane and his colleagues (e.g., Latane, Williams, & Harkins, 1979) all suggest human association can have stress-reducing properties as well. Hence, although an assessment of the accuracy of the predictions from the present physiological reactivity model awaits further research, this model may help to explain the conditions under which social stimuli have stress-enhancing versus stress-reducing properties, and why multifarious social factors such as "social support" predict health outcomes in some instances but not in others.

Implications for Psychophysiology

Perhaps since Lacey's (1959) influential review of the complexity of psychophysiological assessment in therapeutic interactions, investigators have tended to hold social factors constant to minimize variability (cf. Cacioppo, Petty, & Tassinary, 1989). However, there are at least two reasons why the physiological effects of complex social factors (e.g., observational condition) should be important to psychophysiologists *even when these factors are held constant within their studies.*

First, given the ubiquitous social environment and heritage, even fairly basic psychological processes such as learning, categorization, appraisal, emotion, and stress are often elicited or dramatically shaped by social factors (e.g., Cacioppo & Petty, 1983; Wagner, 1988; Waid, 1984). To the extent that the physiological processes elicited by nonsocial and social factors are not completely interchangeable, psychophysiological theories will be incomplete until theories address elemental and contextual social factors and processes.

Second and more importantly, psychophysiological theories will be *inaccurate* to the extent that social factors moderate the very nature of an individual's appraisal of or physiological responses to nonsocial stimuli (see Cacioppo, 1982, pp. 248–250). For instance, significant differences in physiological reactions to a simple auditory stimulus were observed in the present study even though the manipulation in conditions of observation was quite mild. Moreover, this variation across conditions did not simply augment all physiological reactions, but instead influenced only a subset and, hence, the pattern of physiological responses observed. Such a result raises the distinct possibility that inattention to the social context in which psychophysiological data are collected can create the false impression that psychophysiological patterns and relationships are unreliable (cf. Cacioppo & Tassinary, 1989).

To determine whether significant differences in social context (e.g., condition of observation) do, in fact, exist across psychophysiological laboratories, we conducted a survey of all authors of articles published in *Psychophysiology* since 1983 in which electrodermal activity was measured. This latter criterion was selected because results from the present study indicated that mild differences in the conditions of observation may influence the physiological responses observed in these studies.

One hundred sixteen authors or coauthors were identified and were mailed a two-page survey asking about: (a) whether or not, and if so, the manner in which subjects in their laboratory are observed during testing; (b) the procedures used to decrease subjects' anxiety regarding participation in psychophysiological experiments; (c) the occupational status of the experimenters; (d) the percentage of subjects who are male and female; (e) the attention given to possible effects due to the sex of the subject and the sex of the experimenter; (f) the other measures typically recorded and the number of additional electrodes attached when measuring electrodermal activity; and (g) the estimated duration of contact between the experimenter and the subject. Eight surveys were returned undelivered, and one respondent returned an uncompleted survey noting that he/she had not pursued psychophysiological research. Of the remaining 107 potential respondents, completed surveys were received from 57 psychophysiologists, yielding a response rate just over 53%.

Responses to the survey are summarized in Table 1. Briefly, the survey revealed substantial differences across laboratories in the social and contextual factors (e.g., the means by which subjects are instructed or observed, the status differential between subjects and experimenters). Further analyses of the surveys revealed that approximately half (47.4%) of the respondents checked one or more item indicating that their observation of subjects during studies was overt (e.g., experimenter in the same room, videocamera visible to subject). These data, together with the results of the present experiment, suggest that common variations across laboratories, and in some cases across studies within laboratories, may have subtler and more complex physiological effects than previously expected (e.g., offsetting physiological activity in a uniform fashion; cf. Gale & Baker, 1981). Such differences may contribute to the impression that psychophysiological relationships are not reliable (e.g., see Barlow, 1988), when these relationships may be reliable but are complex and context specific (Cacioppo & Tassinary, in press). Consequently, the practice of holding social factors constant within experiments and ignoring their possible influence thereafter may actually compromise the cumulative nature of psychophysiological research unless or until their effects are probed and understood more completely.

Table 1

A survey of variations in social context across laboratories

Experimenter's Association to Subject During Study	
Experimenter same room as subject	19%
Subject clearly visible to experimenter	49%
Experimenter clearly visible to subject	7%
Videocamera clearly visible to subject	30%
Polygraph clearly visible to subject	12%
Polygraph clearly audible by subject	18%
Instructions provided by experimenter	82%
Instructions provided via intercom	35%
Instructions automated	55%
Procedures Used to Reduce Subject's Anxiety	
Presession provided to acclimate subject	37%
Time spent prior to start of experiment	84%
Offer made to answer any questions	82%
No special preparations needed	14%
Occupational Status of Experimenter	
Professor	42%
Professional research staff	61%
Post-doctoral fellow	42%
Graduate student	83%
Undergraudate student	
Honors student	37%
Others	28%
High school student	2%
Sex of Subjects	
Male	49%
Female	51%
Sex of the Experimenter and Sex of the Subject	
Always the same	4%
Always the opposite	4%
Systematically varied	11%
Not considered	82%
Additional Measures Typically Recorded When Measuring Electrodermal Activity	
Respiration	53%
Heart rate	77%
Finger pulse amplitude	17%
Blood pressure	21%
Skin temperature	9%
Electrogastrography	2%
Electromyography	21%
Electro-oculography	17%
Electroencephalography	35%
Other	16%

Note. The estimated length of contact between the experimenter and the subject on the first day of testing averaged approximately 55 min. These estimates ranged, however, between 0–180 min; and 4% of the respondents indicated that they typically test subjects for more than a single day (range: 1–20 days).

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