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Physiological Correlates of Imagery-Induced Orgasm in Women

Beverly Whipple, Ph.D., R.N., F.A.A.N.,[1] Gina Ogden, Ph.D.,[2] and Barry R. Komisaruk, Ph.D.[3]

Orgasm has been reported to occur in response to imagery in the absence of any physical stimulation. This study was undertaken to ascertain whether the subjective report of imagery-induced orgasm is accompanied by physiological and perceptual events that are characteristic of genitally stimulated orgasm. Subjects were women who claimed that they could experience orgasm from imagery alone. Orgasm from self-induced imagery or genital self-stimulation generated significant increases in systolic blood pressure, heart rate, pupil diameter, pain detection threshold, and pain tolerance threshold over resting control conditions. These findings provide evidence that orgasm from self-induced imagery and genital self-stimulation can each produce significant and substantial net sympathetic activation and concomitant significant increases in pain thresholds. The increases in the self-induced imagery orgasm condition were comparable in magnitude to those in the genital self-stimulation-produced orgasm condition. On this basis we state that physical genital stimulation is evidently not necessary to produce a state that is reported to be an orgasm and that a reassessment of the nature of orgasm is warranted.

KEY WORDS: orgasm; imagery; genital self-stimulation; blood pressure; heart rate; pupil diameter; pain thresholds; women.

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[1]College of Nursing, Rutgers, The State University of New Jersey, 180 University Avenue, Newark, New Jersey 07102.

[2]36 Shepard Street, Cambridge, Massachusetts 02138.

[3]Institute of Animal Behavior, Rutgers, The State University of New Jersey, 101 Warren Street, Newark, New Jersey 07102.

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INTRODUCTION

Orgasm has been reported to occur in response to imagery in the absence of any physical stimulation (Ogden, 1981). Ogden reported that 64% of the subjects ($N = 50$) stated that they could experience orgasm from imagery as the only source of sexual arousal, touching no part of the body including the genitalia. Earlier subjective reports of the occurrence of such orgasm exist, but in only 1% (Hite, 1976) or 2% (Kinsey *et al.,* 1953) of the sample of women. Masters and Johnson (1966) reported no occurrence of this type of orgasm in their laboratory setting.

The present study was undertaken to ascertain whether the subjective report of imagery-induced orgasm is accompanied by physiological events that are characteristic of genitally stimulated orgasm. These events include elevation in heart rate and blood pressure (Masters and Johnson, 1966; Bohlen, 1983; Whipple *et al.,* submitted) and pupil diameter (Wagner, 1973). These physiological events that occur in response to vaginocervical stimulation in laboratory rats (Szechtman *et al.,* 1985; Catelli *et al.,* 1987) are considered a syndrome of activation of the autonomic system–sympathetic division (Komisaruk and Whipple, 1988). Furthermore, based on studies in laboratory rats that vaginocervical stimulation elevates pain thresholds (Komisaruk and Wallman, 1977) and differentially suppresses thalamic neuronal responses to pain but not tactile stimulation (Komisaruk and Wallman, 1977), Whipple and Komisaruk (1985, 1988) documented that in women, self-applied vaginal pressure and genital self-stimulation elevated pain thresholds but not tactile thresholds. When the self-stimulation was applied in a pleasurable manner, the magnitude of the elevation in pain thresholds increased, the greatest increase occurring at orgasm. Based on the above findings, we recorded in the present study the following physiological and perceptual variables: blood pressure, heart rate, pupil diameter, and pain and tactile thresholds, in relation to subjective reports of orgasm induced by imagery or genital self-stimulation.

Although other researchers (Bohlen, 1983; Levin and Wagner, 1985, 1987) have measured vaginal blood flow and/or vaginal muscle contractions during orgasm, in this study these physiological measurements were not determined. This decision was based on previous studies from this laboratory in which women chose to use clitoral and/or vaginal self-stimulation when asked to achieve a genital-stimulated orgasm. It was judged that the measurement devices would interfere with the ability of the subject to apply vaginal self-stimulation and might provide genital stimulation during the imagery conditions.

We recognize that there is no universally accepted definition of orgasm. For example, orgasm has been defined as the apex and culmination

of sexual excitement (Miller and Keane, 1987); a sexual climax, marked by a peak in myotonia, vasocongestion, psychological tension, and erotic pleasure (Francoeur, 1982); and a reflex (Kaplan, 1974). Graber (1982) attributed orgasm to the perception of activity in specific genital muscles and organs. Komisaruk (1978, 1982) speculated that orgasm is generated by afferent activity that increases in intensity and synchrony (in response to somatic and visceral afferent and reafferent stimulation), which generates a peak of sensory and motor excitation. After conducting extensive interviews with researchers studying the physiological components of orgasm, Gallager (1982) concluded that an orgasm is an involuntary response to a stimulus. This stimulus is usually thought to be physical, although as cited above, there are indications that imagery is an adequate eliciting stimulus.

Orgasm is a perceptual experience, whose occurrence is reported subjectively. Since orgasm is reported by women to be generated by a variety of methods, the purpose of the present study is to measure specific physiological correlates of subjective reports of orgasm generated not only by genital stimulation but also by nonphysical means, specifically imagery. To understand what constitutes orgasm in women and develop an operational definition, it is necessary to correlate the subjective reports with concurrent physiological measurements. Thus, in the present study, the independent variables are the subjective report of orgasm or highest level of arousal for genital self-stimulation or self-induced or guided imagery conditions, and the dependent variables are the concurrent physiological events.

In a previous study, guided imagery via an audiotape and self-induced imagery were shown to be less effective than genital self-stimulation in elevating pain thresholds and in producing sympathetic activation (Whipple *et al.,* submitted). During that study, one subject was able to experience orgasm from imagery alone. In that subject, pain thresholds and autonomic activity increased significantly during orgasm. We therefore hypothesized that an arousing imagery that resulted in orgasm would produce a significant elevation in pain thresholds. We also hypothesized that the physiological correlates of imagery-induced orgasm would not differ from those of genital self-stimulation-produced orgasm.

METHOD

Subjects

The women ($N = 10$) were paid volunteers who in a preinterview stated that they were able to experience orgasm from imagery alone without physical stimulation. They also stated that they would be able to verbally

report orgasm when it occurred and would be willing to cooperate with all methods used in the study. The mean age of the women was 44.6 years (range: 32–67 years). All reported that they attended or graduated from college. Nine were Caucasian, one was Afro-American. Seven experienced regular menstrual cycles, one had had a hysterectomy, and two reported that they were postmenopausal.

Instrumentation

This study was conducted in the human physiology laboratory in the College of Nursing. After the female investigators toured the laboratory with each woman and reviewed the procedures with her, the woman signed an informed consent, received a psychological evaluation from a psychotherapist, and filled out a questionnaire to provide demographic data.

The same instrumentation and procedures used in previous studies (Whipple and Komisaruk, 1985, 1988; Whipple *et al.,* 1989, submitted) and described below were used in this study.

Pain thresholds were determined by applying a gradually increasing force to each finger of one hand using a Ugo Basile Analgesia Meter (Milan, Italy). During each resting control and experimental condition, the subject placed her finger on the 1-mm diam point of the analgesia meter and a controlled, steadily increasing force was applied ranging from 0 g to a maximum of 1 kg over a 26-sec period. The subject reported by saying "now," when the finger pain was first perceived (defined as "pain detection threshold") and by saying "stop," when finger pain became too uncomfortable to continue (defined as "pain tolerance threshold"). The moment the subject said "stop," the pressure device was lifted from the finger by the investigator. The linear scale is from 0–25 units. These correspond to a linear increase of 0–1000 g. Consequently, a score of 10 = 400 g and a score of 20 = 800 g.

Tactile thresholds were determined during each control and experimental condition by applying a graded series of 20 nylon monofilaments of varied stiffness (von Frey fibers; Stoelting, Inc., Chicago, IL) to the dorsal surface of the hand between the thumb and the index finger. These fibers are graded along a log scale, yielding a linear function of force required to bend each fiber, over a range of forces from 4.5 mg to 447.0 g. The tactile threshold is defined as the minimal force to bend the fiber during which the subject correctly states that she feels the tip of the fiber three out of three times using an ascending/descending method of limits.

Blood pressure in millimeters of mercury (mm Hg), heart rate measured in beats per minute (bpm), and pupil diameter were monitored via a

BioLab system, which was interfaced with a computer in an adjacent room. Blood pressure (via an automatic blood pressure cuff placed on the left calf) and heart rate (monitored on the right great toe with a photocell) readings were recorded every 2 min throughout the experiment and when the woman reported that she reached orgasm. Pupil diameter was measured after pain thresholds were taken during each control and experimental condition. Pain thresholds and autonomic measures were taken during each control and experimental condition and when the woman reported that she was experiencing orgasm.

Pupil diameter was determined using a pupillometer, which consists of an infrared-sensitive video close-up camera and a variable infrared source that is directed at the eye. The eye is maintained in a fixed position by a chin and forehead rest and an eye fixation spot placed in front of the subject. The contrast of the image is adjusted by varying the heat intensity to an optimal measurement level at which the pupil appears uniformly white and the rest of the eye uniformly gray on the video monitor. Relative changes in pupil dilatation are displayed on an analog meter and monitored via a BioLab system. Because of variability in the baseline recordings, and the arbitrary nature of the scale, results are reported as percentage change from baseline. The percentage change is the value during the experimental or resting control condition minus the reference control value (final resting control condition) divided by the reference control value × 100.

Experimental Procedure

Prior to performance of the study, all procedures were reviewed and approved by the Rutgers University Institutional Review Board for the Protection of Human Subjects in Research (IRB). After the questionnaire to obtain demographic data was completed, the woman was asked to relax on a hospital-type bed in a private room in the physiology laboratory. The room environment was quiet and climate controlled. One female investigator was present in the room with the subject. The women were asked not to look at the Ugo Basile Analgesia Meter or the von Frey fibers during the testing.

The physiological measurements and sensory determinations were taken during each control and experimental condition in the following order (a random order was not used since previous studies from this laboratory and pilot data for this study demonstrated no order effect).

1. Precontrol period, resting for 10 min.

2. Experimental period, listening to a 10-min guided-imagery audio tape prepared by one of the investigators. The content of the audio tape was sensuous but not explicitly erotic in nature.

3. Control period, resting for 5 min.

4. Experimental period, applying genital self-stimulation for 10 min in a manner that would most likely lead to orgasm or a peak sexual experience (digital stimulation, vibrator, or a combination of both).

5. Control period, resting for 5 min.

6. Experimental period, self-induced imagery for 10 min, in a manner that would most likely lead to orgasm or a peak sexual experience (no physical self-stimulation).

7. Control period, resting for 5 min.

The entire testing period was approximately 1 hr. At the end of the testing a debriefing session was held between each individual subject and the female investigators to answer any questions and discuss reactions to the experiment. The women remained in control of all experimental procedures at all times and were reminded by the investigators that they could terminate their participation in the study at any time. Each woman served as her own control.

The data analyzed for each experimental condition were the data generated at the point the woman reported orgasm or the highest level of sexual arousal (if orgasm did not occur). The data analyzed for the control resting condition were those obtained immediately after the pain and tactile threshold determinations. All data were analyzed by analysis of variance (ANOVA) for repeated measures, the Tukey protected-*t* post hoc comparison test, or the Student's *t* test using GB-Stat (1989). The significance level was set at $p < 0.05$.

RESULTS

The relative effects of imagery (guided via a prepared audio tape or self-induced) or genital self-stimulation were all determined in the same subject. All data are reported as the group mean ± standard error of the mean, based on individual values.

Incidence of Orgasm Under the Various Experimental Conditions

Of the 10 women in the study, the number reporting orgasm during the various experimental conditions were as follows: guided imagery, 1;

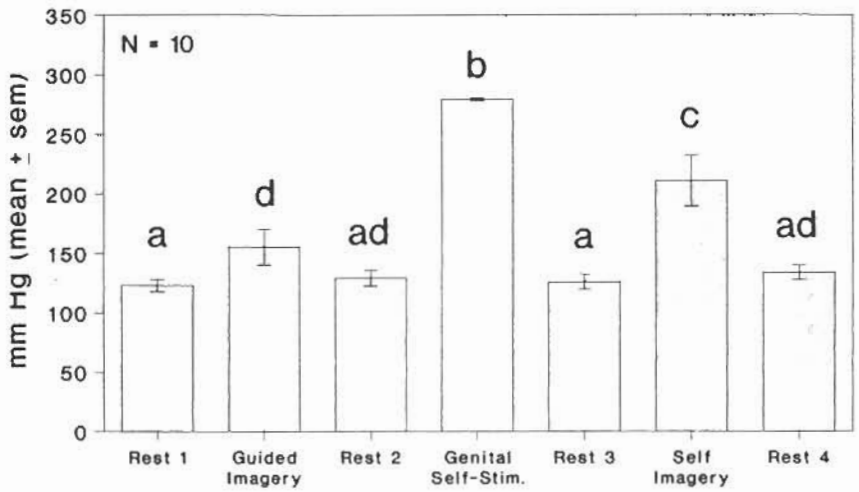

Fig. 1. Systolic blood pressure. Conditions not labeled with the same letter differ significantly from each other; conditions labeled with the same letter do not differ significantly from each other. For example, all three experimental conditions differ significantly from each other, and guided imagery differs significantly from Rest 1 or 3 but not Rest 2 or 4. This convention is used for this and all following figures.

genital self-stimulation, 10; and self-induced imagery, 7. None of the women reported experiencing orgasm during the control resting conditions.

Blood Pressure

The ANOVA for repeated measures comparing the systolic blood pressure across all the conditions was significant, $F(6, 69) = 33.18$, $p < 0.0001$. The systolic blood pressure (mm Hg) during the self-induced imagery condition (210.7 ± 21.45) was significantly greater than during the guided imagery (156.4 ± 15.1) and the four resting control conditions (123 ± 5.1; 129 ± 6.5; 126 ± 6.5; 133.7 ± 5.1) (Tukey test, $p < 0.01$). The systolic blood pressure during the genital self-stimulation condition (279.4 ± 1.1) was significantly greater than during all resting control conditions and both imagery conditions (Tukey, $p < 0.01$). The resting control conditions did not differ significantly among each other (see Fig. 1).

The systolic blood pressure of the women ($N = 7$) who reported orgasm during the self-induced imagery condition (239.3 ± 18.7) was significantly greater than the systolic blood pressure of those ($N = 3$) who did not report orgasm during this condition (144 ± 8.1), $t = 3.55$, $p = 0.01$. The systolic blood pressure of the women who reported orgasm during self-induced imagery did not differ significantly from the systolic blood pressure

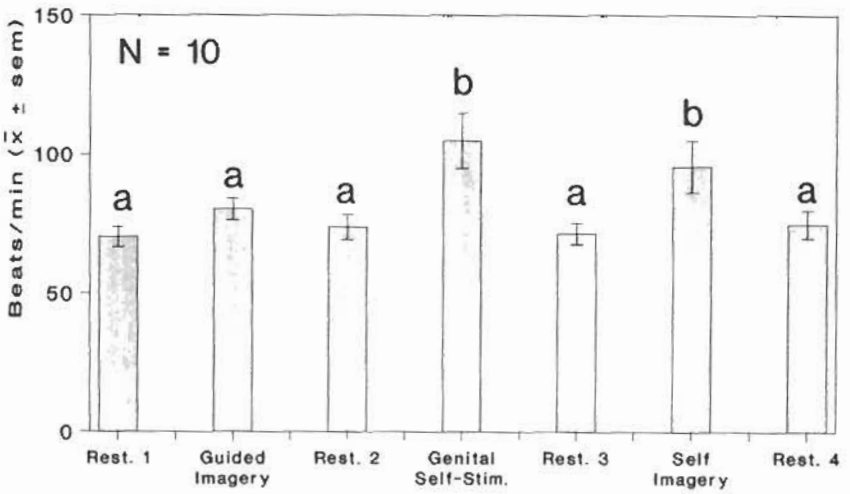

Fig. 2. Heart rate.

of those ($N = 10$) who reported orgasm during genital self-stimulation (279.4 ± 1.1).

Heart Rate

The ANOVA for repeated measures comparing heart rate across all conditions was significant, $F(6, 69) = 9.6, p = 0.0001$. The heart rate (bpm) during the self-induced imagery condition (95.7 ± 9.3) was significantly greater than during the guided imagery condition (80.3 ± 4) and the resting control conditions (73.3 ± 3.7; 73.8 ± 4.5; 71.6 ± 3.9; 74.8 ± 5.1) (Tukey test, $p < 0.05$). The heart rate during the genital self-stimulation condition (104.9 ± 10) was significantly greater than during the guided imagery condition and the resting control conditions (Tukey test, $p < 0.01$). The resting control conditions did not differ significantly among each other and the self-induced imagery condition did not differ significantly from the genital self-stimulation condition (see Fig. 2).

Pupil Diameter

The ANOVA for repeated measures comparing the pupil diameter value across all conditions was significant, $F(5, 53) = 3.04, p = 0.02$. The percentage change in pupil diameter during the self-induced imagery condition (33.4 ± 13.2) was significantly greater than during the second resting control condition (4 ± 8.7) (Tukey test, $p < 0.05$). The percentage change

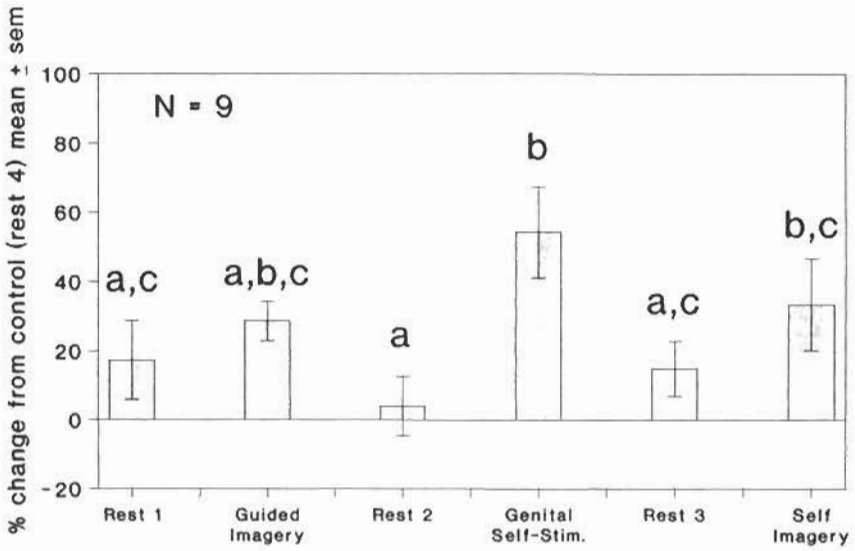

Fig. 3. Pupil diameter.

in pupil diameter during the genital self-stimulation condition was significantly greater (54.2 ± 13.2) than during each of the resting control conditions (17.3 ± 11.42; 4 ± 8.7; 14.9 ± 8) (Tukey test, $p < 0.05$). The resting control conditions did not differ significantly among each other. The guided imagery condition did not differ significantly among any other condition. All of the experimental conditions (guided imagery, self-induced imagery, and genital self-stimulation) did not differ significantly from each other (see Fig. 3).

Pain Detection Threshold

The ANOVA for repeated measures comparing pain detection threshold across all the conditions was significant, $F(6, 69) = 7.5$, $p < 0.0001$. The pain detection threshold (in units) during the self-induced imagery condition (14.49 ± 2.2) was significantly greater than during the guided imagery (10.8 ± 1.1) and the resting control conditions (8.9 ± 1.1; 8.9 ± 1.7; 9.3 ± 1.6) (Tukey test, $p < 0.01$). The pain detection threshold during the genital self-stimulation condition (12.55 ± 1.5) was significantly greater than during the resting control conditions (Tukey test, $p < 0.01$). The resting control conditions did not differ significantly among each other and the self-induced imagery condition did not differ significantly from the genital self-stimulation condition (see Fig. 4).

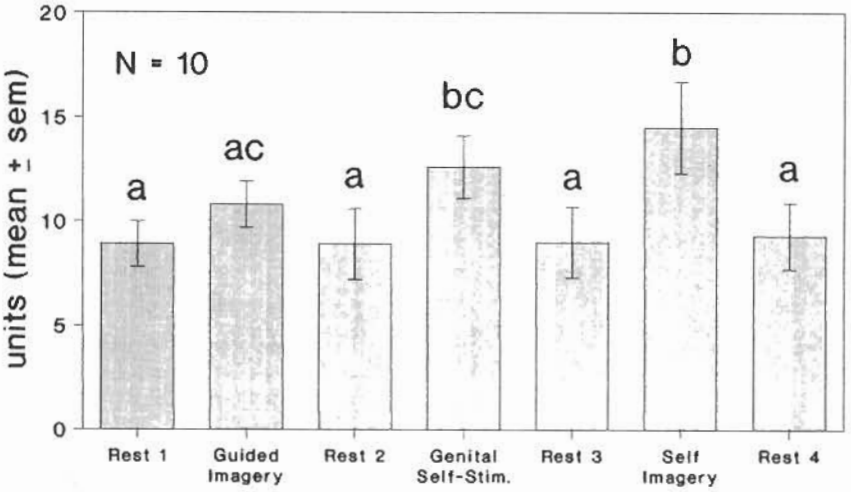

Fig. 4. Pain detection thresholds.

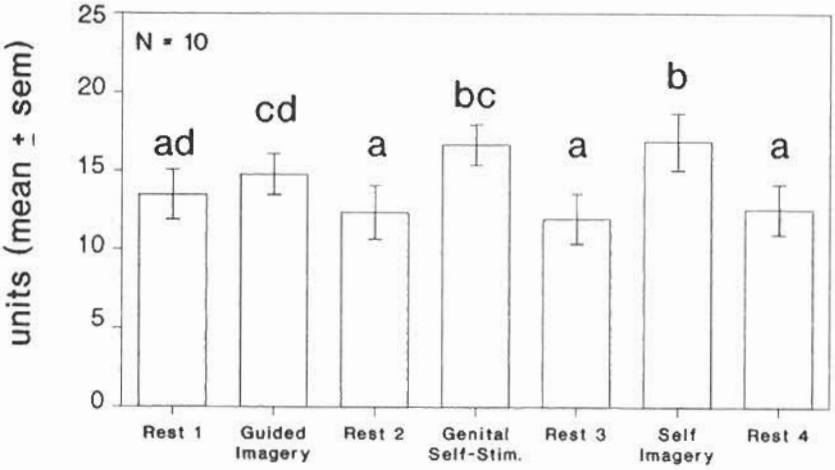

Fig. 5. Pain tolerance thresholds.

Pain Tolerance Threshold

The ANOVA for repeated measures comparing the pain tolerance threshold across all conditions was significant, $F(6, 69) = 8.04$, $p < 0.0001$. The pain tolerance threshold (in units) during the self-induced imagery condition (16.9 ± 1.78) was significantly greater than during the guided imagery condition (14.8 ± 1.3) and the resting control conditions (13.5 ± 1.6; 12.4 ± 1.7; 12 ± 1.6; 12.6 ± 1.6) (Tukey test, $p < 0.05$). The pain tolerance

threshold during the genital self-stimulation condition (16.7 ± 1.3) was significantly greater than during the resting control conditions (Tukey test, $p < 0.01$). The pain tolerance threshold during the guided imagery condition (14.8 ± 1.3) was significantly greater than during the second, third, and fourth resting control conditions (Tukey test, $p < 0.05$). The resting control conditions did not differ significantly among each other. The self-induced imagery condition and the genital self-stimulation condition did not differ significantly from each other (see Fig. 5).

Tactile Thresholds

There were no significant differences in tactile thresholds among any conditions.

DISCUSSION

These findings provide evidence that self-induced imagery and genital self-stimulation can each produce significant and substantial net sympathetic activation and concomitant significant increases in pain thresholds. The magnitude of the increase in pain thresholds in the self-induced imagery orgasm condition was comparable to the increase in pain thresholds in the genital self-stimulation-produced orgasm condition. Therefore, the first hypothesis was supported, i.e., imagery that resulted in orgasm would produce a significant elevation in pain thresholds.

Based on the present findings, self-induced imagery orgasm also produces changes in heart rate, pupil diameter, and systolic blood pressure of a magnitude comparable to those occurring during orgasm produced by genital self-stimulation. Thus, the second hypothesis was supported, i.e., the physiological correlates of self-induced imagery orgasm would not differ from the physiological correlates of genital self-stimulation-produced orgasm.

Since the heart rate, pupil diameter, and systolic blood pressure during genital self-stimulation-produced orgasm did not differ significantly from the same measures during self-induced imagery orgasm, it seems appropriate to broaden the commonly accepted definitions of orgasm. On the basis of the present study, it would appear too limited to sustain a definition of orgasm as a reflex (Kaplan, 1974) or as an involuntary response to physical stimulation (Gallager, 1982).

The present findings raise the question of whether the perception of orgasm is generated directly within the central nervous system and/or

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whether it is a consequence of the perception of muscular exertion and/or peripheral sympathetic activity. During this study, we observed that some of the women showed vigorous muscular movement during genital- and imagery-induced orgasms, whereas others appeared to be lying still. We cannot rule out the possibility that those who appeared to be lying still nevertheless exerted isometric skeletal muscular tension during orgasm.

A limitation of this study is that it did not measure vaginal or peripheral myotonia. The possible effect of sequence of testing is mitigated by the resting control periods that are interspersed with each experimental condition during which all parameters returned to baseline levels.

On the basis of the present study we can state that genital stimulation is evidently not necessary to produce a state that is reported to be an orgasm. Women can come to what appears to be physiologic orgasm as a result of imagery alone, with no physical stimulation of the genitals or other parts of the body. During orgasms induced only by imagery, women can manifest all of the physiological events that we measured of a magnitude comparable to those during orgasms produced by genital stimulation.

Presently, there is a monolithic model of orgasm based on the sexual response cycle, which involves a physical stimulus (Masters and Johnson, 1966). Sex therapy and sex education are based on this model. Since the present study provides evidence that orgasm can also be generated by nonphysical stimulation, a reassessment of the nature of orgasm is warranted.

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