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EEG during Masturbation and Ejaculation

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The occurrence of a distinctive EEG pattern specifically related to sexual arousal and orgasm would provide a reliable and convenient means of identifying such events in the laboratory and would also provide clues to cerebral structures involved in the processes.

EEG-polygraph recordings were obtained under rigorously controlled conditions in four normal male subjects during masturbation and ejaculation. The EEG data were subjected to both impressionistic and quantitative analyses. They showed no remarkable changes during the sequence of relevant physiological responses. The sole effect was a slight depression of alpha activity, a well-known nonspecific effect associated with changes in attention and arousal. Examination of the literature shows little agreement among reported results of studies of EEG changes during orgasm. It is likely that at least some reported changes were artifactual. It is concluded that the case for the existence of EEG changes specifically related to sexual arousal and orgasm remains unproven.

KEY WORDS: EEG; ejaculation; masturbation; orgasm; sexual physiology; spectral analysis.

INTRODUCTION

There have been only a few scattered reports of EEG pattern changes during human sexual responses. Mosovich and Tallaferro recorded the

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EEG during masturbation and orgasm in male and female subjects. The recordings from both were reported to exhibit low-voltage rapid activity during the early stages of arousal, followed during orgasm by high-voltage "paroxysmal three per second waves which are mixed with rhythmic alternating musclar discharges" (Mosovich and Tallaferro, 1954, p. 218). Their findings were also described briefly by Kinsey *et al.* (1953, p. 630). Sarrel *et al.* (1977) reported a similar observation. Heath (1972) described intracranial recordings of spike and slow wave activity from the "septal region" in two patients during sexual intercourse and orgasm. Cohen *et al.* (1976) reported interhemispheric asymmetry of parietal EEG activity during orgasm in 8 of 12 subjects. These reports continue to be cited (Niedermeyer, 1982, p. 84).

While acknowledging the difficulties of obtaining artifact-free recordings, these investigators agreed in emphasizing that the EEG may provide an objective measure of sexual arousal and orgasm. Cohen *et al.* (1976, p. 198) asserted that the EEG provides "a viable methodology for quantitative assessment of orgasmic response." This is echoed in a recent review by Semmlow and Lubowsky (1983, p. 310), who describe the EEG as "a convenient measure of orgasmic response," but one that "shows little sensitivity to earlier stages of arousal."

Since the occurrence of a distinctive EEG pattern specifically related to sexual arousal or orgasm would indeed provide a reliable and convenient means of identifying such events in the laboratory, and would as well provide clues to cerebral structures involved in the processes, we have attempted a constructive replication (Lykken, 1968) of the reported studies.

In the present experiment, we obtained multichannel EEG recordings from a small series of male subjects during masturbation and ejaculation, under conditions stressing control of movement and other artifacts. These recordings were obtained simultaneously with measures of autonomic arousal and musclar activity. Under such conditions, we observed no reliable relationship between EEG and masturbation or ejaculation.

METHOD

Subjects

Four right-handed male subjects, 20–24 years old, were recruited by advertisement. They were paid for their participation in two experimental sessions. Subjects reported themselves to be in good health, verified upon physical examination by one of us.

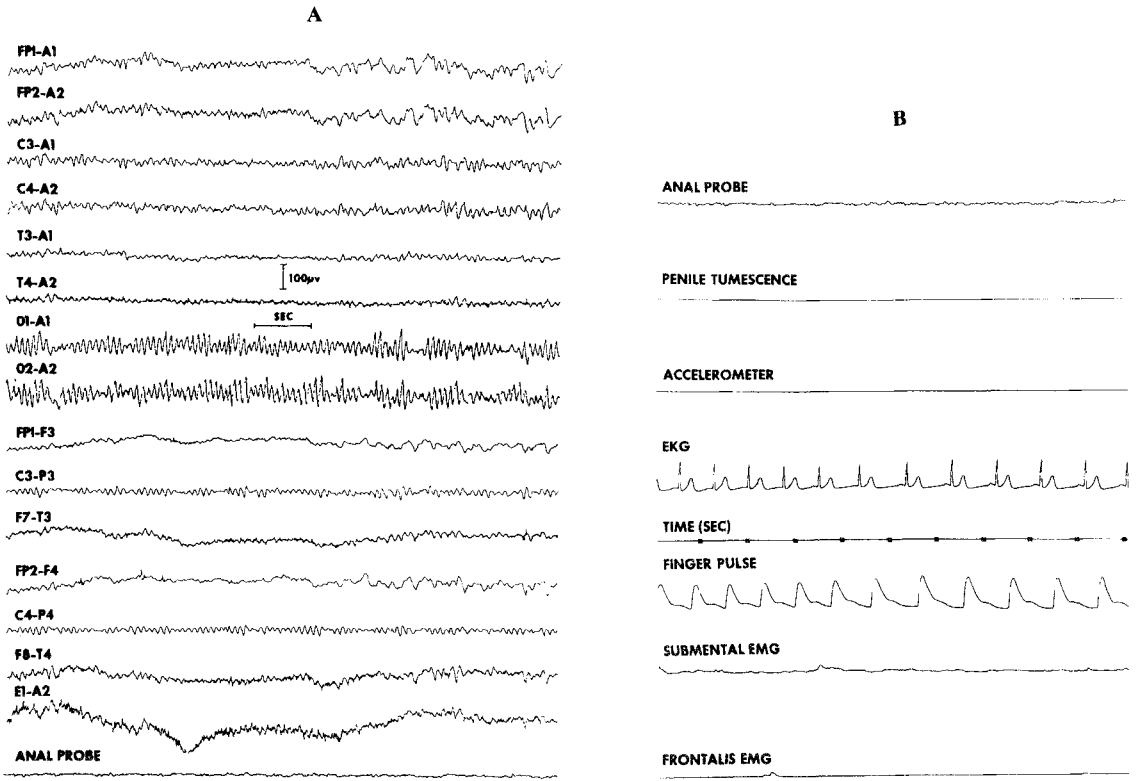

Fig. 1. Sample of baseline recording, Subject 1. (A) Fourteen channels of EEG and one of EOG (E1-A2). For purposes of illustration both here and in Fig. 2A, the anal probe tracing has been substituted in channel 16 for the time code signal, which occupied that position in the original recording, since the anal probe tracing makes comparison of Figs. 1A and 2A with Figs. 1B and 2B easier. There is some vertical eye movement (flutter and blink) artifact in the Fp1 and Fp2 derivations. There is also some very low-frequency skin potential artifact in some of the tracings, especially in the EOG (E1-A1) tracing. (B) Corresponding segment of the polygraph recording. The anal probe tracing shows no activity in this sample.

Table I. EEG Montages

Channel	Subjects 1 and 2		Subjects 3 and 4	
1	Fp1	A1	F3	A1[a]
2	Fp2	A2	F4	A2[a]
3	C3	A1	P3	A1[a]
4	C4	A2	P4	A2[a]
5	T3	A1	T3	A1[a]
6	T4	A2	T4	A2[a]
7	O1	A1	O1	A1[a]
8	O2	A2	O2	A2[a]
9	Fp1	F3	Fp1	F3
10	C3	P3	C3	P3
11	F7	T3	F7	T3
12	Fp2	F4	Fp2	F4
13	C4	P4	C4	P4
14	F8	T4	F4	T4
15	EOG		EOG	
16	Time code		Time code	

[a]Due to the detection of a strong EKG artifact by the left ear electrode (A1) of subject 4, channels 1–8 were recorded with reference to linked ears (A1 + A2) in both the original session and repeat session described in text. The purpose of this maneuver, since the EKG artifact could not be eliminated, was to introduce it equally into all ear-reference tracings so that it would not produce asymmetries in subsequent mathematical analyses.

EEG Recordings

Fourteen-channel EEG recordings (Figs. 1A and 2A) were obtained from widely distributed sites, as indicated in Table I.[4] Electrodes were securely attached with collodion, and signals were amplified with Grass 7P511 amplifiers set to a bandpass of 0.1 to 90 Hz. Electrode impedances were 5 kohms or less. Subjects were grounded by an electrode attached at FpZ. An electro-oculogram (EOG) was recorded from periorbital sites in channel 15, and a time code signal was recorded in channel 16. Channels 1-7 and the time signal were simultaneously recorded on magnetic tape for off-line analysis.

Psychophysiological Recordings

Eight channels of additional data plus the time code signal were simultaneously recorded using a Grass Model 7 polygraph (Figs. 1B and 2B).

[4]The observations reported were originally intended to constitute a pilot study, preliminary to a study with a larger number of subjects. Consequently, when negative results were obtained in subjects 1 and 2, some of the electrode sites were changed to sample alternative areas.

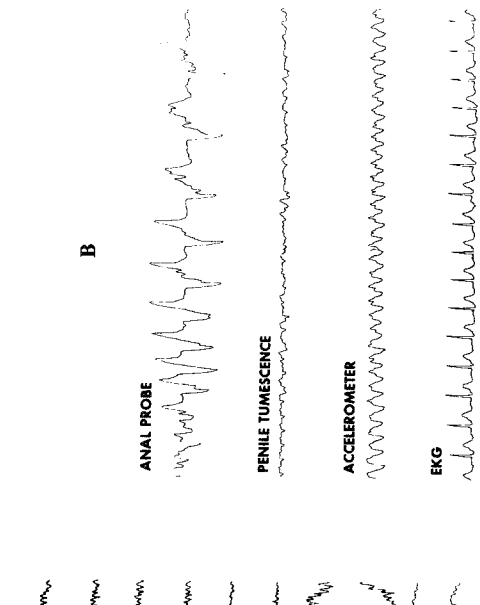

Fig. 2. Sample of recording at oneset of ejaculation, subject 1. (A) EEG tracings. Eye movement and skin potential artifacts similar to those in Fig. 1A. No visible changes in EEG pattern. (B) Corresponding segment of the polygraph recording. The first clear anal contraction occurs 1.6 seconds from the left margin of the figure.

Channel 1: Anal Contractions. Anal contractions were recorded with a pressure-sensitive anal probe described by Bohlen and Held (1979). Signals from the pressure transducer were amplified using a bandpass of 0.1 to 15 Hz.

Channel 2: Penile Tumescence. An attempt was made to monitor penile tumescence with a mercury strain gauge and associated amplifier. The masturbatory movements interfered with the recording, and it is not further discussed.

Channel 3: Wrist Accelerometer. A record of masturbatory movements was obtained using a Grass EPA1 accelerometer taped to the dorsum of the hand (right) used in masturbation.

Channel 4: EKG. Heart rate was measured from an EKG signal derived from electrodes placed bilaterally on the rib cage (lead I).

Channel 5: Time and Event Marker. A measure of subjective timing of orgasm was obtained by asking the subject to press a hand-held button (a) when he first felt that orgasm was inevitable, and (b) with the first ejaculation. A time signal was carried on the same channel.

Channel 6: Peripheral Pulse Amplitude. Pulse amplitude was measured using a photodetector and light source (Grass PTTI) taped to the tip of the index finger of the left hand. The signal was amplified using a bandpass of 0.1 to 15 Hz.

Channel 7: Submental EMG. EMG was obtained from a pair of electrodes taped under the chin with adhesive collars. The signal was integrated and rectified using a Grass 7P3 preamplifier with a time constant of 0.5 second.

Channel 8: Forehead EMG. Forehead EMG was obtained from a pair of electrodes placed bilaterally over the frontalis muscle, using the same procedure as for channel 7.

Procedure

Subjects participated in two sessions, the first of which included the physical examination, an explanation of the equipment and procedures, and masturbation to ejaculation in the laboratory setting without electrodes or transducers attached. During the last and during the experimental session, subjects reclined with eyes closed on a mattress in a sound-attenuated and electrically shielded room. The importance of avoiding unnecessary movements was stressed repeatedly; subjects were instructed otherwise to masturbate using their customary techniques.

The experimental session began with a 5-minute baseline period during which resting EEG and autonomic measures were obtained. Following this

period, subjects were instructed to masturbate until they reached ejaculation. Measurement continued for a period lasting 2½ minutes after the final anal contraction. Subjects were instructed to avoid unnecessary movements, and their compliance was verified by video monitoring of head and torso throughout the session. After the recording session, subjects completed a 26-item questionnaire concerning subjective aspects of the arousal and orgasm experienced.

RESULTS

All subjects successfully achieved orgasm, as indicated by self-report in the questionnaire results, by their button-press responses during the masturbation sequence, and by the presence of a sequence of repeated rhythmic contractions of the anal muscles registered by the anal probe. The average length of masturbation to the first anal contraction was 402 seconds (range, 157–733 seconds), and the average duration of anal contractions, measured from initial to final contraction, was 37 seconds (range, 25–49 seconds). When asked to rate their orgasms on the basis of intensity, as compared with their "usual perception of orgasm," subjects gave an average rating of 3.4 on a scale ranging from 0 (least intense) to 7 (most intense). In addition, subjects reported a variety of common accompaniments of orgasm, including erection, ejaculation, muscular contractions, and alterations in awareness.

EEG recordings with little or no artifact were successfully obtained in all four subjects, with generally low levels of frontalis and submental EMG and absence of excessive activity in the EOG channel. Impressionistic interpretation of the EEGs by one of the authors disclosed no appreciable or consistent changes in the EEG during masturbation and ejaculation. Recordings from a representative subject (subject 1) are shown in Fig. 1. Figure 1A (baseline period) shows an abundance of alpha activity as is commonly seen during resting states. Channel 15 is the electro-oculogram recorded from an electrode at the outer canthus of the left eye. The 16th (bottom) tracing is the recording from the anal probe, which is silent during this period.

Figure 2A shows EEG tracings in the same subject from an epoch encompassing the first anal contraction, seen under the letter O at the left of the anal-probe tracing. Alpha activity is seen clearly to persist during the onset of ejaculation. There is no remarkable change in EEG activity.[5] This

[5]There is some easily identifiable artifact in Figs. 1A and 2A. It is important to note that these artifacts are essentially the same in the two samples. One subject showed more artifact than subject 1; the other two showed almost none.

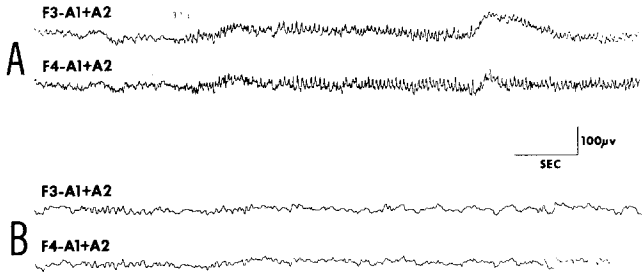

Fig. 3. F3 and F4 EEG tracings during ejaculation, subject 4. (A) Tracings show sharp wave forms around 15 Hz, which started 13 seconds after the first anal contraction. This activity was not present in any other derivations and was not seen in any segment of a repeat recording several days later. (B) Corresponding strip of the repeat recording, showing the period from 10 to 20 seconds after the first anal contraction.

held true for the entire session, including the pre-, peri- and postejaculation periods.

The sole exception was seen in subject 4, whose EEG showed a brief burst of activity at approximately 15 Hz, with onset 13 seconds after the first anal contraction (Fig. 3A). This activity was confined entirely to the bilateral frontal sites (F3 and F4) and was interpreted by the electroencephalographer as probably of muscular origin. Because of the occurrence of this activity, the subject was tested in a repeat session using identical procedures, save that the electrode montage was designed to sample more extensively from prefrontal, frontal, and anterior temporal sites. No evidence of the fast activity was seen in the repeat session. This is apparent in the tracings shown in Fig. 3B, obtained from an epoch corresponding with that depicted in Fig. 3A.

Eight 4-second segments of each of the EEG recordings were selected for further detailed analyses. These segments corresponded with landmark events during the session and were chosen with the additional principal criterion of being as free as possible of movement or other artifact. The eight segments were selected as follows:

Segment 1. First artifact-free segment at the beginning of the baseline period (PRE-1).
Segment 2. Last artifact-free segment at the end of the baseline period, preceding instructions to masturbate (PRE-2).
Segment 3. First artifact-free segment after instruction to commence masturbation (MAST-1).
Segment 4. Segment beginning 15 second before the onset of ejaculation-related anal contractions (MAST-2).

Segment 5. First segment during the "orgasmic phase," to encompass the first anal contraction (AC-1). Because of artifact, a segment beginning 5 seconds later was chosen for subject 3.
Segment 6. Last segment during the "orgasmic phase," to encompass the final anal contraction (AC-2).
Segment 7. Segment beginning 15 seconds following the segment encompassing the final anal contraction (POST-1).
Segment 8. Final artifact-free segment at the end of the 2½-minute postejaculation resting period (POST-2).

Results from cardiovascular measurements during these segments are depicted in Fig. 4. These results are consistent with autonomic changes that have been reported to accompany sexual responses in a number of studies (e.g., Boas and Goldschmidt, 1932; Masters and Johnson, 1966, p. 174; Banerjea and Sen, 1976). Finger pulse amplitude (Fig. 4A) shows a progressive rise during masturbation and ejaculation with the peak amplitude attained in the segment 15 seconds following the final anal contraction. The course of heart rate changes (Fig. 4B) was closely related to the events sur-

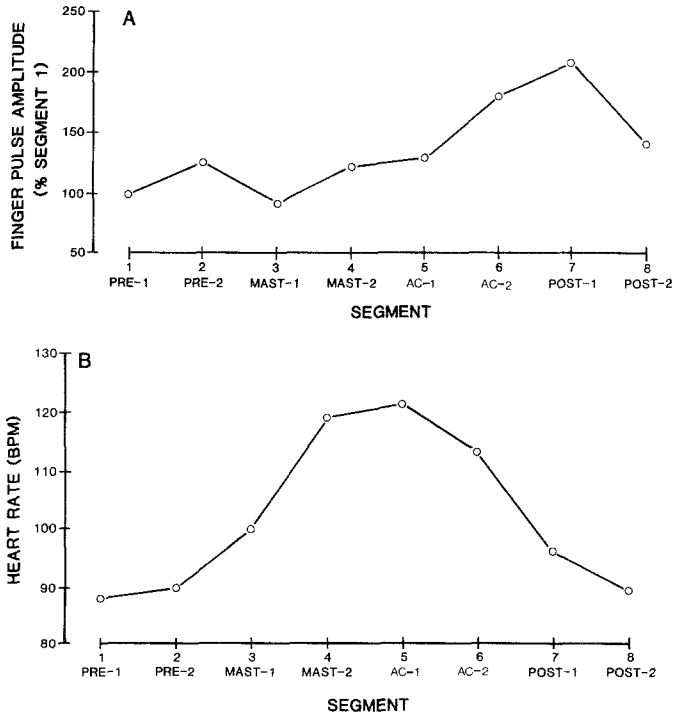

Fig. 4. Plots of finger pulse amplitude (A) and heart rate (B) by segment of the recording session (see text).

rounding ejaculation, the peak corresponding to the onset of ejaculation. By the end of the postejaculation resting period, the heart rate had returned to baseline values.

The wrist accelerometer tracings showed rhythmic masturbatory movements in three of the four subjects during segments 4 and 5 (Fig. 2B); the tracing was technically unsatisfactory in the fourth subject. The average frequency of these movements was 3.6 Hz.

The impressionistic analyses of the EEG tracings were confirmed by frequency analysis of the eight selected EEG segments. Channels 1–7 of the EEG (all referential to ears) were digitized from FM tape at a rate of 361 Hz. Each of the previously described eight segments was divided into six subsegments and analyzed with routine FTFPS in the International Mathematical and Statistical Libraries library of computer programs. The subsegments were shaped with a symmetrical window approximating a Parzen window and analyzed using a Fast Fourier Transform algorithm. The results were averaged over subsegments to yield a single power spectrum for each segment and each EEG channel. Examination of these spectra revealed no consistent differences among segments of the recordings or between the two hemispheres of the brain.

For purposes of statistical analysis, the power spectra were then condensed into five values approximating the traditional delta (0–3.6 Hz), theta (3.6–7.9 Hz), alpha (7.9–13.6 Hz), low beta (13.6–20.7 Hz), and high beta (20.7–27.8 Hz) bands. Separate repeated-measures analyses of variance (ANOVAs) were performed for each band, using both absolute power and relative power (expressed as a percentage of total power within the 0–27.8-Hz band) as variables. Because different EEG montages were used in the four subjects, the prefrontal data (Fp1 and Fp2) from subjects 1 and 2 were combined with frontal data (F3 and F4) from subjects 3 and 4 to serve as corresponding levels of the electrode variable. Similarly, the C3 and C4 data from subjects 1 and 2 were combined with P3 and P4 data from subjects 3 and 4.

These analyses revealed significant effects of electrode site for all bands except the high beta band for absolute power, and all bands except low beta for relative power. The sole effect associated with segment was a marginally significant effect on power within the alpha band, representing a depression seen during the peri-ejaculatory segments. This was found for analyses of both absolute power ($F(7, 21) = 2.63$, $p < 0.05$) and relative power ($F(7, 21) = 2.80$, $p < 0.05$). There were no significant interactions between electrode site and segment.

DISCUSSION

We have obtained EEG recordings during masturbation and ejaculation characterized by a relative lack of artifact. These recordings show no

remarkable changes during the sequence of physiological responses associated with the "orgasmic phase," despite the successful achievement of ejaculations, which were reported to be associated with experiences of "orgasm" of approximately average intensity and were accompanied by representative autonomic and muscular signs. The sole EEG effect was a slight depression of activity in the alpha frequency band. This is unremarkable, since it is a well-known nonspecific effect that typically accompanies diffuse changes in attention, concentration, or arousal (Lindsley, 1951, 1982).

The 15-Hz activity in the frontal area in subject 4 (Fig. 4) is discounted because the electroencephalographer was of the opinion that it was probably muscle potential artifact, because it does not correspond to any effects previously reported, and primarily because it was not replicable.

The lack of significant effects, particularly in the 3–4-Hz range, stands in contrast to previous reports (Cohen *et al.,* 1976; Mosovich and Tallaferro, 1954). One possible reason may be that our stress on artifact-free recordings interfered in some way with processes that might otherwise be involved in less restrictive circumstances. This interpretation in one sense is consistent with the report of Mosovich and Tallaferro (1954) that 3–4-Hz activity was not present in subjects who "did not show evidence of body tension." Our subjects clearly exerted some muscular effort, as shown by the hand accelerometer recordings and by the rises in heart rate, but they may have inhibited some more general type of somatic engagement. But if this interpretation is correct, it would suggest that the 3–4-Hz activity seen by other investigators is related more to a general activity factor than to processes specifically contributing to sexual response.

Another possible interpretation is suggested by our finding that the accelerometer recordings of hand excursions showed that the frequency of masturbatory movements averaged 3.6 Hz, which corresponds closely with the frequency (3–4-Hz) of rhythms previously described in EEG recordings during "orgasm." It follows that such 3–4-Hz activity, when it occurs in EEG tracings, may be movement artifact. Even slight movements of the head or other parts of the body, such as the movements of Parkinsonian tremor, can be accompanied by rhythmic artifacts in EEG tracings. The more vigorous the movement, the more likely the production of artifact. It is not, however, immediately apparent how such an interpretation might account for laterality differences in the 3–4-Hz rhythm or the absence of such rhythms with faked orgasm (Cohen *et al.,* 1976).

Turning to specific examination of the earlier reports of EEG pattern changes during orgasm, Mosovich and Tallaferro (1954) made references to figures, but none were published with the article. A figure contributed by Mosovich was included in the book by Kinsey *et al.* (1953, p. 630). It is impossible to distinguish activity of cerebral origin from artifact in the three samples of tracings shown. This, together with the report that "the two patients who did not show evidence of body tension did not have those 3/sec

waves" (p. 218), can be taken to support a hypothesis that the slow waves seen were movement artifact.

Cohen *et al.* (1976) recorded only two parietal derivations, presumably because the available wide-band integrator they used could analyze only two channels of data at a time. Why parietal sites were chosen was not indicated. The investigators tried to use only tracings that were "most stable and artifact free." In their illustration of raw EEG data, markedly asymmetrical rhythmic 4-Hz activity in the right parietal tracing at the height of orgasm could be of cerebral origin. If so, it is a truly extraordinary phenomenon and should be easily replicable. Cohen *et al.* (1976, p. 197) further state that "apparent frequency changes (noted only by visual inspection in the present study) were manifest in varying degrees in five of the eight experiments in which R/L amplitude ratios were found to change during orgasm." Beyond that, their report concentrates on the symmetry data, consisting of the results of broad frequency band integration. Integrated voltages were higher over the right than over the left hemisphere in seven right-handed subjects and over the left hemisphere in the one left-handed subject. Four of their 12 subjects showed no such changes, nor did any of our four. If changes in symmetry ratios are related to ejaculation or "orgasm" in any systematic fashion, it is difficult to explain the absence of such changes in these subjects.

Sarrell *et al.* (1977) reported data from a single channel of EEG in a female subject to illustrate the use of a portable 4 channel electrophysiological recorder for monitoring sexual activity. Electrode sites were unspecified. One figure shows a sequence of six high-voltage slow waves in the EEG channel following two vaginal contractions in a vaginal plethysmograph channel. The frequency of the waves was about 0.5 Hz. A steady alpha rhythm continues throughout the event, superimposed on the slow waves. Their report does not provide sufficient information to interpret these findings.

The observations of Heath (1972) are not directly relevant. Neither of his subjects was normal (one suffered from intractable epilepsy), neither had normal routine resting EEGs, and the EEG phenomena observed during orgasm were "not reflected on the surface."

In summary, we have failed to demonstrate any significant and specific EEG changes during masturbation, ejaculation, and the subjective experience of orgasm. Examination of the literature shows little agreement among reported results of studies of EEG changes during orgasm. It is likely that at least some reported changes were artifactual. It is concluded that the case for the existence of EEG changes that are specifically related to sexual arousal and orgasm, and can be recorded from the scalp, remains unproven.

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