phoretic mobility similar to that of HbS but do not show the sickling phenomenon (*24*), coexistent β thalassemia (*7*), coexistent α-chain mutations which modify the sickling properties of HbS (*25*), and the HbS/F genotype (*7*).
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Contingent Negative Variation as an Indicator of Sexual Object Preference

Abstract. *The contingent negative variation (CNV) was recorded in the interval between paired visual exposures of male nudes, female nudes, and sexually "neutral" silhouettes. Groups of 12 male and 12 female subjects viewing 50 randomized presentations from each stimulus category responded with averaged CNV amplitudes proportional to the predicted degree of sexual interest in the stimulus classes.*

Clinical and basic research in the area of normal and deviant human sexuality has been hampered by the lack of objective and reliable methods for assessing sexual object preferences. While measures of penile volume changes have demonstrated their value in studies of the male (*1*), and recent studies of vaginal blood flow appear promising in the female (*2*), there exists no single technique which is applicable to both sexes and is adequately sensitive to discriminate between stimuli representing preferred and nonpreferred sexual objects (*3*). Further, the intrusive, time-consuming, and cumbersome aspects of current methods have posed serious obstacles to their acceptance and broader application. We now report the successful application of a well-studied electrocortical measure, the contingent negative variation (CNV), as an indicator of sexual object preference in a group of putatively normal males and females. In addition, the method to be described appears potentially useful in analyzing preference and interest patterns in response to a broad range of visual stimuli.

The contingent negative variation utilized in the present study—also sometimes referred to as the "expectancy wave" or "E-wave"—was first described by Walter (*4*) and has been the subject of extensive neuro-psychophysiological study. The CNV shows itself as a relatively slow surface-negative shift in the baseline of the scalp-recorded electroencephalogram (EEG), which is revealed by computer averaging of epochs of EEG defined by repetitive stimuli. The CNV typically occurs in the period between the presentation of a conditional or "warning" stimulus (S1) and a succeeding unconditional or "imperative" stimulus (S2). The CNV seems to reflect a state of anticipation, expectancy, or preparation for the contingent (S2) stimulus, in that its appearance and amplitude are enhanced in situations which promote the interest and attention of the subject with regard to S2. Experimentally, CNV is facilitated by requiring some response by the subject to S2. Such response, however, is not a necessary condition for CNV, since stimulus qualities of S2 may, in and of themselves, function efficiently to command the subject's interest and attention. Conversely, conditions which promote distraction and inattention serve to inhibit CNV. Likewise, there is evidence to indicate that both high and low levels of autonomic arousal, as represented by anxiety or boredom, are inhibitory to CNV (*5*).

The literature reports only one previous study relating an electrocortical response to sexual stimuli. Lifshitz (*6*) utilized the visual averaged evoked potential (AEP), and noted qualitative differences in the AEP waveforms of certain individual male subjects when presented with female in contrast with nonsexual visual stimuli. However, no attempt was made to assess the differential effect of preferred and nonpreferred sexual object stimuli.

In devising our experimental procedure we reasoned that a subject would greet an opportunity to view a preferred sexual stimulus with a heightened state of anticipation or expectancy, which would express itself in relative CNV enhancement, when such opportunities were contrasted with those to view nonpreferred or nonsexual stimuli. In order to avoid the need for subjects to learn or be conditioned to an extraneous and potentially confounding set of S1 stimuli, it was decided that a brief, initial presentation of the visual stimulus should serve the function of the S1 "warning" stimulus for each trial. Consequently, each trial consisted of two presentations of a back-projected colored slide. The first presentation, serving as S1, lasted 500 msec. The second presentation, serving as S2, appeared after a delay of 1500 msec and remained on for 2000 msec. The subsequent trial was initiated after a fixed delay of 9.45 seconds for equipment cycling. The experiment consisted of 150 trials, 50 trials drawn from each of three categories of stimuli: female nudes, male nudes, and sexually "neutral" figures. To control for the ordering of categories, habituation to the procedure, and possible expectancy effects due to the fixed intertrial interval, trials representing the three categories were presented in a fixed randomized order.

The photographic subjects were males

Table 1. Data for contingent negative variation: amplitude in microvolts.

Stimulus sex	Male subjects (N = (12)		Female subjects (N = (12)		Total
	1st 25 trials	2nd 25 trials	1st 25 trials	2nd 25 trials	
Opposite sex	9.38	9.38	12.72	10.84	10.58
Same sex	7.83	8.02	11.24	8.46	8.89
"Neutral"	6.36	9.15	10.34	6.50	8.09
Mean values	7.86*	8.85*	11.43†	8.60†	9.19

* The mean of these values is 8.36. † The mean of these values is 10.02.

and females of college age. All photographs were prepared by the same photographer with identical technique and posing for all three categories. All photos were taken in a horizontal format and were of full ventral or slightly oblique views of each photographic subject. No attempt was made to obscure or exaggerate the secondary sex characteristics or genitals of the nude subjects. The ten slides within each of the nude categories represented five poses, two by each of five subjects. The category of sexually "neutral" stimuli was posed by a single back-lighted female, groomed and clothed in a sexually ambiguous manner. Her five poses were matched to those of the nude photographic subjects. Contrast and light transmission of the two nude categories were identical. The "neutral" category had greater overall contrast and brightness (300 versus 50 lumens for the nudes) due to the silhouette lighting of the subject.

Twelve male and twelve female subjects were recruited for a "psychophysiological experiment" through a campus newspaper. Subjects were single and ranged from 18 to 22 years old. Subjects were not screened for sexual object preference or sexual experience.

For the experiment subjects were seated comfortably in an electrically shielded, sound-attenuated chamber where they were instructed to fixate on a target in the middle of a back-projection screen within a view box. Subjects were advised that at each trial they would be presented two exposures of either female or male nudes, or human silhouettes. They were instructed to concentrate on the screen and avoid blinking, eye movement, or gross muscular activity during the paired exposures.

Following the 150 trials, ten of the nude slides and one of the "neutral" slides were presented, in turn, and the subject was asked to rate each photographic subject on a semantic differential questionnaire.

Contingent negative variation was recorded from Grass silver–silver chloride electrodes applied with electrolytic paste to the prepared scalp at the vertex (Cz), with linked reference electrodes at the mastoid processes. The electrooculogram, as a control for orbital (eye movement) potentials, was recorded from two Beckman d-c eye orbit electrodes applied at the superior and inferior orbital ridges of the right eye. Baseline shifts in the vertex channel were controlled by the amplifier system which automatically introduced a calibration pulse and voltage zero set immediately prior to the S1 stimulus (*7*). The vertex EEG and accompanying electrooculogram were amplified, tape recorded, and simultaneously averaged for each of the three classes of visual stimuli, utilizing the Fabri-tek Signal Averaging Computer (model 1070). For each subject an empirically derived constant fraction of the electrooculogram potential transmitting to the vertex EEG was subtracted from the EEG (*8*). Occasional trials noted to be grossly contaminated by orbital potentials were excluded during the CNV averaging by an individual who was not aware of the stimulus category being averaged. Separate averaging was performed on the first and second 25 trials within each stimulus category. For each set of 25 trials the 18 least contaminated trials were averaged.

Table 2. Analysis of variance of data in Table 1; A, subject sex; B, stimulus sex; C, stimulus trials (first 25 or second 25); n.s., not significant.

Variable	F	d.f.	$P \leqq$
A	1.20	1,22	n.s.
B	10.08	2,44	.001
C	2.43	1,22	n.s.
A&B	1.26	2,44	n.s.
A&C	10.45	1,22	.01
B&C	0.18	2,44	n.s.
A&B&C	1.81	2,44	n.s.

Graphic transcriptions of the averaged CNV waveforms were coded so that the person abstracting the data would not be aware of the identity of the experimental subject or the stimulus category being examined. The waveform was visually smoothed and a best visual fit linear regression line was drawn through the waveform from the point of maximum electrical positivity and continued through the onset of S2. The amplitude of CNV was considered as the difference in microvolts from the maximum positive point to the point at which the linear regression crossed S2. The latency of CNV was considered as the delay from S1 off to the maximum positive point. Typical waveforms of a male subject are presented in Fig. 1 (*9*). For each subject, CNV amplitude and latency were abstracted for the first and second 25 trials of each of the three categories of visual stimuli.

Data on CNV amplitude and latency were subjected to an analysis of variance statistical procedure for a three-factor experiment with repeated meas-

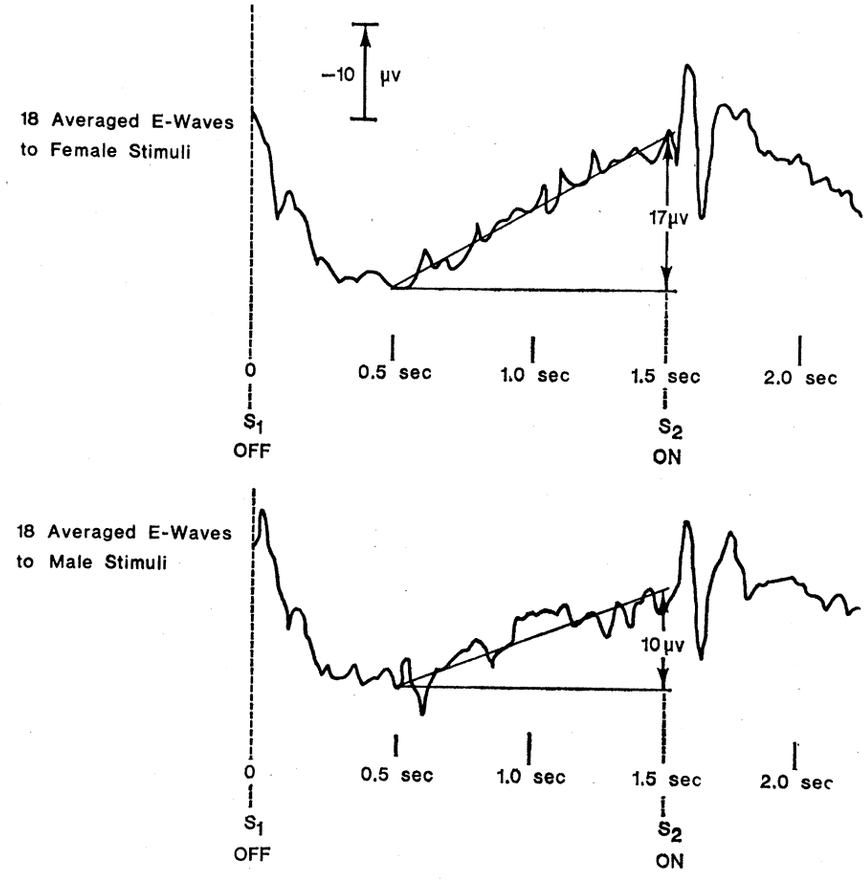

Fig. 1. Typical averaged contingent negative variation (E-wave) waveforms of a male subject to female and male stimuli. [From D. Hamburg and D. Lunde (*12*)]

ures on two factors (*10*). The analysis of the CNV latency data revealed no significant effects or interactions. The CNV amplitude data and analysis are presented in Tables 1 and 2.

The effect on CNV amplitude of the sex category of stimulus proved to be highly significant ($P \leqq .001$). The Newman-Keuls test procedure (*10*) applied to the data revealed that males and females both responded with greater CNV amplitude to stimuli of opposite sex than to either same sex or "neutral" stimuli ($P \leqq .01$). Only female subjects, however, demonstrated a significantly greater response to same sex than to "neutral" stimuli ($P \leqq .05$). When the pattern of amplitude scores of the 24 individual subjects was examined, 18 of the 24 were found to exhibit greater CNV response to opposite than to same sex stimuli [$P = .001$, sign test (*11*)]. This level of discrimination was true for both the first and second 25 trials of exposure to the stimulus classes. A somewhat higher proportion of male subjects responded in the predicted direction. These data are particularly impressive in view of the fact that possibly deviant subjects were not screened out of the sample population.

A significant interaction was observed between subject sex and stimulus trials ($P \leqq .01$). Female subjects exhibited overall higher CNV amplitudes in response to the first 25 trials of the stimulus classes. Male subjects considerably increased their CNV amplitude response to the "neutral" category from the first to second 25 trials of exposure, while female subjects exhibited precisely the opposite pattern. The pattern suggests that as the experiment progressed both male and female subjects came accurately to perceive the subject of the "neutral" slide category as female. This interpretation is supported by data from the questionnaires in which only 4 of the 24 subjects responded to the "neutral" stimulus as "masculine" on the "masculine-feminine" dimension.

Whether the observed amplitude differences are to be interpreted as CNV enhancement with opportunities to view preferred object stimuli, or CNV inhibition in conjunction with nonpreferred object stimuli, cannot be answered conclusively. However, the response pattern noted above with the "neutral" category lends support to an interpretation of CNV enhancement.

The data indicate a clear relation between the level of averaged CNV amplitude and the expected degree of sexual interest in the stimulus categories. These findings support the potential utility of the method as a research and clinical tool for objectively determining sexual interest and object preference patterns in both males and females. Application of the method to subjects with known deviant sexual preferences should more clearly establish its reliability and validity.

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9. Figure 1 reveals a long latency positive potential arising at S1 off and merging with the CNV. This potential was observed in most subjects and is fully described in a longer research report in preparation. This potential is similar to phenomena described by H. Vaughan in *Averaged Evoked Potentials*, E. Donchin and D. Lindsley, Eds. (NASA, Washington, D.C., 1969). Its amplitude was related to stimulus categories at a marginal level of significance, but in a pattern unrelated to that described with CNV. The two measures do not appear to confound, but the presence of the positive potential required a CNV amplitude measurement technique similar to that reported in D. McAdam and E. Rubin, *Electroencephalogr. Clin. Neurophysiol.* **30**, 511 (1971).
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Lysergic Acid Diethylamide and Stimulus Generalization: Rate-Dependent Effects

Abstract. *A stimulus generalization procedure was used to investigate the effects of LSD on sensitivity to auditory stimuli in rats. The shape of the generalization gradient was changed after administration of the drug only with a dose which produced decreases in relatively high rates of responding.*

Several kinds of perceptual disorders have been reported among users of lysergic acid diethylamide (LSD) (*1*). Attempts have been made to study these effects in animals, but the results obtained to date have been confounded by the numerous procedures, experimental subjects, and doses of the drug employed by different investigators. One of the procedures used to demonstrate the effects of drugs such as LSD on perceptual behavior is that of stimulus generalization. It is thought that this procedure may serve as a useful tool for analyzing the sensitivity of normal and drugged animals to changes in their external environment (*2*).

In studies involving stimulus generalization, an animal is trained to respond in the presence of one stimulus or to respond differentially in the presence of two or more stimuli. A generalization test is then given during extinction; several stimuli along the same dimension as the training stimulus are presented, and the animal's tendency to respond in the presence of each test stimulus is recorded. The extent to which the animal's behavior is controlled by the original training stimulus is related to the slope of the gradient obtained. A flat gradient, showing equal amounts of responding in the presence of all test stimuli, indicates little discrimination, whereas a steep gradient, showing maximal responding at the training stimulus, indicates that the animal is under good stimulus control (*3*). By measuring the amount of generalization during both drugged and nondrugged states, information about a drug's effect on stimulus control is obtained.

When generalization is measured in terms of the relative probability of responding to each of several test stimuli, LSD does not appear to alter the obtained generalization gradient (*4*). In view of the fact that (i) this compound has been found to have a large variety of "perceptual" effects (*5*) and (ii) other drugs which similarly alter perception also alter stimulus generalization (*2, 6*), we decided to reexamine the effects of LSD on a more traditional