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Penile Volume Responses to Appetitive and Aversive Stimuli in Relation to Sexual Orientation and Conditioning Performance

By R. F. BARR and N. McCONAGHY

The initial aim of this study was to determine the relationship between penile volume responses to female and male film sequences and sexual orientation in heterosexual and homosexual males. The second aim was to examine the relationship between aversive and appetitive conditioned responses in heterosexual males.

Freund (1963) described a method of determining the sexual orientation of male subjects by recording penile volume changes while slides of female and male nudes were shown. McConaghy (1967, 1969) described a simpler method of measuring penile volume responses. He studied 11 subjects who were not aware of any homosexual feelings and 22 subjects who were conscious of definite homosexual feelings. He reported that all the heterosexual subjects showed penile volume responses to female film sequences which were more positive than responses to male film sequences. In 10 of these subjects this difference was significant at the 0·05 level. Of the 22 homosexual subjects 14 showed greater increases in penile volume in response to the male film sequences than to the female sequences. In 10 of these subjects this difference was significant at the 0·05 level. Both authors concluded that penile plethysmography was a valid method of measuring sexual orientation.

McConaghy (1970) reported the occurrence of conditioned changes in penile volume in heterosexual subjects. These were positive (volume increase) in response to a symbol preceding female film sequences, and negative (volume decrease) in response to a symbol preceding male film sequences. He reported a high positive correlation between conditioned and unconditioned response amplitude, and concluded that the magnitude of the conditioned penile volume response was chiefly determined by the magnitude of the unconditioned response upon which it was based.

The Present Study

In the present study, in addition to attempting to replicate the above findings, penile volume responses to an aversive stimulus were investigated. The method was designed to determine whether such penile volume responses could be conditioned. The relationship between aversive conditioned penile volume responses and appetitive conditioned responses as described by McConaghy (1970) could then be determined.

Method

Sixty male first year university student volunteers were examined (mean age 19·4 years, standard deviation 2·4, range 18–32). Unlike the heterosexual group studied by McConaghy (1967) these students were not selected by asking only those unaware of any homosexual feelings to volunteer. Forty-four male patients who had presented for treatment of homosexual impulses were also evaluated (mean age 29·0 years, standard deviation 9·7, range 15–60).

The method used for measuring penile volume change was as described by McConaghy (1967). The blind end of a fingerstall was cut off and the cut end stretched over the open end of a cylindrical tin. This was connected by tube to a standard Grass pressure transducer. The penis was inserted into the tin through the open end of the fingerstall which maintained an airtight connection. All penile volume changes were converted to correspond with a sensitivity setting of 2 mV/cm. on the Grass recorder.

Each subject was tested with the appetitive and aversive conditioning procedure on the same day,

with a rest period of 20 minutes between the two experiments. Half the subjects received the appetitive procedure first and half the aversive. Figure 1 shows diagrams illustrating the experimental procedures. With appetitive conditioning the subject viewed a film while a Grass 5D polygraph recorded continuously changes in penile volume, skin resistance, heart rate and the time of presentation of stimuli. The unconditioned stimuli were ten female nude sequences alternating with ten male nude sequences presented at intervals of one minute. Each nude sequence was of 10 seconds duration. The conditioned stimuli were photographs of a red circle which preceded the female sequences and of a green triangle which preceded the male sequences. These conditioned stimuli were also of 10 seconds duration. At the beginning of the film the red circle and green triangle were each presented alone on two occasions. These stimuli were set into a travelogue film of London.

The penile volume response was scored by noting the difference between the volume recording at the point of stimulus onset and the point of stimulus offset. The statistical significance of the difference between the ten responses to females and ten responses to males was calculated using the Mann-Whitney test (Siegel, 1956). In this study the U score obtained with this test reflects the tendency for penile volume increases in response to females to be greater than the responses to males. The maximum heterosexual score is 100 and the maximum homosexual score is zero. Scores of 77 and above and 23 and less are significant at the 0·05 level in the heterosexual and homosexual directions respectively.

In the aversive procedure the penile volume responses to ten unpleasant electric shocks were measured. The shocks were delivered by a Grass S4 stimulator and were of one millisecond pulses at the rate of one hundred pulses per second and of one second duration. The shock was applied to the tips of the index and ring fingers of the right hand through 1·5 cm. solder electrodes coated with electrode jelly. The voltage used varied between 30 and 150 volts. Prior to the experiment the subject was given a series of brief shocks of increasing intensity. The voltage chosen for the experiment was one he considered definitely unpleasant.

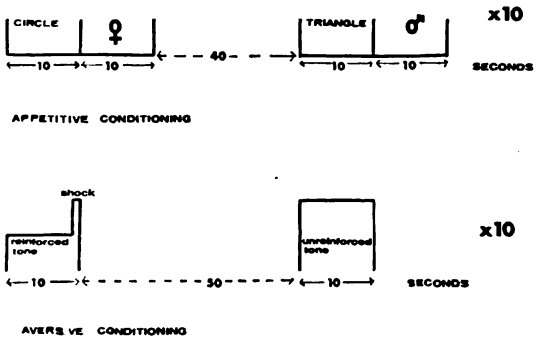

FIG. 1.

The subject was asked to sit quietly, and was told that he would hear a number of quiet tones and also receive some shocks which would be no stronger than the strongest shock he had already experienced. Each shock was preceded by a tone of 65 decibels intensity, 500 c.p.s. and 10 seconds duration. These reinforced tones were alternated, at intervals of one minute, with an unreinforced tone of the same intensity and duration but with a frequency of 1,500 c.p.s. At the beginning of the experiment each tone was twice presented alone. The timing of tones and shocks was controlled electrically by signals on magnetic tape.

The conditioned penile volume response was scored by noting the difference in volume at the point of tone onset to the point of shock onset. The unconditioned response was scored by noting the volume change from the point of shock offset to the maximum deflection occurring within 10 seconds of shock offset. It had been noted in a pilot study that the maximum decrease in penile volume usually occurred within 10 seconds of shock offset.

RESULTS

(a) *Sexual orientation and penile volume responses to nude sequences*

The mean U score for the 60 students was 90·1 (standard deviation 16·3). Of the students 54 (90 per cent) obtained scores of 77 and above, that is in the significantly heterosexual range. The remaining 6 students (10 per cent) obtained scores of less than 77 but more than 23. No student obtained a score in the significantly homosexual range. The mean U score of the 44 patients presenting for treatment of homosexual impulses was 31·9 (standard deviation 31·0). The difference between the mean U scores of the student and homosexual groups was statistically highly significant ($t = 12·600$, d.f. 102, $p < 0·001$).

(b) *The unconditioned penile volume responses*

Fifty-eight of the 60 subjects had a positive total penile volume response (trials 1–10) to the female film sequences. The mean total

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response to females was + 23·3 units (standard deviation 31·8). Comparing the means with zero these responses were positive at the 0·001 level (t = 8·284, d.f. 59).

Forty-three of the 60 subjects had a negative total penile volume response (trials 1–10) to the male film sequences. The mean total response to males was − 4·9 units (standard deviation 8·0). Comparing the means with zero these responses were significantly negative (t = 4·678, d.f. 59, p < 0·001).

Fifty-six of the 60 subjects had a negative total penile volume response (trials 1–10) to the electric shocks. The mean total penile volume response to shocks was — 6·7 units (standard deviation 6·0). Comparing the means with zero the responses to shock were significantly negative at the 0·001 level (t = 8·616, d.f. 59).

For the 43 subjects who had a negative mean response to the male film sequences, the product-moment correlation between unconditioned response amplitude to male sequences and to electric shock was + 0·19 (not significant).

(c) *Conditioned changes in penile volume of the 60 students*

Penile volume increases occurred in response to the red circles preceding the female film sequences. The mean conditioned penile volume response (trials 2–10) was more positive than the mean penile volume response to the initial two unreinforced red circles. Using the t test (paired observations) this difference was statistically significant at the 0·001 level (t = 5·761, d.f. 59). The correlation between each subject's total conditioned response amplitude (trials 2–10) and total unconditioned response amplitude (trials 1–10) was + 0·574 (d.f. 58, p < 0·001). It can be concluded that conditioned penile volume increases occurred, and that the amplitude of conditioned responses was significantly related to the amplitude of the unconditioned responses on which these were based.

The increases in mean penile volume in response to the female sequences tended to become larger in later trials (Fig. 2). This suggested that the unconditioned responses as measured contained a conditioned component. The latency of the penile volume increase

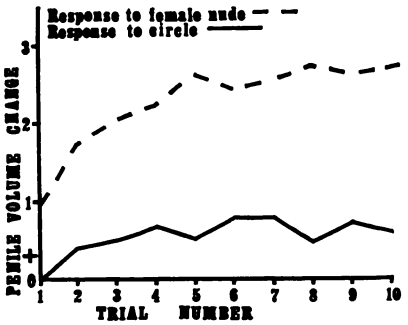

FIG. 2.—The mean penile volume responses of 60 student subjects to 10 female film sequence and 10 preceding circles (conditioned stimuli).

in response to the first female nude sequence for the 60 students was 2·6 seconds (standard deviation 0·8). Hence with the conditioning procedure used in this study any increase in penile volume occurring in the first two seconds after the onset of the female nude is part of the conditioned response to the preceding red circle. The penile volume changes of the 54 subjects who had U scores of over 77 (that is in the significantly heterosexual range) in response to the circle and female were measured at two second intervals for trials 3 and 4 and trials 9 and 10. In trials 3 and 4 the mean change in penile volume during the first two seconds of female sequence presentation was + 0·010 units. In trials 9 and 10 the mean penile volume change in the same period was + 0·247 units. (Fig. 3.) This difference in the shape of the total response in trial 3 compared with trial 9 was significant

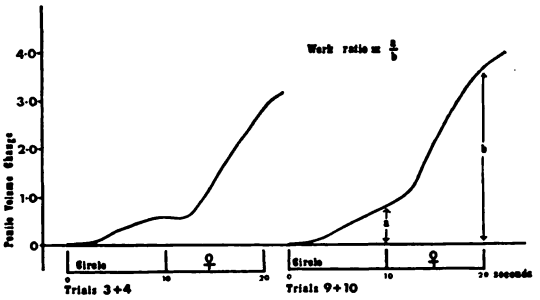

FIG. 3.—The mean penile volume responses of 54 students subjects, with U scores of over 77 (i.e. in the significantly heterosexual range) to female film sequences and preceding circles, measured at two second intervals.

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at the 0·0025 level (t test, paired observations, one tailed, t = 3·463 d.f. 53). Comparing trial 4 with trial 10 the difference in mean penile volume increase during the first two seconds of female presentation was significant at the 0·01 level (t test, paired observations, one tailed, t = 2·597, d.f. 53).

The mean penile volume responses of the 60 students to the green triangles preceding the male film sequences were more negative (volume decrease) than the mean penile volume response to the initial two unreinforced triangles (Fig. 4). Using the t test (paired observations) this difference was significant at the 0·001 level (t = 6·214, d.f. 59). The correlation between each subject's total conditioned response amplitude (trials 2–10) and unconditioned response amplitude (trials 1–10) was + 0·563 (d.f. 58, p < 0·001). It can be concluded that conditioned penile volume decreases occurred in response to the green triangles preceding male sequences and that the amplitude of these responses was significantly related to the amplitude of the unconditioned responses to the male sequences. However though the latency of the unconditioned penile volume decrease is not as long as that of the increase, it is still longer than one second. Thus the unconditioned response as measured from the time of onset of the unconditioned stimulus would include a conditioned component.

In the procedure using electric shocks as unconditioned stimuli the penile volume responses to the preceding tone were negative, i.e. the volume decreased (Fig. 5). The mean conditioned penile volume response was more negative than the mean penile volume response to the initial two unreinforced tones. This difference was significant at the 0·001 level (t test, paired observations, t = 3·459, d.f. 59). The mean conditioned penile volume decrease to the reinforced tone was greater than the mean penile volume decrease to the unreinforced tone. This difference was significant at the 0·001 level (t test, paired observations, t = 5·231, d.f. 59). The product-moment correlation between mean conditioned response amplitude (trials 2–10) and mean unconditioned response amplitude (trials 1–10) was + 0·409 (d.f. 58, p < 0·001). It can be concluded that conditioned decreases in penile volume occurred in association with an unpleasant electric shock and that the amplitude of the conditioned responses was significantly related to the amplitude of unconditioned decreases following electric shock. Since the penile volume decreases to the reinforced tone were significantly greater than those to the unreinforced tone, it can be concluded that differentiation between the two tones occurred.

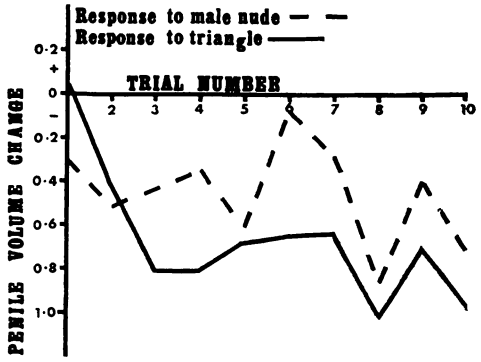

FIG. 4.—The mean penile volume responses of 60 student subjects to 10 male film sequences and 10 preceding triangles (conditioned stimuli).

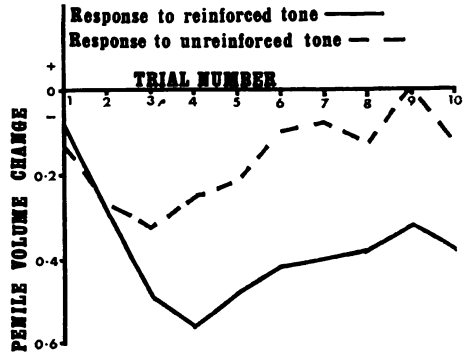

FIG. 5.—The mean penile volume responses of 60 student subjects to 10 reinforced and 10 unreinforced tones in the aversive conditioning experiment, using an unpleasant electric shock as the unconditioned stimulus.

(d) *The relationship between conditioned penile volume responses in the two experiments*

For the 54 subjects with U scores above 77, i.e. in the significantly heterosexual range,

the Pearson rank order correlation between mean penile volume conditioned response (trials 2–10) in the appetitive and aversive procedures was −0·302 (d.f. 52, $p < 0·05$). This suggests that conditioned penile volume increases in the appetitive procedure were significantly related to conditioned penile volume decreases in the aversive procedure. However since it is known that conditioned response amplitude is related to unconditioned response amplitude this correlation may depend on individual differences in penile volume reactivity rather than a relationship between conditioning performance in the two experiments. For this reason the conditioning performance of each subject was assessed by calculating the 'work ratio' of the conditioned responses. The concept of work ratio was described by Martin and Levey (1969) and is defined as the proportion of the total response achieved by the conditioned response at the moment of unconditioned response onset (see Fig. 3).

In this study a slightly modified measure of work ratio was used for practical reasons. Since it was not always possible to distinguish the unconditioned response from the conditioned response, the amplitude of the latter was read at the point of unconditioned stimulus onset. The total response to circle and female was measured by noting the volume change from conditioned stimulus onset to the point of unconditioned stimulus offset since penile volume increase was almost always still occurring at this point (see Fig. 3). In the aversive procedure the total response to tone and shock was measured by noting the volume change from conditioned stimulus onset to the point of maximum deflection occurring within the 10 seconds following unconditioned stimulus offset.

For the 54 subjects in whom the U scores were within the significantly heterosexual range, the Pearson product moment correlation between work ratio for responses to circle and female and work ratio for responses to tone and shock was + 0·424 (d.f. 53, $p < 0·01$). It can be concluded that penile volume conditioning using female film sequence as unconditioned stimuli showed a significantly positive relationship with penile volume conditioning using electric shocks as unconditioned stimuli.

The correlation between unconditioned and conditioned penile volume response amplitude and work ratios in the two experiments were as follows:

TABLE I

	Unconditioned response to females	Conditioned response to circles	Work ratio circles and females	Unconditioned response to shocks	Conditioned response to tones	Work ratio tones and shocks
Unconditioned response to females	1·000					
Conditioned response to circles	+0·574*†	1·000				
Work ratio circles and females	−0·127	+0·544*	1·000			
Unconditioned response to shocks	−0·190	−0·036	+0·021	1·000		
Conditioned responses to tones	−0·214	−0·302*	−0·246	+0·409*†	1·000	
Work ratio tones and shocks	+0·122	+0·352*	+0·424*	−0·027	−0·715*	1·000

n 54 (subjects with U scores in significantly heterosexual range)
† correlation calculated using all 60 student subjects
* correlation significant $P < 0·05$.

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Discussion

Penile volume responses and sexual orientation

The 60 students were not questioned about their sexual histories. It was assumed that this group would be predominantly heterosexual. The results outlined above placed 90 per cent of this group in the significantly heterosexual range and the remaining 10 per cent obtained intermediate scores. No student obtained a score in the significantly homosexual range. This is perhaps surprising but may be explained by supposing that those students with a homosexual orientation may not have volunteered for the study, having heard from others that it involved penile response measurement.

It will be noted that the standard deviation of U scores for the 44 patients presenting for treatment of homosexual impulses was high (31·0). Five of these patients had U scores of 77 or over, i.e. in the significantly heterosexual range. All five of these patients' histories indicated that they had had satisfactory sexual intercourse with women. Four of the five said that they preferred women to men as sexual partners. Seventeen of the patients had U scores of less than 77 but above 23. Of these, eight had had sexual (47 per cent) relationships, not always including sexual intercourse with women. The remaining 22 patients had U scores of less than 23, i.e. in the significantly homosexual range. Of these only seven (31 per cent) had had sexual relationships not always including sexual intercourse, with women. These findings lend support to the claims of Freund (1963) and McConaghy (1967) that penile plethysmography is a valid method of assessing sexual orientation. McConaghy's findings (1967) are replicated using a larger sample of heterosexual subjects.

Unconditioned penile volume responses

The increases in penile volume in response to nude female film sequences, shown by the 60 students, were hardly surprising. These changes were rarely large enough to be obvious to the subject or to produce an erection. Many subjects reported that they found the film uninteresting and yet showed consistent penile volume increases in response to the female sequences.

The decreases in penile volume in response to the male sequences shown by 43 of the 60 students, were notable. Such volume decreases in response to male sequences have been described by McConaghy (1967) in a group of 11 heterosexual student subjects. These volume decreases during the male sequences are not due to recovery from sexual arousal produced by the preceding female sequences (Colette, 1970). It seems that an inhibitory process, causing a decrease in penile volume, occurs when a nude male is viewed by the majority of male heterosexual subjects.

The decrease in penile volume in response to unpleasant electric shocks has not been previously described. It seems unlikely that these responses are part of the orienting response since they do not occur in response to any novel stimulus, e.g. the initial presentation of circles, triangles or tones. Colette (1970) has reported that penile volume decreases also occur when student subjects view slides of victims of serious road accidents. It seems probable that these penile volume decreases in response to electric shocks or disturbing slides are part of the fear response.

Since the correlation between volume decreases in response to males and volume response to shocks was small and not significant, it seems likely that different mechanisms operate in the two situations.

Conditioned penile volume responses

In this study the amplitude of conditioned changes in penile volume were found to correlate strongly and positively with the amplitude of the associated unconditioned responses. These findings replicate those of McConaghy (1970). Working with classical conditioning of the galvanic skin response, Cadoret (1963) reported a similar positive correlation between unconditioned and conditioned response amplitude. Conditioned response amplitude therefore depends on the reflex sensitivity of the response system under study as well as the amount of learning which the subject shows. To minimize the variance due to the amplitude of the unconditioned responses the relationship between appetitive and aversive conditioned responses was examined using measures of their respective work ratios.

The significant positive relationships found between penile volume conditioning using female sequences and that using electric shocks as unconditioned stimuli deserves comment. A general factor of conditionability is implicit in theories such as those of Pavlov (1955) and Eysenck (1957). No satisfactory evidence has been previously produced to support this concept (Lovibond, 1964). A positive relationship was found in the non-patient group in this study between conditioned responses based on unconditioned stimuli in two different sensory modalities, and further varying in that one was aversive and the other appetitive.

The concept of a general factor of conditionability implies a relationship between conditioning measures across different systems both for stimuli and responses. The present study examined only one response system; however, the unconditioned stimuli used in the two experiments were quite different. The findings are therefore encouraging for these who hope to base a theory of personality on a general factor of conditionability.

The conditioning performance of the homosexual patients and its relationship to their response to treatment will be reported in another paper.

Summary

Penile volume responses to female and male nude film sequences in 60 heterosexual students and 44 patients with homosexual impulses were studied. It was concluded that measurement of penile volume changes is a valid method of assessing sexual orientation. Penile volume increases in response to females and volume decreases in response to males and to electric shocks were described for the group of 60 heterosexual students. Conditioned penile volume changes which occurred in association with the unconditioned changes were described. It was found that a relationship exists between appetitive penile volume conditioning using female nudes and aversive conditioning using electric shocks as the unconditioned stimuli.

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