Table 1. Effects of amino acids upon the time required for abscission of unfertilized ovaries of two varieties of tobacco. The figures show average time in hours from anthesis to completion of abscission.

Lizard's Tail		Little Turkish	
0.01*M*	0.1*M*	0.01*M*	0.1*M*
	Methionine		
24	20	31	26
	Leucine		
50	38	80	40
	Alanine		
57	45	85	60
	Glutamic acid		
57	45	112	60
	Valine		
80	50	130	90
	Cystine		
98	89	170	161
	Cysteine		
94	No abscission	126	No abscission
	Control (water)		
99	93	176	165

others is uncertain at present, but it is generally agreed that indoleacetic acid plays a major role in the control.

The dissolution of the middle lamella of the cell wall during abscission was described first by Lee (*3*). Facey (*4*), through microchemical tests, characterized the dissolution as a change of calcium pectate into pectic acid which, in turn, is changed to water-soluble pectin. Recently Cormack (*5*) has emphasized the calcium pectate character of the cementing layer between cells. Ordin, Cleland, and Bonner (*6*) have reported that the methyl carbon atom of labeled methionine is rapidly incorporated into the pectic materials of cell walls of *Avena* coleoptile sections, and Byerrum and Sato (*7*) have also reported the incorporation of the methyl group of methionine in pectin isolated from radish plants. These observations suggest that methylation of the carboxyl groups of adjacent pectin molecules may be involved in the splitting of calcium bridges leading to abscission and that the amino acid methionine may serve as a methyl group donor. Experimental evidence indicates that an amino acid factor does, in part, control abscission.

Two varieties of *Nicotiana tabacum*, namely Lizard's Tail and Little Turkish, were grown under uniform greenhouse conditions and used as experimental plants. Various aqueous solutions of L-amino acids (DL-methionine, DL-leucine, DL-valine), after being adjusted to *p*H 6.0, were injected directly into the unfertilized ovaries of flowers at the time of anthesis by means of glass tubing drawn to a fine point. In 24 hours, 0.15 to 0.2 ml of the solution were taken up by the tissue. Fertilization was prevented by covering the stigma with a small foil cylinder. The results of such treatment upon the abscission of the flowers are tabulated in Table 1, for a representative experiment. Each value represents the average time required for abscission to occur for ten flowers on one plant. Cysteine at a concentration of 0.1*M* proved toxic, as evidenced by a shriveling of the tissue without the occurrence of abscission.

The effect of methionine is quite remarkable, the time for abscission of the ovary on Lizard's Tail plants being reduced from 4 days to 1 day, and the time for abscission of the ovary on Little Turkish plants being reduced from 7 days to 1 day. A significant acceleration of abscission was also obtained with leucine, alanine, and glutamic acid. Although the role of methionine as a methyl donor in organisms is well established (*8*), there is little or no information on the general aspects of methylation or transmethylating systems. The effects of amino acids other than methionine may result from their serving as methyl donors directly or from transformations giving rise to labile methyl radicals.

These observations suggest that methionine, as a methyl donor, and indoleacetic acid interact to control abscission (*9*).

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28 October 1957

Production of Reversible Changes in the Central Nervous System by Ultrasound

For the past several years an intensive research effort has been in progress at the Bioacoustics Laboratory of the University of Illinois on the production of selective lesions in the tissues of the central nervous system by high intensity ultrasound (*1*). Considerable information has been obtained concerning the dosage conditions required for the production of such lesions, and neuroanatomical studies utilizing this technique are now in progress. Relatively recent electrophysiological investigations indicate that *reversible* suppression of transmission along neural pathways can be accomplished by applying a controlled dosage of ultrasonic radiation at various sites along these pathways (*2*). By irradiating with ultrasound in the lateral geniculate nucleus it is possible to suppress temporarily the potential usually evoked in the visual cortex in response to a light stimulus. It should be noted that this effect is produced by a dosage of ultrasound which does not cause any histologically observable lesion in the tissue. This ultrasonic technique of producing reversible changes offers unique opportunities for three-dimensional mapping of central nervous system function.

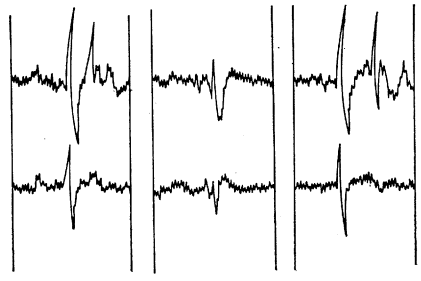

Fig. 1. Cortical potentials evoked by a flash of light (left) before irradiation, (middle) at the termination of irradiation, (right) 30 minutes after irradiation.

Bipolar recording electrodes are placed in the appropriate cortical areas on both hemispheres to detect the evoked potentials. The focused ultrasonic beam source is used to irradiate the region of one of the lateral geniculate nuclei of the animal (cat) since these nuclei are sites of synaptic stations along the visual pathway. The ultrasonic energy must be transmitted from the irradiator to the brain through degassed Ringer's solution, and the intervening skull bone must be removed.

Stimulation of the eye by light is repeated at fixed time intervals before, during, and after ultrasonic irradiation, and continuous electrical recording is in progress during the course of the experiment. A series of three light flashes, with approximately 3 seconds between flashes, is used to stimulate the eye of the animal. This series of flashes is repeated at variable intervals of time before, during, and after exposure to the ultrasonic radiation. The focus of the sound beam is placed successively in and around the region of the lateral geniculate nucleus. With a suitably chosen sound level and with an exposure time in the range from 20 to 120 seconds, it has been possible to produce reversible suppressions of various components of the elicited electrical response in the visual cortex. The type of result illustrated in Fig. 1 has been ob-

tained in a number of animals. Figure 1 shows the cortical potentials (two electrodes) evoked by a flash of light (i) before ultrasonic irradiation, (ii) at the termination of the ultrasonic exposure period, and (iii) subsequent to irradiation. At the termination of the ultrasonic irradiation period the amplitude of the primary response (upper record) was reduced to less than one-third of its original value. The amplitude of the secondary response (upper record) was reduced to practically zero. Complete recovery of the primary and secondary response was apparent 30 minutes after exposure.

Experiments are in progress to quantify further the conditions for producing controlled reversibility and to determine the site or sites (synapses, axons, cell bodies) of action of the sound (*3*).

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3. This research was supported by contract AF 33(616)-3306 with the Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.
* The name of the Bioacoustics Laboratory was recently changed to Biophysical Research Laboratory of the College of Engineering.

14 October 1957

Effects of Caffeine and Chlorpromazine on the Sexual Behavior of Male Rats

Although the effects of stimulant and tranquilizing drugs on sexual behavior are of considerable importance, the amount of systematic research on this problem has been negligible. Soulairac and Coppin-Monthillaud (*1*) have reported that after an injection of 30 mg of caffeine (and sodium benzoate) per kilogram, male albino rats decreased their latency to first sexual activity and increased their rate of copulation. The study described in this report (*2*) compares the effects of moderate doses of caffeine and chlorpromazine on the sexual performance of 17 150-day-old male hooded rats. The previous sexual behavior of the rats varied from complete impotence to extreme vigor.

Table 1. Average performance for various criteria of sexual behavior. (Not included are two subjects which did not perform at all on any of the trials.)

Behavioral measures	No.	Caffeine	No drug	Chlorpromazine	Friedman analysis of variance
Latency to:					
(i) first mount	9	13.4	26.4	69.7	$\chi^2 = 10.1$*
(ii) first copulation	9	13.4	28.3	71.3	$\chi^2 = 9.5$*
(iii) ejaculation	6	436.7	589.2	528.3	$\chi^2 = 7.0$†
Frequency of:					
(i) mounts	15	4.1	4.7	3.9	Not significant
(ii) copulations	15	16.1	15.1	12.0	$\chi^2 = 7.4$†
Percentage of group that:					
(i) copulated	15	80	87	87	Not significant
(ii) ejaculated	15	47	50	47	Not significant
Copulatory rate:					
(i) for subjects that copulated	9	2.41	1.87	1.45	$\chi^2 = 8.7$*
(ii) for subjects that ejaculated	6	2.80	1.64	1.63	$\chi^2 = 9.2$*

* Significant beyond the 0.01 level of probability. † Significant beyond the 0.05 level of probability.

Each male was given four 15-minute tests, spaced at least 2 days apart. Males were injected with 20 mg of caffeine (and sodium benzoate) per kilogram before one test, with 1 mg of chlorpromazine per kilogram before another test, and with isotonic saline (no drug) before two tests (*3*). Drug tests were alternated with no-drug tests. All injections were given intraperitoneally, between 15 and 60 minutes before the start of the test; this time-interval was within the effective range of the drugs. The drugs were dissolved in the same volume of isotonic saline (1 ml/kg) that comprised the no-drug injections. The rats were randomly assigned to one of four groups, which differed in the sequence of drug and no-drug tests. During each of the four test sessions one group was under caffeine, one group was under chlorpromazine, and two groups were under no drug. By these procedures, the order of drug conditions was counterbalanced, and each drug condition was tested in each session.

The tests were conducted in a circular observation cage 30 in. in diameter. Each male was given 2 minutes alone in the cage before the introduction into the cage of a female which was in full behavioral heat. The sexual behavior of male rats consists of mounting the female and making a brief intromission (copulation). On some occasions the male may mount without accomplishing an intromission. After a number of intromissions, generally between 10 and 20, ejaculation occurs. The male withdraws from the female and shows no sexual interest for at least 15 seconds after each intromission and for at least several minutes after ejaculation.

Table 1 shows these measures of sexual activity, presented in terms of (i) latency in seconds of first occurrence after introduction of the female; (ii) frequency of occurrence during the 15-minute test; (iii) percentage of group performing the response; and (iv) copulatory rate. Copulatory rate is the average number of copulations per minute to ejaculation (or, if no ejaculation occurs, from the first copulation to the end of the test). These measures and the procedures are more fully described elsewhere (*4*). As is shown in Table 1, caffeine decreased the latencies to mount, copulate, and ejaculate and increased the frequency and rate of copulation. Chlorpromazine had opposite effects on all these measures except latency to ejaculation. Of interest is the failure of both drugs to alter significantly the percentage of subjects which copulated or ejaculated.

In order to test for the effects of the drugs on subsequent no-drug sessions, the tests following administration of caffeine were compared with the tests following administration of chlorpromazine. An additional 15-minute no-drug test was given to animals whose last regular test was with one of the drugs, in order to complete this procedure. The animals made more than twice as many mounts and 24 percent more copulations during the no-drug session following administration of chlorpromazine than during the no-drug session following administration of caffeine. The difference in number of mounts is statistically significant ($p < 0.05$ by Wilcoxon matched-pairs rank test). There were no reliable differences in the other measures of sexual behavior. Since the time interval between sessions was ample to allow the drug effects to dissipate, these results apparently point to differences in behavior learned under the two drugs. A more strenuous sexual response may have been learned under chlorpromazine to over-