4) The Oldowan cultural sequence from Bed I probably represents a shorter period of time than stages 1 to 5 of the Chelles-Acheul culture, which span Bed II (4).

5) None of the stone artifacts or hominid fossils collected from Bed I are appreciably older than 1.7 million years.

RICHARD L. HAY
Department of Geology and Geophysics, University of California, Berkeley 4

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Intrauterine Foreign Body: Effect on Pregnancy in the Rat

Abstract. *A silk suture placed in the lumen of one uterine horn of rats before mating prevented pregnancy in that horn although normal implantation occurred in the unoperated horn. The suture did not interfere with fertilization or the tubal transport of ova, nor did it induce a decidual reaction; it appeared to prevent pregnancy by causing failure of implantation.*

At a recent conference (1), on intrauterine contraceptive devices, there was no available experimental information on the mechanism of their action. Ishihama (2), reporting on a large series of women, discussed intrauterine devices for use in birth control. He presented no experimental data to identify the time, site, or mode of action. Our study was undertaken to determine at what stage of reproduction in the rat an intrauterine foreign body would interfere with pregnancy.

Mature, female rats (Long Evans strain) with normal estrous cycles and

maintained on a standard diet were used for this study. They were anesthetized with ether, and the right ovary, oviduct, and uterine horn were exposed through a dorsolateral incision. An atraumatic needle, attached to a silk suture (5–0), was inserted through the antimesometrial wall of the horn, passed along its lumen, and brought out through the same wall, approximately 5 to 8 mm above the point of entry. The suture was pulled through the site of introduction until it lay within the uterine cavity. The upper end of the suture was cut, and a knot was tied adjacent to the uterine wall to fix the suture in position. The incision was closed, and a vaginal smear was taken. The female was then placed with a male. After the surgery, vaginal smears were taken each morning, and the day on which sperm were seen was designated as the first day of pregnancy.

An initial group of nine females (groups A and A₁, Table 1), autopsied or laparotomized between the 7th and 14th days of pregnancy, showed regular implantation in the control horns. In seven operated horns where the suture remained in place, neither sites of nidation nor deciduomata around the suture area could be found. In two animals (group A₁), the sutures were not in the uterus at necropsy, and implantation appeared normal bilaterally (Fig. 1). Nine operated animals (groups B and B₁, Table 2) were killed on the third and fourth days of pregnancy, at which time the reproductive tracts were dissected free, and the uterine horns and oviducts were flushed to recover ova. No demonstrable differences in the number of ova, position in the tract, morphology, or rate of cleavage could be found between control and operated sides. On the 5th day of pregnancy, only one of six animals (group C, Table 2) with retained sutures had ova in the operated horn, although all but one of the contralateral horns contained normal ova. In two animals (group C₁, Table 2), the suture had become displaced, and on the 5th normal ova were recovered from both horns.

Histological examination of uterine tissue from the sutured areas showed no decidual reaction or inflammation. In general, the only notable differences between sections from operated and control horns was a partial denudation of the epithelium lining the lumen and the presence of a few leukocytes within the lumen. This was possibly caused by
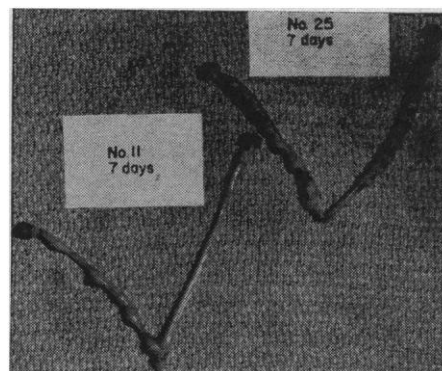

Fig. 1. Uteri from two animals, 7 days pregnant, showing normal bilateral implantation (No. 25, suture not present at autopsy) and unilateral implantation (No. 11, suture present at autopsy).

passage of the suture. The lack of endometrial epithelium did not prevent implantation, since operated animals who had lost their sutures still implanted normally.

The results indicate that in rats an intrauterine foreign body prevents pregnancy by interfering with implantation rather than by interfering with fertilization or the tubal transport of ova. The cleavage rate and position in the reproductive tract of ova recovered from both horns on the 3rd and 4th days correlated well with those reported

Table 1. Effect of silk suture surgically placed in the right uterine horn before breeding.

Suture	No. of implantations of ova			
	Right side		Left side	
	Total	Average	Total	Average
Group A, nine animals, 7 to 14 days pregnant				
Retained	0	0	17*	4.3 ± 1.5
Group A₁, two animals, 7 to 14 days pregnant				
Displaced	13	6.5	14	7

* In three animals the implantations were confirmed by laparotomy but not counted.

Table 2. Effect on the number of ova recovered.

Suture	No. of ova			
	Right side		Left side	
	Total	Average	Total	Average
Group B, seven animals, 3 to 4 days pregnant				
Retained	22*	3.1 ± 1.9	31†	4.5 ± 1.1
Group B₁, two animals, 3 to 4 days pregnant				
Displaced	8	4	8	4
Group C, six animals, 5 days pregnant				
Retained	3	0.5	19	3.2 ± 2.1
Group C₁, three animals, 5 days pregnant				
Displaced	7	2.3	5	1.7

* Recovered from tube in all seven animals.
† Recovery from tube in six animals and from uterus in three, including two animals in which ova were recovered in both tube and uterus.

by Dickmann and Noyes (3) in their studies on unoperated animals.

The demonstrated absence of ova from the operated horn on the 5th day reflects an unfavorable uterine environment, induced by the presence of the foreign body. Intraluminal factors may act upon the blastocysts, so that they disintegrate; or alterations in normal uterine tone and motility may allow the ova to escape into the vagina before the time of implantation.

L. L. DOYLE
A. J. MARGOLIS

Department of Obstetrics and Gynecology, University of California School of Medicine, San Francisco

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Proprioceptive Discrimination of a Covert Operant without Its Observation by the Subject

Abstract. *When the subject occasionally emitted an invisibly small thumb twitch (detected electromyographically), he received a tone as a signal to press a key. After several conditioning sessions, the tone was progressively diminished to zero. The subject nevertheless continued to press the key whenever he emitted a thumb twitch, and he reported that he still heard the tone.*

A response so small as to be visually imperceptible to subject and experimenter alike may, on the basis of electromyographic detection, be successfully conditioned by standard operant procedures (1). We now show that the faint proprioceptive feedback from such a response can become a discriminative stimulus for other behavior.

Our specific objective was to train the subject, although he might remain otherwise unresponsive to an occasional minute twitch in his left thumb (*m. abductor pollicis brevis*), nevertheless to "report" its occurrence within 2 seconds by pressing a key with his right index finger. Should this prove unfeasible we hoped at least to demonstrate preparatory activity in a muscle associated with key pressing (*m. extensor carpi radialis brevis*), since this would indicate that one covert response, the thumb twitch, had become a discriminative stimulus for a second, the incipient movement of the index finger. The latter we call "sub key press."

The first five subjects, all of them young adults, exhibited sub key presses. Three others, who underwent more prolonged training, came to execute the overt key press.

In the first session we determined operant level for both thumb twitch and sub key press. These unconditioned rates of occurrence for the two responses would, of course, produce some instances where the sub key press would follow the thumb twitch within 2 seconds by chance. Accordingly, evidence for the formation of a discrimination required that our experimental procedures bring about an unmistakable increase in the proportion of such joint occurrences.

In Fig. 1 the third column of cumulative records, labeled "Hits," displays this type of event for each session. The first column, "False Alarms," shows sub key presses *not* preceded by a thumb twitch within 2 seconds, and the second column, "Misses," shows thumb twitches *not* followed by a sub key press within 2 seconds. The total number of sub key presses is thus the sum of "False Alarms" and "Hits," and the total number of thumb twitches is the sum of "Misses" and "Hits." Each of the responses reveals an operant level rate of approximately 600 per hour, or about one every 6 seconds. These overall rates did not change appreciably throughout the experiment.

In a second session we compounded the proprioceptive stimuli produced by the thumb twitch with a readily discriminable exteroceptive stimulus. This was a moderately loud 1000-cycle tone of about ½ second duration, superimposed on the constant, random masking noise. We instructed the subject to press the key with his right index finger whenever he heard this tone, and then to note the advance in his score as shown on an illuminated digital display. His total score, he was told, would directly determine his pay for the session. (At the end of each session he was paid 2 cents for each reinforcement which he had scored.)

We triggered the tone as quickly as the experimenter's reaction time permitted whenever we saw on an oscilloscope a deflection which represented the thumb twitch. This deflection consisted of a discrete sinusoidal wave with
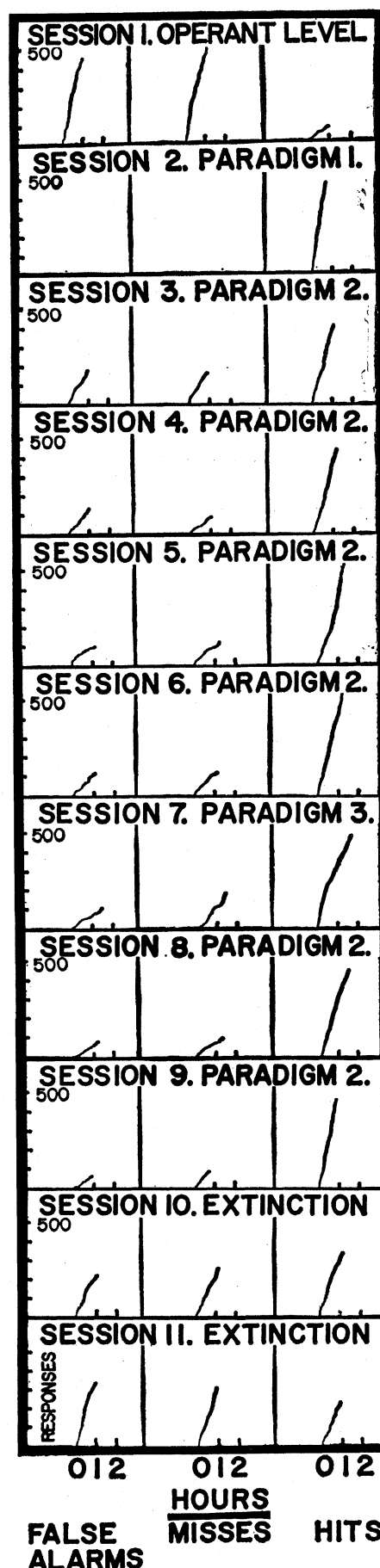

Fig. 1. Cumulative response curves for a single subject.