out jeopardy to public health adds significantly to confidence that the use of nuclear explosives in large excavation projects such as the trans-Isthmian sea-level canal is feasible.

JOHN S. KELLY
Division of Peaceful Nuclear Explosives, U.S. Atomic Energy Commission, Washington 25, D.C.

Note

1. The data from these studies are being prepared for publication in technological reports.

3 August 1962

Transfer of the "Sex-Ratio" Factor in Drosophila willistoni by ingestion

Abstract. Thirty-nine females from a normal strain of *Drosophila willistoni* were kept in bottles containing a drop of a supernatant of a macerate of "sex-ratio" females of the same species. Two of these females acquired the "sex-ratio" condition and transmitted it to their progenies.

Some females of several species of *Drosophila* produce unisexual, or almost unisexual, progenies consisting of females and few or no males. This "sex-ratio" (SR) condition, which is dependent on the female and not on the male with which she is mated, has been studied by several workers. Poulson and Sakaguchi (*1*) have shown that in *Drosophila willistoni* this kind of sex ratio is caused by the presence in the bodies of the females of a microorganism which is apparently a species of *Treponema.* The same has been demonstrated in *D. paulistorum* and *D. equinoxialis* by Malogolowkin (*2*). Poulson and Sakaguchi found that the maintenance of the microorganism depends upon the genotype of the host.

Intra- and interspecific transfer of the sex-ratio condition by injection (*3*), and "cure" by temperature treatment of the flies (*4, 5*) were obtained in several species. In order to discover the mechanism by which this character maintains itself in natural populations, Magni (*4*) tried to transfer the factor to normal females of *D. bifasciata* by having different proportions of normal and SR females develop in the same food medium. The results were negative.

Our report describes a new method of transfer of the factor from SR strains of *D. Willistoni* into normal strains of the same species.

One hundred virgin females from a normal strain were kept in ten sterilized bottles (ten females in each bottle) without food for 7 hours. A drop of the supernatant, obtained by L'Héritier's technique (*6*) from a macerate of females of the SR strain was placed in each bottle. Some of the flies immediately approached the drop and fed on it. After 17 more hours, the surviving flies, 54 in number, were crossed in pair-matings, in vials containing banana-agar medium. Thirty-nine of these flies were fertile (pair-matings are not always successful in *D. willistoni*), and 37 gave normal proportions of sexes.

The other two (E18 and E42) acquired the "sex-ratio" condition, which they transmitted to their progenies. The offspring of these two females were counted until the fourth generation. Despite the appearance of females which did not show the "sex-ratio" condition, the "sex-ratio" was maintained in some of the females. The percentage of males produced by the two females, E18 and E42, at different times after the ingestion of the macerate of sex-ratio flies is shown in Table 1.

As a control experiment, the same number of flies were given the supernatant prepared from a macerate of normal females of *D. willistoni.* Among the 100 females used, 49 survived and the 35 fertile matings produced progenies with a normal proportion of both sexes (Table 2).

Table 1. Percentages of males produced by the two females, E18 and E42, at different times after they had ingested the macerate of sex-ratio flies.

Time after ingestion (days)	Flies counted (No.)				Males (%)	
	E18		E42		E18	E42
	F	M	F	M		
1–20	25	14	17	15	35.8	43.7
20–43	40	11	56	34	21.5	37.7
43–53	16				0	

Table 2. Results obtained in F_2, F_3, F_4 of *D. willistoni.*

Control group	Total No. of flies		Females tested (No.)	Unisexual progenies
	F	M		
		Fly E18		
F2	266	91	15	8
F3	291		14	14
F4	249	16	18	14
		Fly E42		
F2	110	53	9	2
F3	69	8	5	4
F4	144	90	13	6

The causative agent of the "sex-ratio" condition in *D. willistoni* can, consequently, be transferred to a normal strain of the same species by allowing flies to ingest the supernatant from a macerate of females from SR strains.

G. G. CARVALHO
M. P. DA CRUZ
University of Brazil, Rio de Janeiro

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7. We wish to thank Drs. Ch. Malogolowkin, O. Frota-Pessoa, and Th. Dobzhansky for their advice and help.
8. This work has been made possible by grants from the Conselho Nacional de Pesquisas and the University of Brazil.

15 August 1962

Direct and Transcallosal Induction of Touch Memories in the Monkey

Abstract. A monkey, after corpus callosum transection, will fail to recall through one hand tactual tasks that he has learned through the other hand. However, if a monkey has already learned a task through one hand, destruction of the corpus callosum does not greatly affect his subsequent recall of that task through the other hand. It is concluded that task learning through one hand develops separate memory trace systems in both hemispheres.

The normally occurring transfer of training between the hands is supported by the corpus callosum in primates (*1*). In the absence of the corpus callosum, tactual experience and tactual learning seem to occur independently through the two hands. In an animal in which the commissure is intact, transfer of training between the hands suggests that memory trace systems may be established in both hemispheres even when there is restriction of tactual learning through one hand. The possibility exists, however, that mnemonic effects may be induced only in the hemisphere related to the "trained" hand and that subsequent performance through the "untrained" hand is sup-

Table 1. Data on transfer of training from right to left hand in four control monkeys, and in four companion monkeys with corpus callosum and anterior commissure transected, after completion of training with the right hand only. The values in columns 2 and 4 represent the number of trials required to achieve the criterion of learning in performing tasks with the right hand in the initial trials. The values in columns 3 and 5 represent the number of trials required to attain the criterion of learning in subsequent tests in which performance was with the left hand.

Stimulus	Trials for control (No.)		Trials for operated animal (No.)	
	Right hand	Left hand	Right hand	Left hand
	Tactual-pattern test			
Smooth; grooved	500	40	520	80
	Roughness test			
Easy (grits Nos. 60, 16)	360	20	420	60
Moderately difficult (grits Nos. 60, 30)	640	40	440	40
Difficult (grits Nos. 60, 46)	1860	100	1360	140

ported by the transcallosal utilization of the primary mnemonics of the "trained" hemisphere. Work with interocular transfer of visual learning in cats in which the chiasma has been sectioned has indicated that both mechanisms may be operative—that in the case of a simple task, correct responding through the untrained eye could be supported by the secondary trace system of the "untrained" hemisphere alone, whereas, in the case of a more difficult task, correct responding through the untrained eye would depend on the availability of the primary mnemonic system of the "trained" hemisphere (*2*). Because of the great phylogenic gap between cat and primate we felt it important to investigate the relative degree of development of the memory trace systems in the two hemispheres after unilateral restriction of learning in the monkey.

Eight monkeys of the species *Macaca mulatta* were grouped into four pairs and were taught tactual discrimination responses through their right hands only. One pair of monkeys was taught a form discrimination response with the stimulus objects shown in Fig. 1, at left. Each of the remaining three pairs was taught a different set of roughness discrimination tasks in graded series of three. Silicon carbide grains of standard grits were used in constructing the stimulus objects for the roughness-discrimination tasks. Discrimination of objects coated with grit No. 60 (Fig. 1, far right) was rewarded; discrimination of objects coated with grits Nos. 16, 30 (Fig. 1, second from right), and 46 was punished in tasks designated easy, moderately difficult, and difficult, respectively. After all pairs of monkeys had attained a level of success of 17 correct responses in 20 trials (the criterion of learning), they were given 500 additional tasks of the same kind, under the same conditions.

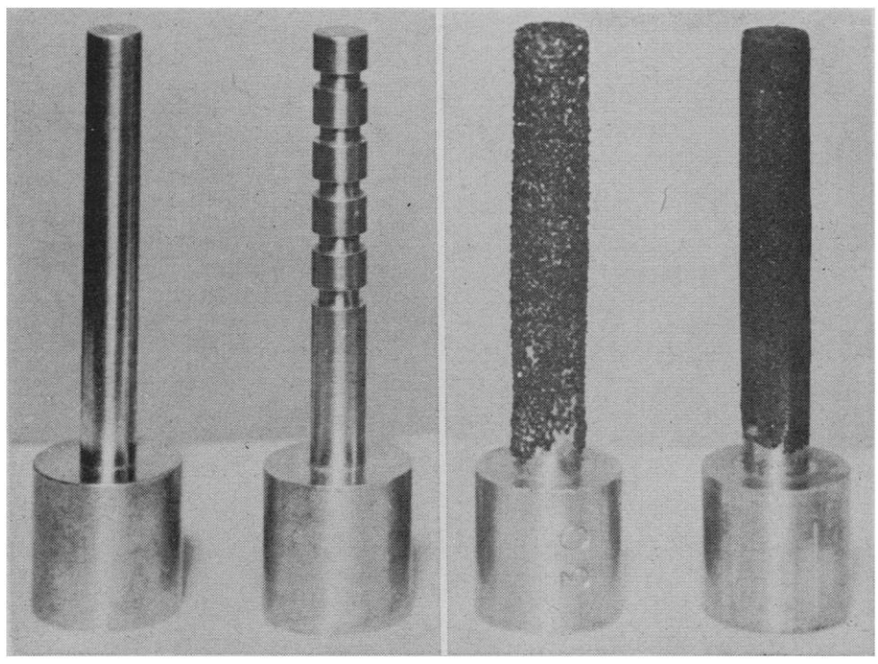

Fig. 1. Pairs of stimulus objects. At left, objects used in the form discrimination task; at right, objects used in the "moderately difficult" roughness discrimination task.

One monkey of each pair was then set aside while the other underwent complete section of the corpus callosum and anterior commissure. Two weeks after the operation, both monkeys of each pair were again tested on their respective tasks, but for the first time through their left hands. As may be seen in Table 1, solution of the problems through the left hands was achieved about equally rapidly by the animals with sectioned commissure and by those with commissure intact. In both groups some retraining through the left hand was frequently required before the monkeys could reach the previous level of learning. Performance through the initially trained right hand was also tested and found unaffected by the transection of the corpus callosum.

We conclude that sensory experiences transmitted to only one hemisphere through the afferent touch pathway induce memory trace systems in both hemispheres in the primate. These trace systems of the two hemispheres thereafter possess the potential of separate existence, as evidenced by their continued expression subsequent to total section of the commissure. The transcallosally induced memories seem less well defined than memories induced directly, since some retraining is regularly required to establish learning through the untrained hand. The system of commissural association in the primate is developed to such an extent that the mnemonic system underlying the learning of even the most difficult task may receive well-developed contralateral expression (*3*).

FORD F. EBNER
RONALD E. MYERS
Department of Physiology and
Division of Neurological Medicine,
Johns Hopkins School of Medicine,
Baltimore, Maryland

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3. This work was supported by U.S. Public Health Service grant No. B 2627.
14 June 1962