TRANSFERABILITY OF ELECTRO-CONVULSIVE SHOCK INDUCED SHORT TERM MEMORY IMPAIRMENT BY BRAIN HOMOGENATES IN RATS

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(Received on January 30, 1981)

Summary : Six rats were subjected to a series of five electro-convulsive shocks. Their brain extracts were injected intraperitoneally into six other rats trained to perform a short term memory task. They showed a significant short term memory impairment after twentyfour hours and fortyeight hours and also, a difficulty in learning the task. The controls which consisted of rats injected with brain extracts of rats not subjected to any fits showed good memory trace and capacity to build up their memory.

In this connection a new single-trial technique for short term memory was devised and standardised based on rat-trap principle and avoidance of unpleasant experience.

Further, it was noticed that rats subjected to direct fits ate less and consumed less water. Those injected with brain homogenates of convulsed rats however, seemed not to deviate from the normal.

INTRODUCTION

There is evidence that short term memory is quite considerably impaired by electro-convulsive shock (6). Further, the point that electro-convulsive shock leads to several chemical changes that include a fall in protein synthesis responsible for memory impairment has also been studied exhaustively (2,3). The possibility of Puromycin like substance being responsible for this has also been suggested (2). Whether a chemical is produced as a result of repeated fits, which on transfer into normal animal impairs the latter's short term memory is a possibility, which to our knowledge, seems to have been unexplored. This has been the object of our study.

MATERIAL AND METHODS

Short term memory and electro-convulsive shock :

The equipment used was based on rat-trap principle. It consisted of a narrow passage (2 feet long) covered with glass on top. The floor was so arranged that, when a rat crosses a particular line (Limit Line), it would be made to drop down instantaneously. Opposite the entrance, an arrangement for fixing a bread slice along the wall was made, so that a rat was required to cross the whole length of the passage to reach the slice of bread. The whole thing was erected at a height of 2 feet, using wooden walls as pillars which covered a basin of 2 feet x 1 feet, with water at room temperature to a level of 2 inches.

Twelve rats (Wistar albino, 2 months old, weight 125 to 150 grams) were selected, (R1 to R12). R1 to R6 were grouped as 'Test', R7 to R12 were grouped as 'Controls'. They were "Semi-Starved". (Rats given only 10 grams of food per day with sufficient water).

The test rats were on each day subjected to single trial consisting of letting them enter the passage. As soon as the rat crossed the 'limiting line', it was made to drop down into the water by the trapping mechanism. Once in water, it would be removed within thirty seconds and subjected to electro-convulsive shock of 150 m. amps for 0.2 seconds using an electro-convulsiometer. Its memory was assessed after 24 hours and 48 hours. (after each assessment however, it was subjected to the fit within 30 seconds). The controls had a similar task to perform but with no fit to follow.

The details were tabulated (Table IA and IB).

Transfer of brain homogenates :

Here six rats (T1 to T6) were selected as "Test" group.
six rats (C1 to C6) were selected as "Control" group.
six rats (E1 to E6) were selected for "Convulsive Shocks".
six rats (B1 to B6) were selected as "Blank".

(Blanks consisted of rats not subjected to shocks).

Six rats (E1 to E6) were subjected to a series of 5 electro convulsive shocks of 150 M amps for 0.2 seconds each (one on each day) with a gap of one day following the

third shock. Brain extracts from these rats were injected intraperitoneally into the test rats (T1 to T6) separately within thirty seconds after the short-term memory task.

Similar extracts were injected from Blanks (B1 to B6) into controls (C1 to C6) which had short term memory task.

RESULTS

TABLE I-A : Differential performance in short-term memory of test and controls after electroconvulsive shock.

Test Rats

Rats	*Time taken to cross the limit line (in seconds)*		
	Before convulsion (First session)	*24 hrs after first convulsion (Second session)*	*24 hrs after second convulsion (Third session)*
R1	2	1	2
R2	1	3	2
R3	1	3	3
R4	5	2	3
R5	4	3	2
R6	2	1	1

P Value < 0.05

TABLE I–B : Controls

Rats	*Time taken to cross the limit line (in seconds)*		
	First session	*Second session 24 hrs later*	*Third session 48 hrs later*
R7	1	15	Never Crossed*
R8	1	25	—do—
R9	2	25	—do—
R10	2	15	—do— till 77 Secs.
R11	2	40	Never Crossed*
R12	2	12	—do—

P Value > 0.001.

*Note : The controls were given maximum time of 5 minutes to cross the line but none had crossed by then, except R10.

Test and control groups were tested after 24 and 48 hours and memory assessed. Results were tabulated (Table IIA and IIB).

TABLE II-A : Differential performance in short term memory of tests and controls after the injection of brain homogenates.

Test Rats

Rats	Time taken to cross the limit line (in seconds)		
	Before injection of homogenates	After injecton of homogenates	
		24 hours	48 hours
T1	1	4	3
T2	3	10	8
T3	2	1	2
T4	2	3	1
T5	5	15	6
T6	4	2	3

P Value < 0.05.

TABLE II-B : Controls

Rats	Time taken to cross the limit line (in seconds)		
	Before injection of homogenates	After injection of homogenates	
		24 hours	48 hours
C1	1	4	Never Crossed*
C2	2	15	70
C3	2	5	Never Crossed*
C4	8	20	—do—
C5	25	30	—do—
C6	15	12	—do—

*Rats were given 5 minutes time to cross the line but none of these had crossed by then. Further, C1, C5 and C6 never stirred from the entrance, C3 and C4 went to the line twice and returned back to the entrance.

Technique of extraction :

The extraction was done in accordance with the procedure adopted by Ungar *et al.* in transferring learned fear in rats (8).

Rats were anaesthetized under ether and decapitated. Dissection was carried out under ice. The portion between medulla oblongata and cerebral cortex was dissected out, i.e. portion excluding cortex, cerebellum and medulla oblongata. This part of the brain was homogenised in distilled water for a concentration of 1 *gm/cc* for 5 minutes. This was then centrifuged for 15 minutes at 2000 rpm. 0.4 *ml* of the supernatant as the material to be injected.

DISCUSSION

Table IA and IB : Before convulsion, all the test rats have behaved in the same manner. After the convulsion (24 and 48 hours later) no significant change has been noted ($P>0.05$). The rats have not remembered the short term memory task done prior to convulsion. In the case of controls, not subjected to electro-convulsive shock, very significant learning has been noted ($P<0.001$). This suggests that convulsions produced by electro-convulsive shock impairs short term memory.

Table IIA and IIB ; Before injection of brain homogenates, all the test rats have behaved in the same manner. After the injection of brain homogenates of rats subjected to fits, no significant change has been noted in test rats ($P>0.05$). The test rats have not remembered the short term memory task done prior to injection. In the case of control rats, injected with brain homogenates of rats not subjected to fits, very significant learning has been noted ($P<0.001$). Perhaps, in the test rats, the injected factor might have impaired short term memory.

The study suggests that a convulsion induced by electro-convulsive shock not only impairs the short term memory in a given rat, but also produces a transferable factor which can by itself impair short term memory.

We also incidently observed, an additional interesting finding. Rats subjected to direct fits ate less ($P<0.001$) and consumed less water ($P<0.001$) just after two fits, whereas those injected with brain homogenates of convulsed rats behaved as they had done before injection.

T-Test was used for statistical analysis.

Regarding the methodology, usage of a control group injected with brain homogenates of non-convulsed rats excludes the possibility of any other chemical (other than that produced by convulsion) responsible for memory impairment.

Selection of the region for injection is in accordance with the report that maximum short-term memory activity in rats occurs between cortex and medulla oblongata (5).

Intraperitoneal route was chosen for injection based on a report that memory transfer is independent of route of injection (4). Perhaps, chemical responsible for memory impairment could also be so transferred.

It is a well documentated fact that an ECS - induced short-term memory impairment is chemically mediated. The possible explanations that have been conclusively put forward are increased Acetyl Choline, reduction in RNA, increase in 5HT (1) and reduction of Adrenergic activity (7). Though Barondes *et al.* have considered the role of "memory inhibitors" like puromycin and Actinomycin in inducing a memory deficit, (3), that this chemical is transferable as suggested by our studies. Subsequently it may be possible to isolate the transferable chemical responsible for memory impairment, just as the chemical responsible for positive memory transfer (8,9,10).

ACKNOWLEDGEMENTS

We acknowledge with great sense of indebtedness, Dr. C.M. Francis the Dean of St. John's Medical College for permitting us to do the work. Dr. K.N. Sharma the then Professor & Head of Physiology Department for his expert guidance, Dr. P. Simhadri, Professor of Physiology, Dr. Thangam Joseph, Professor of Pharmacology, Dr. G.D. Kalyankar, Professor of Biochemistry and Mr. A.S. Mohammed of Statistics, St. John's Medical College for their valuable co-operation in our work.

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