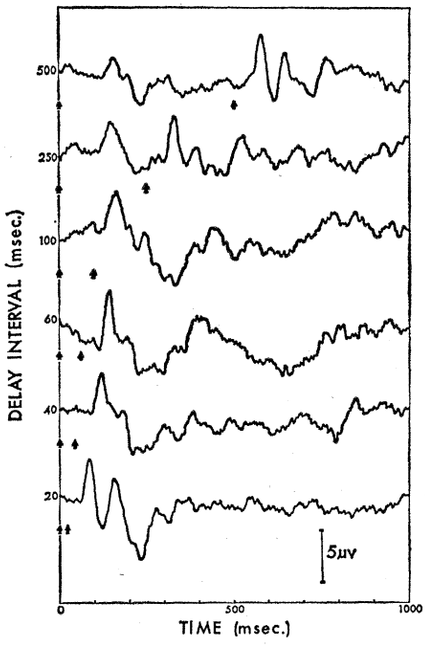


Fig. 2. Average evoked potentials from visual area of subject SY to paired flashes separated by different delay intervals. Onset of first flash indicated by arrow on ordinate, second flash by second arrow; interval of delay between flashes shown on ordinate. Both flashes the same as in Fig. 1.

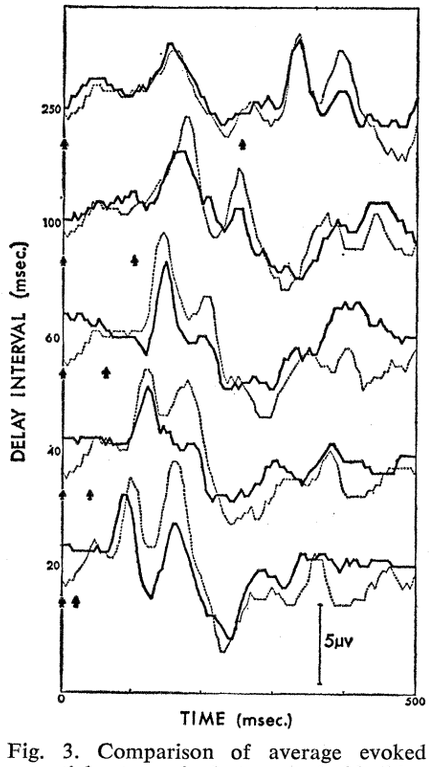


Fig. 3. Comparison of average evoked potentials to paired test and blanking flashes (solid line) and synthesized average evoked potentials for test and blanking flashes recorded separately (dotted line). For both records arrows indicate, respectively, the onset of the test and blanking flashes.

age evoked potentials for the blanking flash appear to merge with those of the test flash. By contrast, at 20-msec delay, where the first stimulus is perceptually blanked by the second, the potentials appear to be like those of the blanking flash either at 500-msec or when presented alone (see Fig. 1). This suggests that in the blanking stage the evoked potentials for the second stimulus displace those of the first stimulus.

The foregoing results seem to show that the average evoked responses obtained with paired stimuli can be classified into three general groups as a function of the interval between flashes: (i) *no perceptual interaction*—two stimuli are perceived separately, accompanied by average evoked potentials which do not overlap; (ii) *perceptual interaction*—the apparent brightness of the first flash is enhanced by the second, accompanied by potentials which overlap; (iii) *perceptual blanking*—the first flash is obliterated by the second, accompanied by potentials which suggest displacement of responses to the first flash by those of the second.

In an attempt to evaluate the specific contributions of each of the flashes to the average evoked potentials obtained for paired stimulations, hypothetical potentials were constructed by algebraic summation of the separate average evoked potentials for the two flashes. In performing this synthesis on the I.B.M. 7094 computer, the average evoked potentials for the blanking flash were shifted temporally to correspond to the delay interval between the paired stimuli. Figure 3 illustrates the remarkable similarity of the potentials obtained (solid line) to the hypothetical potentials (dotted line). The temporal and amplitude correspondences for the major wave components appear to be quite close, except for the second negative and positive components of the blanking flash, which consistently have a higher amplitude in the curve for the hypothetical potentials than they do in the curve for the potentials obtained. Within limits, therefore, the data suggest that the electrocortical activity associated with perceptual interactions to paired flash stimulations may result from additive brain processes. This tends to support the assumptions of other workers (*8*) who have used paired somesthetic stimuli. Further investigations of the deviations between the potentials actually obtained and the hypothetical potentials are now being made, and by a process of successive approximations we may be able to approach a definition of the operations performed by the brain in the generation of the average evoked potentials to the paired visual stimuli (*9*).

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## Fear and Pain: Their Effect on Self-Injection of Amobarbital Sodium by Rats

Abstract. *Rats receiving occasional brief electric shocks pressed a bar, which caused them to be injected with amobarbital sodium, more frequently than the control rats to which they were yoked and which were injected when their partners pressed but whose own bar activated only a recorder. This differential effect was not shown by pairs run without shocks.*

A variety of experimental studies summarized by Miller (*1*) support the hypothesis that one of the effects of amobarbital sodium is to reduce fear.

Experimental evidence shows that the rapid reduction of fear reinforces the response immediately preceding this reduction (*2*). Therefore, if amobarbital does reduce fear, rats maintained in a fear-evoking environment should learn a response which is immediately followed by a painless, quick-acting dose of amobarbital. Such learning would be a new type of evidence for the hypothesis that this drug reduces fear and also would be relevant to the problem of drug addiction.

Twenty-eight male albino rats weighing approximately 330 g were prepared, each with a cannula, inserted permanently in the jugular vein, which terminated either at the tricuspid valve or in the auricle of the heart (see *3*). In this way the drug was administered painlessly and gave immediate effects.

The rats were run in yoked pairs in adjoining Skinner boxes, one rat in each pair serving as a control for the random (operant) level of responding, as well as for the exciting or depressing effects of the drug or of the shocks to be administered. The bar in one box was active so that each time it was pressed an injection of 0.012 ml of a 40 mg/ml solution of amobarbital (equivalent to approximately 1.5 mg/kg) was injected at a rate of 0.144 ml/min simultaneously into both rats. The bar in the second box, containing the yoked control rat, was connected only to a counter. Thus the injections of the rat in the first box were contingent on its pressing its bar; for the rat in the second box the injections were not contingent on its pressing its bar. Since the pair of rats was treated alike in all other respects, any reliable differences in the number of times they pressed the bars must be due to the fact that receiving the drug was contingent on bar pressing in the one case, but not in the other.

Each pair of rats was run for 1 hour each day. One group of eight pairs was subjected to fear and pain by being given unavoidable electric shocks of approximately 0.1-second duration and 1-ma strength every 60 seconds during the hour. The other group of six pairs was run without shocks. The total number of times each rat pressed its bar was recorded at the end of each hour.

The effect of receiving the drug immediately after pressing the bar is indicated by the difference between the scores of the contingent and noncontingent members of each pair. In the pairs not receiving shock, there was no appreciable difference throughout the six days of the experiment; hence the lower curve fluctuating around zero, shown in Fig. 1. As is typical of rats introduced to a new situation without any reinforcement for bar pressing, both groups showed a daily response rate that declined progressively from approximately 17 presses per hour on the first day, to approximately 5 presses per hour on the fifth day, after which the rate remained relatively constant.

In the group receiving shock, the control (noncontingent) rats showed a curve indistinguishable from that of the two groups which did not receive shock. But the experimental (contingent) rats, which happened by chance to start below the rate of their partners and hence yielded an initially negative difference score, increased their responses progressively until the third day, and thereafter showed a decrease in the number of responses, as shown by the upper curve in Fig. 1.

Analysis of variance performed on these data yielded a significant interaction between shock conditions and days ($p < .025$) showing that the obvious difference between the two curves in Fig. 1 is, indeed, statistically reliable. Since inspection showed that this difference was due to the performance of the shocked animals, an analysis of trend was performed on their data. It indicated that the quadratic component, representing the up-and-down aspect of the upper curve, was highly significant ($p < .005$), accounting for approximately 70 percent of the variance.

From these data, one can conclude that for the shocked rats, the injections of amobarbital sodium immediately following bar pressing had a reinforcing effect which caused learning through the third day. This effect could either be due to a reduction in fear as postulated, or to a reduction in pain.

Under the conditions of this experiment, amobarbital did not appear to have any appreciable reinforcing effect for animals run without shock. If the rats had been made physically dependent on the drug so that they showed severe withdrawal symptoms, it is conceivable that this drug would have had a reinforcing effect even in the group not receiving shock. Preliminary results of experiments still in progress suggest that both psychological stress and withdrawal symptoms are involved in determining the rate at which rats will work to inject themselves with morphine.

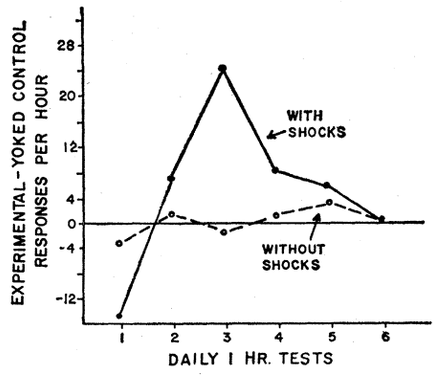


Fig. 1. The reinforcing effect of amobarbital sodium on rats receiving occasional electric shocks and those not receiving shocks. The effect is measured as the difference in rate of bar presses by rats whose responses produce injections of the drug, and of the controls that are yoked to them, who are injected when their partners respond, irrespective of their own responses.

Figure 1 shows that after the third day the superiority of the contingent animals in the shocked group gradually disappeared, indicating that the drug was losing its reinforcing effect. This result shows a similarity to the clinical picture in which a drug prescribed to relieve fear and tension may be quite effective at first, but becomes less so with repeated use.

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