EFFECT OF D-AMPHETAMINE AND ALCOHOL ON ATTENTIVE MOTOR PERFORMANCE IN HUMAN SUBJECTS

by

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IN THE PAST FEW YEARS, much concern has been expressed over the fact that an increasing number of people are operating motor vehicles under the influence of a wide variety of drugs. The impairment produced by even small amounts of alcohol has been known for a long time, and it is of prime importance therefore to determine the effects of alcohol when used in combination with other drugs.

The amphetamines are in widespread use as stimulants, particularly by some professional drivers. It is of interest that we know how d-amphetamine affects attentive motor performance, especially when an attempt has been made to reduce the depressing effects of alcohol.

D-Amphetamine shows its highest degree of stimulation in a situation of fatigue and, for this reason, is ideal for overcoming the boredom and fatigue induced by several hours of driving.

To take advantage of this fact, a long, involved and tiring task was presented to forty paid volunteers in the form of a double-blind experiment.

This experiment was designed to evaluate human attentive motor performance while experiencing the depression of alcohol, the stimulation of amphetamine, and the effect of combining these two drugs.

The subjects were divided into four groups of ten, with one group acting as control and receiving placebo drug only. Of the three remaining groups, one received a beverage containing 45 ml. of ethanol per 150 lbs. of subject's body weight plus a placebo drug, and the last received the same alcohol beverage along with 5 mg. of d-amphetamine.

Attentive motor performance is measured by the Pursuit Meter shown in Figure I, which consists of a dual beam oscilloscope and a steering device that the subject can use to control one of the oscilloscope beams. The Pursuit Meter is programed to display patterns of varying complexity with one beam while the subject's task is to track these patterns with the other beam.

The input signals from the two beams and an error signal are applied to three separate channels on a strip recorder and the resulting record is then analyzed for an error score.

Four patterns were used in this experiment and are shown in Figures II-V. Each of the subjects were presented the four patterns ten times, before consuming the beverages and drugs, and in this way each acted as his own control. The scores received after the beverages and drugs were ingested could then be calculated as per cent impairment or per cent improvement from the normal or control value.

The test patterns were presented ten times each at half-hour intervals for 3½ hours. After each test period, the blood-alcohol level of the subjects who had consumed beverages was determined by breath analysis.

Figure VI represents the results from pattern 1. The points plotted are the error score averages of the four groups for each half-hour test interval.

In general, ingested d-amphetamine takes effect in about an hour and reaches its peak effect in 2-2½ hours, while the alcohol in our subjects' blood reached its highest level between 30 to 60 minutes. At the time when the amphetamine is at its peak effect, the blood-alcohol levels have decreased to approximately 50 mg. % or the equivalent of the alcohol in two bottles of beer in a 150-pound man.

With pattern one, the subjects with placebo only achieved about a 10% improvement in their performance due to learning. The subjects with alcohol plus placebo drug showed the initial depression of the alcohol and substantial improvement.
in performance as the alcohol is metabolized. The subjects with d-amphetamine only exhibited a larger initial increase which leveled off at about 20% improvement in performance after one hour.

The group of subjects who had taken d-amphetamine plus alcohol again displayed the impairment of the alcohol during the first hour. However, at this time their performance was slightly better than that of the placebo only group and improved greatly as the alcohol was metabolized.

Figure VII represents the results from pattern two, and again, the subjects with placebo only showed the learning involved during the 3½ hour period. The placebo plus alcohol group is seen impaired initially with performance improving as the alcohol
Fig. II: The first pattern was this simple sine wave, line A, which represents the problem signal. The second tracing, line B, represents the subject's typical response to the problem, and the third tracing, line C, is the error signal. If the subject had exactly superimposed the dot he controlled on the pattern dot, the error signal would have been a straight line. The error score was calculated as measured deflections from this straight line.

Fig. IV: This is the third pattern presented to the subject, line A, which was a fast, random, and unpredictable wave. This pattern proved to be the most difficult of the four. Line B represents the response signal and line C, the error signal.

Fig. III: This is the second pattern or problem signal, line A, which was a faster, more complex sine wave; line B is the subject's response signal and line C is the error signal.

Fig. V: This is the fourth pattern, line A, which is a slow, random, and unpredictable wave. The decrease in presentation speed made it easier to track than pattern three. Line B shows the subject's response, and line C shows the error signal.

is metabolized. The subjects with d-amphetamine plus alcohol do not appear impaired but again approximately those with placebo only until the peak effect of the amphetamine and the metabolism of the alcohol combine to cause a steady improvement in performance. The d-amphetamine only group showed the superior performance in this pattern with the peak being at 2½ hours.

Figure VIII represents pattern three, the most difficult pattern. The placebo group displayed the general improvement from learning while the subjects with placebo plus alcohol continually improved their performance to a peak of about 20% over the 3½ hour period. In this situation of stress, the d-amphetamine failed to stimulate the performance of the subjects with amphetamine plus alcohol and this group did not perform as well as those who had placebo plus alcohol or placebo only. The subjects with d-amphetamine only did show the greatest improvement in performance in this pattern with the peak at 2½ hours.
Figure IX represents the results of pattern four, in which the subjects who had d-amphetamine only showed a marked improvement in performance over the other three groups. Again the d-amphetamine failed to stimulate the amphetamine plus alcohol group beyond the improvement shown by the subjects with placebo only and those with placebo plus alcohol. However, both the amphetamine only subjects and the subjects with amphetamine plus alcohol showed their peak improvement at about 2 hours.

Conclusion
We have shown that the attentive motor performance of human subjects is heightened by d-amphetamine to the point of improving the performance of simple tasks by those receiving alcohol. However, in situations of stress where the relief of fatigue or boredom is not enough to initiate an improved performance, d-amphetamine fails to show its effect on those subjects depressed by alcohol. D-amphetamine is not an effective means of improving one's driving skills while under the influence of alcohol.
DISCUSSION

Dr. Wist: There is apparently an interaction between difficulty of this task here and the effect of drug combination. As I recall, the results of pattern A indicated that toward the end the performance of d-amphetamine plus alcohol was better than in any other condition, whereas with amphetamine one of the worst conditions was represented on the graph. I was wondering whether you might comment on this fact and whether or not you have any explanation of why that sort of effect might take place.

Mr. Brown: I'm afraid I don't have one, but we are using threshold levels of alcohol. At 50 milligrams per cent, some people will be impaired and some people won't, and using just five milligrams of amphetamine, you will find that in some situations some will do better than those who do not receive alcohol. But, in general, we have shown that those who received alcohol were depressed and those who had not received alcohol were stimulated. As long as the subject could kind of guess his way, he did improve his performance when he had had alcohol, but when the patterns were more complex and he couldn't guess, his reflexes were slowed down and the amphetamine did not show a tremendous improvement over the alcohol. So the amphetamine did not effect improvement. But, as to why the individual groups would, on occasion, show a vast improvement, I think could be attributed mostly to the fact that we are only in the threshold area of alcohol in the 50 milligrams per cent and maybe in this case the people in this group weren't impaired.

Dr. Taylor: Did you try to find out whether your subjects could tell whether they had received placebo or amphetamine?

Mr. Brown: I don't believe that was undertaken in this experiment. It was a double-blind study and none of the subjects knew for sure whether they had amphetamine or not, and neither, of course, did the operator. I don't think the study was undertaken to determine whether or not they thought they had.

Mr. Bernstein: In our study, we had them try to guess whether or not they had amphetamine, and seven out of the eight guessed they did have amphetamine and as to whether they had amphetamine and alcohol, three out of the eight guessed they had the amphetamine with the alcohol.

Mr. Kaplan: It would appear with the amphetamine that they could guess it.

Mr. Bernstein: But with the alcohol and amphetamine they could not guess that they had the amphetamine.