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The Effects of d-Amphetamine on Risk Taking*

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With 1 Figure in the Text

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There is much evidence that the amphetamines exert strong effects on dimensions relevant to mood or feeling-states. Mood changes in the direction of optimism, heightened self-confidence, etc., have been obtained by numerous investigators (e.g., NATHANSON 1937; BARMACK 1938; BAHNSEN, JACOBSEN and THESLOFF 1938; and LASAGNA VON FELSINGER and BEECHER 1955). Considering the abundance of such data, one would expect to find corresponding objective behavioral evidence. It might be expected that behavioral indications would be readily obtained in situations involving value judgments, risk estimations, etc. Specifically, one would expect to find the dimensions of heightened optimism, self-confidence, etc., reflected by heightened risk-taking in uncertain outcome settings, i.e., those in which subject's strategy depends upon his judgments of outcome probability and/or favorability. To date there is little objective evidence that the amphetamines have any such behavioral effects. SOMERVILLE (1946) was unable to demonstrate a measurable effect on judgments (tactical decisions) of military officers working on a 72-hour program of staff duty exercises, and HAUTY and PAYNE (1957) found no significant effect on "level of aspiration" discrepancy scores in the Air Force SAM Pursuit Confusion Task. These negative results are not altogether convincing. In SOMERVILLE'S study, the observed judgments dealt with rather familiar types of situations for which established "working rules" were available. This is not the type of situation which one would expect to be maximally sensitive to the effects of "mood" variables on judgments. The situation employed by HAUTY and PAYNE might be expected to be more sensitive to such effects, since their subjects had little relevant prior experience in which to anchor their judgment. There is still the possibility that the situation was too "structured" — i.e., the subjects had too much reliable objective data upon which to base their estimates for maximum sensitivity in registering mood-related

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effects. A more important objection, however, is that the single dosage employed (5 mg *d*-amphetamine) is a rather small one, although sufficient to produce measurable effects of other types (e.g., vigilance phenomena) in most young adult subjects. In effect, this study showed that it is possible to administer a therapeutically effective dosage of *d*-amphetamine, without significantly affecting this particular index of judgment. It did not, of course, prove that the drug has no effect on judgment in general. It does suggest that larger dosages and/or more subtle techniques may be necessary if judgment effects are to be manifested in the laboratory. The experimental setting itself may well inhibit this type of drug response, as contended by HAWKINS *et al.* (1960).

As a final consideration, the results of the SMITH and BEECHER (1960) study are important. They observed the effects of 14 mg *dl*-amphetamine and of 100 mg secobarbital upon swimming performance of trained athletes, conducting measurements both individually and in groups swimming together. The subjects, who swam under drug or placebo, were subsequently asked to estimate their performances in terms of amount of time required to complete a course. Under amphetamine the times, which were actually somewhat improved, tended to be over-estimated. Under secobarbital, both of these effects were reversed. Distortions were generally more pronounced when swimming alone. These results are difficult to interpret, since there is some evidence that both of the drugs tested tend to cause overestimation of elapsed time in emotionally "neutral" situations (cf. DEWS and MORSE 1958, for amphetamine; GOLDSTONE, BOARDMAN and LHAMON 1958, for both drugs). Thus, it would be expected that any effects of either drug on the "optimism-pessimism" component might be confounded with its more specific effect on time perception.

Maximum sensitivity in registering "judgment" effects would be expected in a relatively unstructured situation: one in which there were no strong predispositions (to make the decision process automatic), or convenient sets of rules (to make the decision process mechanical). Preferably, the situation should be a unique one, to minimize behavioral dependence on prior related experiences, and should afford quantitative indices of changes in judgmental tendencies. In accord with these specifications, the following experimental procedure was devised to test the hypothesis that *d*-amphetamine, through its effect upon "optimism," will increase risk-taking behavior.

Method

The experiment utilized a gambling situation in which numbers of cigarettes were involved. The subjects, male penitentiary inmates, use cigarettes as a medium of exchange. The number of cigarettes (seven

packs as a starting "stake") involved in each test session represented to the subject the buying power of several days' labor. A substantial portion of this quantity usually changed hands, with some subjects losing their entire stakes and others more than doubling them. The procedure is derived from that described by SIEGEL (1956), and the detailed measurement philosophy is presented in HURST and SIEGEL (1956). Utility functions for different subjects are derived on the basis of their choices between alternative gambles in an uncertain-outcome ($p = q = .50$) situation. The gambles involve possible gains and losses of different numbers of cigarettes.

For the present purpose, response data are to be compared, under drug and placebo conditions, on the criterion of *relative preference for the more risky as opposed to the less risky options.* The following examples illustrate how the criterion index is computed:

Outcome	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
E	—3	—19	14	—3	32	17	32	17
Non-E	—34	—19	—34	—19	—16	1	1	17

For instance, if subject chooses Option A_1 and event E ($p = .50$) occurs, he loses 3; if non-E ($p = .50$) occurs, he loses 34. However, if subject chooses Option B_1 instead, he has the foreknowledge that he will lose 19 cigarettes regardless of the outcome. Thus Option A_1 is the riskier of the two alternatives, in that it involves the greater possible loss. It will be noted that, in each of the four examples given, "Option A_1" represents a riskier choice than "Option B_1". If we compute the total number of "Option A"-type (high-risk) choices made by each subject out of the standard set of 30 choices we have the required index of risk taking tendency. "Option A" is introduced here merely as a label. No such labels were presented to the subjects.

The event of "E" of subjective probability $p = q = .50$ was created by rolling a die on which are printed two zero-association value nonsense syllables, each occurring on three of its six surfaces.

Two such dice were used, and were alternated throughout each test session: one with the syllables QUJ and QUG, the other with the syllables XEG and WUH. It has been shown by DAVIDSON, SUPPES and SIEGEL (1957) that the roll of such a die constitutes an event of *subjective* probability = .50 for most subjects, contrary to the toss of a coin or other common "chance" events. To control for any possible preferences which may have existed, the "winners" were varied randomly. Thus, for trials involving the "XEG-WUH" die, "XEG" represented "Event E" and "WUH" represented "Non-E" roughly 50% of the time. The rest of the time, "WUH" represented "Event E" and "XEG" represented "Non-E". The subject was familiarized with this procedure in a series of five practice trials.

The mathematically "expected values" of the high-risk and low-risk alternatives were balanced throughout the series. For instance, note that in our previous examples the "expected value" of Option A_1 is

$$.5\ (-3) + .5\ (-34) = -18.5,$$

while the "expected value" of Option B_1 is

$$.5\ (-19) + .5\ (-19) = -19.0.$$

Thus, Option A_1 has the higher "expected values," as well as involving the greater risk. Similarly, Option A_2 has a higher "expected value" than Option B_2, but Option B_3 has a higher "expected value" than A_3, and B_4 a higher "expected value" than A_4.

Of the standard set of 30 choices offered to each subject, 15 were constructed so that the high-risk choice had the higher "expected value" and 15 so that the low-risk choice had the higher "expected value." This procedure was employed as an attempt to control for any drug-induced changes in "rationality," "mental alertness," etc., which might have induced subjects to choose the greater "expected value" regardless of risk (and thus maximize gain on a long-term basis). Actually, none of the subjects tested gave any indication that he had actually computed the "expected values" (as determined from post-test interviews), and none of the subjects made choices in strict accord with "expected values."

The 30 pairs of options were displayed to subject as soon as the practice trials were completed. For each choice, experimenter would point to the two options involved and then mark the response made by subject. An assistant meanwhile recorded the response latency (time between experimenter's pointing and subject's response) by means of a stop watch.

The 29 subjects who completed the experiment were selected from 73 volunteers recruited by means of an advertisement in the prison news-paper. Volunteers were requested for a "drug experiment" in which subjects would have the opportunity to acquire cigarettes. They were not told the purpose of the experiment, nor what drug was used. Selection of the original 30 subjects from the 73 volunteers was accomplished by screening out those with medical and psychiatric contraindications, sub-average IQ scores, and histories of drug addition. For the 30 subjects selected, U.S.P.H.S. IQ's ranged from 104 to 131, with a median of 113. Ages were not recorded, but seemed to range from early 20's to late 40's.

Each subject served as his own control. In both experimental and control conditions, he ingested capsules (containing either the drug or a placebo) one and one-half hours before testing. For the drug condition 10 mg *d*-amphetamine sulphate was used. In balanced sequence, the

subjects were measured under drug and placebo conditions. The two sessions for each subject occurred one week apart. After he had completed both sessions, subject was asked if he had experienced "any effects from the capsules" on either occasion, and to describe these effects. He was also asked if he had any particular strategy in making his choices.

After the data were obtained, the risk-taking hypothesis was tested by comparing the number of high-risk alternatives chosen by each subject in the experimental condition with the number he chose in the control condition. The comparison was done with WILCOXON'S (1949) matched pairs signed rank test for the significance of differences between paired observations.

Results and Discussion

During the experimental (drug) condition, 19 of the 29 subjects made more high-risk choices than they did during the control condition. With 7 subjects, the control condition yielded the greater number of such choices, and 3 subjects showed no difference between conditions. The Wilcoxon test (see above) was significant at $p < .05$, indicating that the sum of the ranks of the differences in favor of the hypothesis reliably exceeded the sum of the ranks of the differences in the unpredicted direction. Fig. 1 depicts the number of high-risk choices made by subjects under experimental and control conditions.

A correlation of —.49 ($p < .01$) was obtained between the drug-induced change in risk-taking, measured by (number of high-risk choices under drug) minus (number of high-risk choices under placebo) and the drug-induced change in latency, measured as (mean latency under drug) minus (mean latency under placebo). Since the drug would be expected to reduce latency in proportion to the extent that it increased "optimism" or "confidence," this correlation is in the expected direction. It could, of course, have arisen from other sources.

In the post-test interviews, 7 subjects reported miscellaneous subjective and/or physiological effects from the capsules given on the drug-containing occasion. Nine subjects reported effects from the capsules containing the placebo, while 7 subjects reported effects from both. The remaining 6 subjects reported no effects for either occasion. There was no discernible pattern to the effects reported on either (drug or placebo) occasion. One subject made the rather disconcerting observation that on the second (drug) session it "felt like I'd been given a dose of benzedrine." However, he was the only one who came at all close to reporting the usual symptomatology. Thus, it seems unlikely that any serious overall bias was introduced by a suggestion effect such as might have resulted from subjects sensing cues of the drug's presence. The results, therefore, constitute a significant and perhaps "unconscious" increase in risk-taking.

No subject reported having employed anything resembling a truly mathematical "strategy" in making his choices.

An auxiliary finding relates to the drug's effect on the "rationality" of the subjects' decision-making. One could define this, perhaps arbitrarily, in terms of the relative frequency with which subject chooses the option with the higher "expected value." This effect could presumably be tested independently of any change in risk-taking behavior, since objective value was evenly balanced between the high-risk and low-risk options in the series of alternatives offered to the subjects.

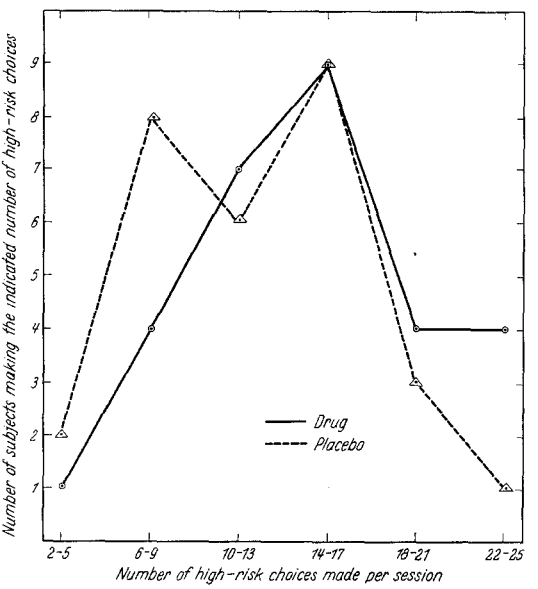

Fig. 1. Number of high-risk choices made under drug and placebo

The results with the Wilcoxon test indicate that the drug produces a significant ($p < .05$, two-tailed) tendency to make a greater number of choices of the alternative with the objectively greater "expected value." It had been anticipated that any tendency toward greater "expected value" would be measurable independently of the tendency toward greater risk-taking, since the options had been constructed with the differences in "expected value" arranged to favor equally often the high-risk and the low-risk alternatives. However, the data show a tendency for most subjects to prefer the low-risk alternatives in the placebo condition. This tendency to err on the side of "conservatism" means that any small tendency toward increased risk-taking will tend to move the subject's choices toward a region of greater "expected value." The converse is also true. The two effects are not resolvable in the choice situation employed here. To discriminate between them, it would be necessary to devise a series of alternatives with which the tendency of most subjects is to err in the direction of extravagance. As an tentative hypothesis, the "risk-taking" interpretation might be preferable since it appears to be more meaningful than an "increase in rationality."

A qualification is also in order concerning the role of the placebo effect. Since the suggestion effect of ingesting capsules is probably not simply additive with the pharmacological effect of the medication, the present use of only two groups (drug and placebo) does not permit a clear resolution of the pharmacological component. More crucial evidence for the present findings would be provided by replication of the study with additional treatment groups such as "no capsules" and "drug disguised." Important differences in performance and mood effects of amphetamine have been noted when these variations were introduced (cf. KRUGMAN *et al.* 1960, and ROSS *et al.* 1962).

Summary

The effect of *d*-amphetamine on the risk-taking behavior of penitentiary inmates was investigated, utilizing a gambling situation involving cigarettes. The experimental situation consisted of choices between alternative gambles involving different amounts of risk. The 29 men served as their own controls, with the number of high-risk choices made by each subject when under drug (10 mg *d*-amphetamine sulfate, orally) being compared with the number of choices made during his placebo session. The difference was significant in the direction of increased risk-taking under the drug. The results are interpreted as offering tentative support to the hypothesis that *d*-amphetamine increases risk-taking, although alternative interpretations are provided.

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