EFFECTS OF TWO COMMON MEDICATIONS ON COMPLEX PERFORMANCE

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I. Introduction.

Many individuals, at the first sign of a cold, follow the admonishments of the TV commercials and take one of the large variety of antihistaminics available on the market. Similarly, lesser numbers of individuals troubled with stomach disorders take a variety of medications to alleviate symptoms. The bottle in which the antihistamine comes typically cautions the user not to drive or operate machinery in the event that drowsiness should occur. It is to be expected that people would observe this caution with various degrees of care and that different people would adopt different criteria as to when drowsiness is present. An analogous situation can be said to exist in the case of those gastrointestinal remedies containing barbiturates. It is clear that doses of these two types of medications exceeding some level would lead to decrements in the individual's performance capabilities. What is not clear is the effect, if any, of normal, clinical dosages.

The purpose of this exploratory research was to examine the effects of normal, clinical dosages of Donnatal and chlorpheniramine maleate on the performance of complex tasks assessing important elements of human behavior of the sort involved in aircraft and air traffic control operations.

II. Method.

Subjects. The 10 subjects who served in this experiment were college students who had received extensive preliminary training and experience on the battery of tasks used. They were trained and tested in five-man groups; the test apparatus provided five subject positions, and testing five subjects simultaneously not only permitted the measurement of group performance but was also both efficient and economical. The subjects were paid for their services at a rate of approximately $9 per 4-hour session. They were also offered a bonus of $2 for performance that "equalled or exceeded the level" they had previously demonstrated themselves to be capable of achieving.

Apparatus. The apparatus used in this experiment has been described in detail elsewhere* and, therefore, will be described only briefly here. The subjects performed on a battery of five tasks presented in six different combinations so that both the level and natures of the workload imposed could be varied. The tasks are identified by the following names: warning lights monitoring, probability monitoring, arithmetic, code-lock (a group task), and target identification.

The warning lights task involved the monitoring of a static process and consisted of two aspects. The first aspect was represented by five red lights—one at each corner and one in the middle of the panel. The subject was instructed to push the button below a given red light any time that light was illuminated. The second aspect consisted of green lights paired with the above-mentioned red lights. With this task, the subject was required to push a button below a given green light to re-illuminate that light if it should go off. For each of these two tasks, response times were measured in tenths of a second from the onset (or offset) of a light until the subject returned the light to its normal condition by pushing the appropriate button.

The probability monitoring task required the subject to scan four, randomly fluctuating meters to determine if the average of the pointer positions of any meter had deviated from zero (12 o'clock). The "signal" to which he was to respond was a shift in the mean of a given meter from zero to 25 units to the right or the left. If the subject suspected a bias to be present on a particular meter, he tested his hypothesis by throwing a three-position, spring centered lever-

* Chiles, W. D., E. A. Alluisi and O. S. Adams: Work schedules and performance during confinement. *Human Factors*, 10:143–196, 1968.

type switch in the direction of the suspected bias. The pointer would automatically come to rest on its correct mean, thus, giving him immediate feed-back as to the accuracy of his response. Time was recorded to the nearest second from the introduction of a bias until the appropriate response removed the bias or until that bias was replaced by a new bias on that or some other meter.

The mental arithmetic task required the subject to sum two three-digit numbers and subtract a third three-digit number from that sum. He entered his answer by appropriate manipulation of a set of three decade pushbuttons for the first three digits and a three-position, center-off switch to indicate whether the fourth digit was a "0" or a "1." Problems were presented at a rate of three per minute; performance was scored in terms of the percentage of problems correct.

The target identification task required the subject to view a standard "target image" and then decide whether the first, second, or neither of two comparison images was the same as the standard image. The task was made somewhat more difficult by random distortion of the comparison images. Problems were presented at a fixed rate of two per minute. The subject indicated his answer by depression of the appropriate one of three buttons marked "1", "2", and "N" (Neither). Performance was measured in terms of the number of correct responses.

The code-lock task, which involved group performance, required the subjects to find the correct sequence in which each subject should push the code-lock button located on each subject's panel; entering the correct sequence illuminated a green light. The onset of a red light on each subject's panel indicated to the subject that a problem was present and, during the search for the correct sequence, provided an immediate indication that an error had been made. The subjects followed a standard search procedure until each subject had pushed his button once and only once in the correct sequence at which time the green light was illuminated. After a 30-second delay, the same problem was presented again and the subjects were to enter the previously obtained solution as rapidly as possible without error. Then, after another 30-second delay, a new problem was presented. The subjects used an earphone intercom system to coordinate both their initial search for the correct sequence and the entering of their second solution. Measures were made of the time required to reach the first solution, the time required to enter the second solution, the total number of errors, and the total number of responses for the first and for the second solutions.

Procedure. Performance was measured during one session for a given day on the combinations of tasks shown in Table 1; each test session lasted 4 hours and consisted of two of these programs in succession. Although no break was provided in the 4-hour schedule, subjects could, with permission, leave their duty stations one at a time for purposes of going to the rest rooms or getting a drink of water during the period beginning at 105 minutes and ending at 130 minutes.

TABLE 1.—Basic 2-hour Task Performance Schedule

Task	Time (Minutes)								
	00	15	30	45	60	75	90	105	120
Reaction time	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
Meter monitoring	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
Mental arithmetic		XXX	XXX						
Problem solving			XXX	XXX	XXX	XXX			
Visual discrimination						XXX	XXX		

Drug administration. The two drugs used in this experiment were Donnatal (phenobarbital—16.2 mg.; hyoscyamine sulfate—0.1037 mg.; atropine sulfate—0.0194 mg.; hyoscine hydrobromide—0.0065 mg.; plus lactose) and chlorpheniramine maleate (4 mg.; plus lactose). The capsules containing the drugs were identical in size and appearance; they were taken immediately before a given test session began. The experiment consisted of five sessions. The first session was a "no-capsule" baseline control. In the subsequent sessions, the capsules were admin-

istered "double blind." All subjects in a crew received the same drug on a given session. On two of the sessions, subjects were given a capsule containing Donnatal; on one session they were given a capsule containing lactose; and on one session they were given chlorpheniramine maleate. The only information given to the subjects about the drugs was that on a given day, they would be taking a normal dosage of one of two commonly used medications.

III. Results and Discussion.

Friedman's analysis of variance by ranks was used to evaluate the differences in performance across the three basic drug conditions. Separate analyses were performed for the red lights, green lights, and probability monitoring tasks for each of the six combinations of tasks under which these three monitoring tasks were performed. Separate analyses were also performed for the arithmetic and target identification tasks for each of the two task combinations under which they were performed. Thus, 22 analyses were carried out—18 for the monitoring tasks and four for the active tasks. No analysis was attempted on the code-lock task since only group performance was measured on this task and, with only two groups of subjects being tested, no adequate estimate of error variance was available. The results of these analyses for the red, green, and probability monitoring tasks are shown in Tables 2, 3, and 4 respectively. The results of the analyses of the arithmetic and target identification data are shown in Tables 5 and 6.

Table 2. Red Lights Monitoring

(Mean Response Times in Seconds)

Task	Donnatal	Chlor. Mal.	Placebo	X^2r	P
Monitoring only	1.17	1.16	1.03	1.55	------
Arithmetic	.94	1.24	1.00	2.6	------
Arithmetic & code-lock	1.12	1.20	1.35	5.85	<.10
Code-lock	1.04	1.31	1.16	2.45	------
Target identification and code-lock	1.60	1.12	.97	11.15	<.01
Target identification	1.29	1.70	1.04	6.20	<.05

Table 3. Green Lights Monitoring

(Mean Response Times in Seconds)

Task	Donnatal	Chlor. Mal.	Placebo	X^2r	P
Monitoring only	3.44	2.54	2.56	.05	------
Arithmetic	3.22	2.08	2.14	3.65	------
Arithmetic and code-lock	2.14	2.87	4.91	.05	------
Code-lock	2.51	3.52	2.70	2.6	------
Target identification and code-lock	3.09	5.19	2.98	.35	------
Target identification	3.00	4.63	2.98	1.4	------

Table 4. Probability Monitoring

(Mean Detection Times in Seconds)

Task	Donnatal	Chlor. Mal.	Placebo	X^2r	P
Monitoring only	63.05	62.48	60.09	.6	------
Arithmetic	70.73	68.57	65.49	1.4	------
Arithmetic and code-lock	65.66	68.62	70.32	2.6	------
Code-lock	65.66	68.62	70.32	2.6	------
Target identification and code-lock	67.50	74.28	68.95	2.6	------
Target identification	67.25	74.50	72.06	.08	------
	67.86	78.76	74.51	3.8	------

Only two of the resultant statistics reached the .05 level of significance, and both of these were for the response times to the red lights. Response time to the onset of red lights when the task combination involved performance of the red light task concurrently with the target identification and code-lock tasks differed significantly for the three drug conditions (P is less than .01). The ordering of the mean times was, from shortest to longest, placebo, chlorpheniramine maleate, and Donnatal. Performance of the red lights task also differed significantly for the three drug conditions (P is less than .05) when this task was performed in combination with the target identification task without concurrent code-lock performance. However, in this

case, although the shortest response times were again associated with the placebo condition, the ordering of the other two drug conditions was reversed; performance with Donnatal was better than with chlorpheniramine maleate.

TABLE 5. Arithmetic Performance, Percent Correct

Task	Donnatal	Chlor. Mal.	Placebo	X^2r	P
With code-lock	89.6	87.8	84.9	3.65	------
With monitoring only	91.8	91.1	92.7	2.26	------

TABLE 6. Target Identification, Percent Correct

Task	Donnatal	Chlor. Mal.	Placebo	X^2r	P
With Code-lock	81.3	74.0	79.0	1.95	------
With monitoring only	87.3	85.0	85.3	1.80	------

Clearly the law of parsimony dictates that obtaining two significant statistics out of the total of 22 that were computed should properly be attributed to chance. This interpretation is reinforced by two further considerations. First, there is no rationale that would predict that this task would show an effect of either or both of these drugs in the absence of any effect on other tasks. Second, in previous research with the battery of tasks, the red warning lights task has been highly resistant to the effects of relevant variables. The fact that the ordering of the two drugs for the two different task combinations is reversed also suggests that this finding is something other than a real effect of the drugs.

It was recognized from the beginning that the dosages of the two drugs were marginal in terms of producing a measurable effect on performance. The rationale for selecting these dosages was that the information that was needed was with respect to the effects of ingestion of typical amounts of the drugs in question. Further, it was assumed that people follow instructions when taking such drugs, and therefore, information as to the effects of overdoses would not be particularly useful. Clearly, if the nature of these two drugs were less well known, this rationale would be less appropriate.

Another factor that tended to minimize the possible effects of the drugs was that the subjects were highly trained for their "jobs." The subject with the least total training on the task complex had experienced more than 50 hours of directly relevant practice on the task complex as a participant (along with the other nine subjects) in earlier (non-drug) experiments. Thus, the workload imposed on the subjects by even the most demanding task combinations had, by the beginning of this study, been reduced to a minimum. However, it should be noted that the workloads imposed by the heavier demand conditions (mental arithmetic plus group problem solving and visual discrimination plus problem solving) are quite high. Even the best subjects require something on the order of eight to ten repetitions of the basic 2-hour schedule before their performance begins to level off. Hence, it is argued that the various levels of workload used in the study provide reasonable approximations to the kinds of demands placed on the man involved in routine performances. It should be noted that the results might very well have been different with less well-trained subjects.

It is concluded that the dosages of Donnatal or chlorpheniramine maleate used in our experiment do not have a deleterious effect upon highly trained subjects in the performance of the tasks that were assessed by this particular multiple task performance battery. The major qualification of this conclusion lies in the fact that only ten subjects were tested. Although this number of subjects is adequate for the purposes of establishing average effects, it does not permit any detailed examination of individual differences in relation to the possible occurrence of idiosyncratic reactions of particular subjects.