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ADDICTION RESEARCH CENTER INVENTORY (ARCI): DEVELOPMENT OF A GENERAL DRUG ESTIMATION SCALE

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With the use of the Addiction Research Center Inventory, it is possible to estimate with a considerable degree of certainty that an opiate addict who obtains scores on empirical drug scales (15) or the reactivity factor scale (9) that are two or more standard deviations above the standardization mean for opiate addicts is under the influence of a psychologically active drug. Thus, only a small percentage of opiate addicts will obtain T-scores above 70 (two standard deviations above the mean using opiate addicts for a no-drug and placebo condition) under a no-drug or placebo condition, whereas under an adequate dose of psychologically active drugs such as morphine, amphetamine, alcohol, pentobarbital, chlorpromazine, LSD, pyrahexyl, scopolamine, etc., the percentage is generally over 50 per cent. Estimation of whether a subject is under the effect of a drug is problematical if his T-scores are substantially below 70.

The problem of determining whether a subject is under the effect of a drug would be reduced if a scale could be constructed which would indicate the expected scores on empirical drug scales for a no-drug or placebo condition. The present study was designed to determine whether a control-estimator scale could be developed. Such a scale seems essential for clinical use of the test. That is, in clinical use one might wish to indicate whether a subject is under the influence of drugs. A scale indicating scores expected under a no-drug condition would be a valuable aid for interpreting the significance of drug scale scores that fall below a T-score of 70.

Two requirements referring to control and estimation need to be satisfied for the hypothetical scale. One requirement is that the scale should indicate the reaction to be expected on drug scales for a no-drug or neutral condition (referred to as control); a scale composed of items that do not show drug-effects would fulfill this requirement. Thus, items such as those relating to tiredness, anxiety, impatience, euphoria, etc., are inappropriate since drugs may drastically alter response probabilities on items referring to these states. The second requirement is that the responses to selected items should be correlated with the scales which are sensitive to drugs. This estimator requirement would increase the probability that the score on the control-estimator scale would be the same as those on drug scales for the no-drug condition. If the drug scales are not significantly correlated with the postulated control-estimator scale, there would be no firm basis for estimating whether a difference between an empirical drug scale and the postulated scale was due to chance. It was also expected that the control-estimator scale would be correlated with drug scales regardless of the drug condition under which the correlations were determined.

Several findings suggested that a general drug control-estimator scale could be developed. First, in a criterion analysis of LSD effects on the Addiction Research Center Inventory (ARCI), the responses to a high proportion of items which did not differentiate LSD and a no-drug condition were significantly correlated with a LSD scale (6). Second, there are a number of common drug effects for seven different drugs used in the present study (7, 9, 15). Third, the probability of a "true" response on drug sensitive questions is very low for the no-drug condition (12). The proba-

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bility of responses is related to the social desirability characteristic of items (1). Responses to items with low social desirability values are positively correlated and some items with low social desirability values are not affected by drugs. Fourth, there may be an underlying factor for some individuals which enables them to agree that they feel different or changed, regardless of the condition (drug or no-drug) under which they are tested.

METHODS

Subjects: A general description of 219 subjects and procedures was presented by Hill *et al.* (15). It is sufficient to state here that empirical scales were developed using opiate addict subjects (test group of 100 subjects except for morphine and alcohol conditions) who were given the ARCI under the following conditions in randomized order at weekly intervals in a single-blind replicated measurements design: No-drug, placebo (oral and i.m. placebo), pentobarbital (200 mg, i.m.), chlorpromazine (day 1, 25 mg, q.i.d.; day 2, 50 mg, q.i.d.; day 3, 75 mg, one dose only, oral), LSD (1.5 μg/kg, oral), amphetamine (30 mg, i.m.) and pyrahexyl (90 mg, oral). Eighty subjects were used in the test development group for morphine (20 mg, i.m.) and 50 subjects were used for alcohol (3.0 cc/kg of 30 per cent alcohol). Thirty or more subjects were tested and retested on each drug condition in addition to a no-drug and placebo condition to cross-validate scales.

Materials: The Addiction Research Center Inventory (ARCI) is a 550-item true-false structured personality inventory, similar in format to the MMPI and was devised to measure subjective drug effects as well as psychopathology and personality characteristics (9, 12, 15). It can be used with any literate population and is not restricted to use with opiate addicts; it has been used with effectiveness with normal, mentally ill and alcoholic subjects (8, 13). An empirical scale was developed for each drug listed above by selecting questions which differentiated between a drug and placebo at the .05 level or less. The scales held up under cross-validation (15). A carelessness scale detects subjects who are illiterate, careless or confused (11). Factor analytic scales are correlated with drug effects as well as personality scales (9). A so-called reactivity factor or scale is practically identical in function to the LSD empirical scale (9).

STATISTICAL ANALYSES

Development of the General Drug Control-Estimation Scale (DE): To satisfy the prediction requirement, tetrachoric correlations (2) were determined for the relation between responses to each of the 550 ARCI items and the morphine, amphetamine, pentobarbital, chlorpromazine, LSD, pyrahexyl and alcohol empirical scales using the drug condition in the test group that was used for scale development with the scale associated with the drug name.[2] Thus, correlations of responses to each item with the morphine empirical scale (subjects were divided at the median) were determined for the morphine 20-mg condition. Similar tetrachoric correlations were determined for items with the amphetamine scale under the amphetamine condition, the pentobarbital scale under the pentobarbital condition, the chlorpromazine scale for the chlorpromazine condition, the LSD scale for the LSD condition, the pyrahexyl scale for the pyrahexyl condition and the alcohol scale for the alcohol condition. The average correlation of each item with the seven empirical scales was also determined.

To satisfy the control requirement or the selection of nondrug sensitive questions, the significance of the difference between each condition (no-drug, placebo and drug conditions) on each item was determined using

[2] IBM 650 programs developed by Drs. J. W. Hamblen, S. O. Navarro and Mr. Ron Cummings of the University of Kentucky were used. Some tests were scored by Mr. J. D. Gay.

chi square for independent measures (2).[3] Items were selected for the DE scale which produced an average correlation of .3 or greater with the seven empirical scales and which did not differentiate between no-drug, placebo and the seven drug conditions at the .05 level.

Correlations using scores on the DE scale: Test-retest product moment correlations were determined on DE scores for the test development group on conditions in which an N of 100 was used. The range of time between testings for drug conditions was from 1 to 14 weeks. Retest reliability was also determined on a validity sample of 73 subjects for the no-drug and placebo condition. Product moment correlations between DE and each empirical scale were determined for the test development group of 100 subjects within each condition.

T-scores (mean of 50 and a standard deviation of 10) were established on a standardization sample of 504 tests for the no-drug and placebo conditions using the procedure described by Hill *et al.* (15). The T-score transformation is given elsewhere (10). Other statistics will be given in the results.

RESULTS

Items: The items forming the DE scale are given in Table 1. All of the items are scored in the "true" direction. More items are correlated with the GDP scale than any other scale. Thus, 363 items significantly differentiated (p less than .05) subjects above the median from those below the median within the LSD condition (Test group, $N = 100$). This figure greatly exceeds the number of items that differentiate placebo from any drug. The maximum differentiation (174 items) was obtained between the placebo and LSD condition (15).

[3] The correlation between chi square for dependent versus independent measures was .95 for LSD-placebo differences. The mean chi-square difference was only .1 on the 550 ARCI items for 100 subjects (6)

Reliability of the DE scale: The retest correlations between conditions on the DE scale remain high and fairly constant. The average retest correlation on the DE scale between the no-drug condition and nine drug conditions (includes a 1.0 μg/kg dose of LSD and 60-mg dose of pyrahexyl) is .84. The comparable retest coefficients between the amphetamine (30 mg) and LSD (1.5 μg/kg) conditions and other conditions are .79 and .87 respectively. Retest reliability is also high in a validity group. Thus, the product moment correlation between no-drug and placebo in a validity group of 73 subjects was .89, a few hundredths higher than for the test group (r of .86). The Kuder-Richardson (KR-20) reliability coefficient (4) on the DE scale is .89 for the combined no-drug and placebo conditions. Comparable KR-21 coefficients were found in nonopiate addict populations. KR-21 for 207 mental hospital patients (13), 48 alcoholics and 33 college students[4] are .88, .79 and .82. KR-21 coefficients are usually somewhat lower than KR-20 coefficients.

Predictor characteristic of the DE scale: DE is significantly correlated with all empirical scales at the .01 level regardless of the condition (no-drug or drug) for which they were determined. Several correlations are above .80 and most correlations are above .50 (Table 2).

Control characteristic of the DE scale: Stability of DE scores for subjects is indicated by the high retest reliability of the DE scale regardless of conditions across which it is determined. Stability for conditions on the DE scale is indicated also by the low mean T-score changes for drugs. Thus, the means for various drug conditions fall within three T-score points (one third of a standard deviation) of the standardization mean of 50 (Table 3) which was established for the no-drug and placebo conditions. In both the no-drug and placebo

[4] Alcoholics were tested by Dr. G. Fuller, Willmar State Hospital, Willmar, Minnesota. Normal college students were tested by Dr. Roy Yamahiro, General Mills, Minneapolis, Minnesota.

17. Occasio
19. Even tl
45. It woul
51. I am be
87. I like t
119. Getting
121. I am di
133. My fan
work
140. I am aj
145. I am gi
175. I am ir
176. Arguing
185. I canno
188. Too oft
191. My par
192. When s
200. Love a
212. I don't
214. I would
223. My par
224. I am al
231. I am th
240. My mo
241. I somet
271. I quite
297. When I
305. One of
308. I don't
315. I am li
334. I wish
335. Nothin
338. I need
349. No one
350. My the
352. I often
363. My par
372. There i
392. I am ur
393. My fan
work
394. My goa
402. I was n
404. It is ur
405. When i
419. Parents
424. I feel a
433. I am of
445. My pas
467. When I
477. These c
498. I am m
508. I believ
513. I am m

* All questi

TABLE 1

*Questions Used in the DE Scale**

17. Occasionally when I am mad at someone I will give him the "silent treatment."
19. Even though I know it isn't true I feel that people are looking at me.
45. It would be better if people would stop pretending.
51. I am bored by things that interest the average person.
87. I like to know important people because it makes me feel important.
119. Getting something for nothing really appeals to me.
121. I am disgusted with myself.
133. My family does not like the work I have chosen (or the work I intend to choose for my life work).
140. I am apt to dislike little faults of people when I feel the way I do now.
145. I am greatly annoyed by being interrupted when I am thinking.
175. I am inclined to go into more detail than is necessary.
176. Arguing makes me nervous.
185. I cannot love or feel sorry for people.
188. Too often people try to tell me what to do.
191. My parents have often objected to the kind of people I went around with.
192. When a child, I frequently did not understand why I was punished.
200. Love and marriage are for other people.
212. I don't like to talk when I first wake up.
214. I would rather listen to a conversation than take part in one.
223. My parents and family find more fault with me than they should.
224. I am afraid of what I may say to people.
231. I am thinking more about the pleasures of the past than the things I might do in the future.
240. My mother was more interested in other things than in me.
241. I sometimes find it hard to stick up for my rights because I am so reserved.
271. I quite often mistakenly bump into things.
297. When I hold my arm straight out my elbow feels as if it is becoming stiff.
305. One of my fears is not being able to do the things I like.
308. I don't seem to care what happens to me.
315. I am liked more because of my wit than because I am easy to get along with.
334. I wish I were not so old.
335. Nothing gives me more pleasure than to beat a "sucker."
338. I need to keep a "poker" face so that people won't know what I am thinking.
349. No one seems to understand me.
350. My thoughts drift to various things I don't want to think about.
352. I often take myself too seriously.
363. My parents and family find more fault with me than they should.
372. There is no reason why anyone should speak above a whisper.
392. I am unusually sensitive to bright lights.
393. My family does not like the work I have chosen (or the work I intend to choose for my life work).
394. My goals in life seem very different from other people's.
402. I was mainly punished, as a child, for disturbing my parents.
404. It is unusual for me to be so frank.
405. When in a group of people I have trouble thinking of the right things to talk about.
419. Parents are usually not very affectionate.
424. I feel as if I had taken a laxative.
433. I am often troubled by constipation.
445. My past shortcomings do not seem to be very important to me now.
467. When I wake up in the morning parts of my body, such as my arm, still seem to be asleep.
477. These questions remind me of my troubles.
498. I am more curious than friendly.
508. I believe other people have more weaknesses than they are willing to admit.
513. I am moody.

* All questions scored in true direction.

conditions within an opiate addict population, the T-scores on GDP scale and empirical scales are approximately equal. However, under drug conditions, the means for empirical scales are much greater than those for DE. The difference between the mean for an empirical scale and DE within any drug condition is usually the highest on the drug scale designed for a specific drug. Thus, the highest empirical versus DE scale difference for morphine is on the morphine scale; for alcohol the largest difference is found for the alcohol and DE scale.

TABLE 2

Correlations between DE and Empirical Scales for Various Conditions for the Test Group of 100 Subjects

Conditions	Empirical Scales						
	M	P	C	L	B	Py	A
No-drug	70	80	56	63	69	25	45
Placebo	68	80	65	62	64	23	49
Pentobarbital	65	75	63	61	61	41	54
Chlorpromazine	79	80	67	66	76	45	60
LSD	85	84	67	77	87	61	65
Amphetamine	75	80	62	69	73	48	55
Pyrahexyl	75	77	59	66	74	44	51

Decimals are eliminated in all correlations.

Empirical scale abbreviations: M = morphine; P = pentobarbital; C = chlorpromazine; L = LSD; B = benzedrine(amphetamine)); Py = pyrahexyl; A = alcohol.

DISCUSSION

In the present study an attempt was made to develop a general drug control-estimator scale that could be used with empirical drug scales to show whether any particular subject is affected by or under the influence of a psychologically active drug. The DE scale can be considered effective for this purpose if scores on it are reliable, unaffected by drugs and correlated with all empirical drug effect scales. The DE scale meets all three criteria in an opiate addict population. DE is the most reliable scale on the ARCI using test-retest methods. It is as reliable or more reliable than scales in other standard personality inventories including the MMPI (14), Guilford-Zimmerman Temperament Survey (5) and the California Psychological Inventory (3) using the KR-20 internal consistency reliability statistic (4) as revealed in unpublished studies involving 175 or more opiate addict subjects. The reliability of the scale was very high in several cross validation samples including non-addict populations. In contrast to empirical drug scales, DE is highly resistant to drug effects. The mean DE scores for all drugs in the present series were within three T-score points of the standardization

TABLE 3

Mean T-Scores of Various Drug Conditions on DE and Empirical Scales

Conditions	N*	Scales							
		DE	M	P	C	L	B	Py	A
No-drug	262	50.1	50.1	50.1	50.0	49.9	50.3	49.6	49.5
Placebo	242	50.5	49.7	50.3	51.3	50.5	49.3	49.9	50.2
Morphine, 20 mg	148	53.3	64.7	61.4	58.4	61.2	62.4	65.2	62.5
Pentobarbital, 200 mg	190	52.7	56.2	60.1	58.2	57.3	54.3	59.9	60.2
Chlorpromazine (see subjects)	173	51.4	53.9	56.4	61.9	56.7	51.2	59.7	59.3
LSD, 1.5 μg/kg	172	52.0	61.0	62.1	62.1	66.3	58.4	67.2	66.9
Amphetamine, 30 mg	190	52.1	60.5	58.1	54.3	58.5	62.3	61.9	58.3
Pyrahexyl, 90 mg	170	50.7	55.0	56.8	59.7	58.2	53.0	65.5	59.8
Alcohol, 3.0 cc/kg of 30 per cent alcohol	90	51.9	59.5	62.8	62.2	62.9	56.4	69.0	71.2

* N is the number of tests for the combined test group, validity group and retested subjects.
See Table 2 for scale abbreviations.

mean of 50. The lack of drug effects on DE combined with the high reliability of the scale indicates that scores for DE remain stable irrespective of the drug condition. The DE scale is a good estimator scale since it is significantly correlated with all empirical scales as well as the reactivity scale for each drug condition. The predictor correlation coefficients are much lower for the pyrahexyl scale, but the Py scale is the least reliable empirical scale (lower test-retest coefficients). Differences between the Py and DE scale therefore should be interpreted with caution. Many of the predictor coefficients are above .7. The predictor characteristic is also maintained in nonopiate addict populations. In a study of mentally ill subjects the correlations between DE and the following empirical scales are: morphine scale ($r = .72$), pentobarbital ($r = .81$), chlorpromazine ($r = .71$), LSD ($r = .78$), benzedrine ($r = .57$), pyrahexyl ($r = .28$) and alcohol ($r = .62$). In addition a correlation of .76 was found between the reactivity factor scale and DE (13). Hence, the DE scale is also an estimator scale in a group of mentally ill subjects.

The attributes of the DE scale may become more definite by considering other ARCI scales. A number of factor analytic scales such as neurotic sensitivity versus psychopathic toughness (NP scale) were developed (9) which are insensitive to drug effects, and are not significantly correlated with empirical drug scales. There may be some question of whether some factor analytic scales are control scales since drug effects are not evident on them. Thus, scores on NP are stable regardless of the condition, but since it is not correlated with empirical scales, a score on it does not represent expected scores on drug scales for a no-drug condition for individual subjects. If the concept of control is applied to groups, as opposed to individual subjects, any scale which does not show drug effects would appear to qualify as a control scale. For diagnosis of drug effects in individual subjects, a nonestimator scale is practically of no value, since it does not indicate the expected scores for a no-drug condition.

As pointed out above the DE scale is an estimator scale for several nonopiate addict populations. However, DE may not appear to be a control scale for other populations such as the mentally ill (13) and alcoholics,[4] since empirical scale means are substantially above it. It is expected that DE would be a control scale for other groups if ARCI scales are standardized for other groups under a neutral or no-drug condition since the DE scale has been found to be very resistant to experimental manipulations in other samples. More study is needed with other populations to establish definitely whether DE can be generally used as a control scale. Any drug condition or conditon which produces a great deal of hostility may render the scale ineffective, since many of the items suggest hostility.

To illustrate how DE in combination with drug scales can be used to show whether a subject is on a drug or functional equivalent of a drug, scores of three subjects are given in Figure 1. Subpart A shows the scores of an opiate addict under placebo and an acute dose of amphetamine. Note that the scores on DE and empirical scales are approximately equal under placebo, but that some scores on empirical scales are vastly greater than DE under amphetamine. A single high difference between DE and an empirical scale indicates a drug effect. The difference between the chlorpromazine (C) and DE is within chance expectations. The lack of a large difference on C *vs.* DE is related to the finding that amphetamine does not produce a large effect on the C scale. A similar analysis of subpart B can be made for an opiate addict under placebo and alcohol. That is, the high difference between the alcohol scale (A) and DE scale indicates a

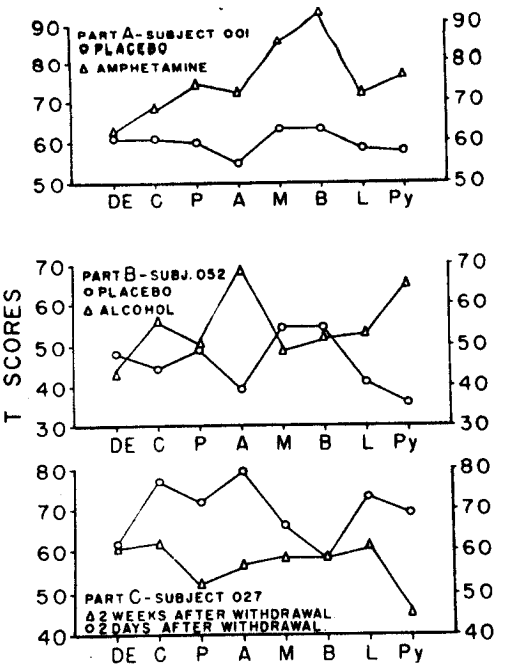

FIG. 1. T-scores are given on the ordinate and ARCI scales are given on the abscissa. Each subpart contains the T-scores that were obtained by a subject for two conditions. For example, scores for subject 001 (subpart A) are given for a placebo and amphetamine condition; the T-score on the DE scale for the placebo condition was 60. Scores on DE and empirical scales are approximately the same for the placebo condition, but the scores on some empirical scales are usually higher than DE for the drug conditions. The abbreviations for scales are given in Table 2.

drug effect. Under the placebo condition it can be noted that some empirical scale scores are slightly above DE and some are slightly below. Subpart C indicates the scores of an alcoholic who was tested two days after withdrawal from alcohol (functional equivalent of a drug effect) and retested two weeks later.[4] The withdrawal effect is indicated by the large difference between several empirical scales and the DE scale. It is anticipated in this regard that functional equivalents of drug effects (9) such as stress, withdrawal from alcohol or opiates, acute stage of physical or mental illness, fatigue, joy, etc., will be indicated by elevations on empirical scales and by substantial differences between empirical scales and DE. This theoretically means that what is being measured by the difference between DE and empirical drug scales or the reactivity factor scale is probably the extent of general psychological reactive change rather than some general drug effect.

SUMMARY

A general drug control-estimation scale (DE) was developed for the Addiction Research Center Inventory using 100 opiate addict subjects. Two requirements need to be satisfied for the DE scale. One is that the scale should reflect scores to be expected on empirically derived drug effect scales for a no-drug condition or it should be resistant to the effects of psychologically active drugs. The other requirement is that the scale should correlate with empirically derived drug effect scales. The scale satisfies both criteria. Consequently, the difference in the score on empirical scales and the DE scale is a reliable index of the presence or absence of drug effects for morphine, amphetamine, pentobarbital, LSD, alcohol, chlorpromazine and pyrahexyl that were used in the study. The DE score indicates the expected scores on empirical drug scales for a no-drug condition in opiate addicts. The DE scale is the most reliable scale of the Addiction Research Center Inventory using test retest methods and reliability is not attenuated by drugs. DE is relatively more weighted with items on hostility, low frustration tolerance, inadequacy and familial problems.

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