MODIFICATION OF COGNITIVE STRUCTURE FOR CONCEPT INTERRELATIONSHIPS UTILIZING A REFERENCE COORDINATE SYSTEM

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CHAPTER I

INTRODUCTION

The effective acquisition and communication of knowledge is of primary importance in the academic setting. Psychologists and educators agree on this point. There is less agreement, however, on techniques for communicating knowledge and for evaluation of the effectiveness of knowledge transmission. Ausubel (1963a) and other cognitive theorists suggest that an optimal environment for learning occurs when there is some congruity between organization and presentation of instructional materials and the cognitive structure of the learner. According to this view, methods of instruction should be devised for the presentation of concepts in a manner that facilitates their incorporation into the learner's cognitive framework.

The goal of this research was to utilize mappings of students' cognitive structures for the purpose of designing instructional programs aimed at altering, when necessary, those structures.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

Concept Learning

Concepts will be defined as units of knowledge labeled by a word or words which convey, in part because of their relational qualities, meaningful general information which can aid in the understanding of specialized instances. The concept can be considered as the smallest unit in the content structure of an area. More specifically, in any given subject matter area there exists a set of elements or concepts which, taken together, represent the content structure of the area.

The majority of earlier studies in the area of concept formation were criticized for their apparent lack of generalizability to a classroom setting (Ausubel, 1963a; Anderson, 1973). The emphasis in this study is not on how concepts are formed. The investigation is concerned with the relationship between the memory representation of concepts (cognitive structure) and the objective or content structure of the material.

Content Structure

Structure is defined as "an assemblage of identifiable elements and the relationships between those elements" (Shavelson, 1974, p. 231). Content structure then is the set of identifiable elements or concepts whose interrelationships form a meaningful body of material. For a given discipline we can infer a set of identifiable concepts whose interrelationships form an organizational structure which is reflective of the accumulated knowledge for that discipline. Fenker (1975) contends that the organizational structure for an entire discipline is based on the interrelationship of its concepts.

Johnson and his colleagues (Johnson et al., 1971) used equations (e.g., force = mass x acceleration; work = force x distance) to arrive at a model for the content structure of physics. These equations were composed of constitutive (relational) concepts and epistemic (operational) terms. The equations or definitions were used as "rules" governing content structure. As can be seen in Figure 1, the concepts are arranged in a hierarchical fashion, and their degree of interrelatedness is a function of their relative positions.

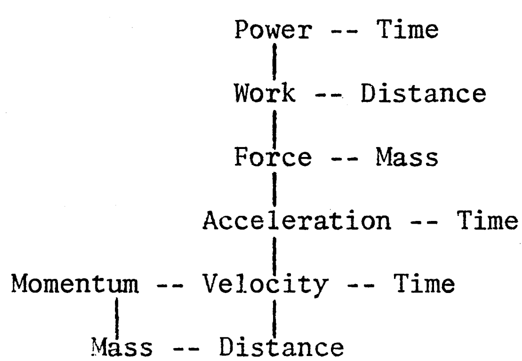

Figure 1. Johnson's et al. (1971) Model of Concept Interrelationships

Using physics majors as subjects, Johnson et al. (1971) administered three tasks: free-association, constrained-association, and similarity ratings. Results showed that, in accord with his model, the associations made to the concepts reflected the relational positions of the concepts present in the model.

The investigation of content structure for classical physics may be greatly facilitated due to clearly identifiable relational and operational concept definitions. There also are mathematical rules in physics which govern the interrelationships among concepts (e.g., $m=f/a$). Much of the investigation of content structure has involved the subject matter areas of physics (Johnson, 1964, 1965, 1967, 1969; Johnson, Cox, & Curran, 1970; Shavelson, 1972), mathematics and related areas (Shavelson & Stanton, 1975; Fenker, 1975).

There are numerous disciplines, however, whose content structure cannot be expressed in terms of mathematical equations. Research and experimentation will hopefully provide valid and systematic techniques for the representation and measurement of the content structure for those areas. Alternative methods for measuring content structure are discussed later.

Cognitive Structure

The existing structure into which individuals attempt to fit new information will be referred to as cognitive structure. "Cognitive structure is a hypothetical construct which refers to the organization (relationships) of concepts in memory" (Shavelson, 1974, p. 232). This organization consists of related concepts and serves in giving meaning to incoming material. The more stable and explicit the framework, the greater the chance that new information will be learned and retained.

Ausubel (1963a) refers to the basic components of cognitive structure as "subsumers" (p. 219). Subsumers are concepts which have a high degree of abstractness and inclusiveness and occur high in the hierarchical arrangement of cognitive structure. Concepts which are less abstract and less inclusive are said to be subsumed under the organizers which precede them in the hierarchy.

Progressive differentiation is, according to Ausubel (1963b), the principle by which concepts and specific information are organized in cognitive structure. Given an hierarchical arrangement of knowledge, the organizational structure is such that concepts of greater inclusiveness are thought to be linked in a downward progression to concepts of lesser generalizability. The more general and inclusive geographical and political concept of "Country" might be considered as a subsumer; for example, the related and more specific concepts of "region," "state," "county," "city," etc. In other words, less generalizable concepts are subsumed under concepts with greater generalizability. In this model, learning can be said to occur when data can be related to existing cognitive structure and are subsumed by a more inclusive relevant conceptual system. The more stable the existing relevant conceptual system the greater the possibility for understanding and retaining the new material. This is an important point given the second stage of the subsumption process: For a period after a subconcept or new piece of information has been added to the cognitive system the new data can be separated as a distinguishable unit from the system (Ausubel, 1963a). During the second stage, obliterative subsumption (Ausubel, 1963a) occurs. This is the process in which over a period of time the new information becomes subsumed under a more inclusive concept to the extent that it is no longer identifiable as a discernible entity. While the specific information can be said to be forgotten, Bruner (1966) contends that the material can be reconstructed from the subsumers when needed. The more stable and explicit that the relevant conceptual system is, the easier it will be to reconstruct specific parts or details when they are needed. If the conceptual system is not clear and stable, all subsequent learning is jeopardized (Ausubel, 1963a).

Representation and Measurement of Cognitive and Content Structure

Word association tests, phylogenetic tree construction, and similarity rating tasks have been the most widely used techniques for generating data for the analysis and visual depiction of cognitive structure. Word association tests, perhaps the most used method (Deese, 1962; Johnson, 1964, 1965, 1967; Johnson, Cox, & Curran, 1970; Johnson, Curran, & Cox, 1971; Shavelson, 1972, 1974; and Shavelson & Stanton, 1975), focus on the associative properties of conceptual material. To the extent that memory is associatively organized, word association tests appear to provide a reasonable representation of an individual's cognitive structure. Johnson (1964) found that free-association responses to physics concepts were directly related to concurrent enrollment in a physics class. Subjects who were enrolled in the course at the time of the study produced more responses to stimuli than did subjects who had been previously enrolled in the class or subjects who had never had the class. He also found, in a later study (Johnson, 1965) that number of responses to stimuli were positively correlated with problem solving skills in physics. Shavelson (1972) found a similar relationship. Word-association tests therefore appear to have some validity as measures of memory representation for physics concepts. However, other techniques have also been useful for investigating cognitive structure. These techniques also appear to be valid.

Phylogenetic tree-construction and directed graphing are labels for a similar technique in the measurement of cognitive structure. Shavelson (1974) utilizes a fairly common format for graphing tasks. Subjects are instructed to construct a graph using key concepts, and the number of lines connecting the constructs are used to obtain a numerical measure of similarity between concepts.

In the similarity rating task subjects are asked to rate, using a specified numerical scale, the similarity or dissimilarity of conceptual stimuli presented in pairs (Fenker, 1975; Stasz, Shavelson, Cox, & Moore, 1976; Wainer & Kaye; Stanners & Brown, in press). According to Preece (1976), this technique is the most direct method for measuring the semantic proximity of two words. Convergent validity studies have shown that similarity rating tasks and word-association tests yield similar results and that both can be demonstrated to be consistent with models of content structure (Johnson, 1969; Johnson et al., 1970; Johnson et al., 1971). These studies, as well as others (Fenker, 1975; Stasz et al., 1976; Wainer & Kaye, 1974; Brown & Stanners, in press; Stanners & Brown, in press) appear to demonstrate the validity of similarity rating tasks as techniques for measuring concept interrelationships.

Shavelson and Stanton (1975) investigated construct validity interpretations of two of the above three measures of cognitive structure. Word association, graph building, and card sorting were examined for the occurrence of convergent validity. Using Shavelson's (1972) method of digraph analysis (this type of analysis will be discussed later) to first measure content structure, the results supported the convergent validity of the three measures of cognitive structure. All three measures yielded similar representations of cognitive structure for key concepts and, importantly, the representations provided close approximations of content structure. These findings were replicated in a second experiment (Shavelson & Stanton, 1975) using a different sample.

Current, methods for measuring or determining content structure fall into two broad categories. We will call these categories the text-analysis models and expert-determined models. Text-analysis models are based on the semantic and linguistic analysis of pieces of text. Shavelson (1972) and Fredericksen (1972) both utilized digraphs in their text-analysis models. The Shavelson digraphs were constructed by diagramming sentences containing two or more key concepts. The concepts were then located as points in Euclidean space by utilizing specific conversion rules (Shavelson, 1972). The digraph-distance matrix was formed by computing the distance (where distance equaled the number of lines that most directly linked any two points) between points. Content and cognitive structure similarity was reflected by small computed Euclidean distances between content structure (digraph-distance matrix) and cognitive structure (relatedness-coefficient matrices derived from word-association data). Frederiksen constructed a semantic model based on digraphs. The model is quite elaborate and therein lies a possible limitation for its use as a device for the analysis of content structure.

Content structure has also been investigated utilizing individuals knowledgeable in a specific area. Rather than attempting to construct a theory for text analysis, experts are asked to define the content structure (Fenker, 1975; Shavelson & Stanton, 1975; Stasz, Shavelson, Cox, & Moore, 1976; Wainer & Kaye, 1974; Brown & Stanners, in press). This approach may have distinct advantages over the text-analysis approach for certain topic areas, especially those whose concepts are not governed by tight relational rules. Ease of use in applied research is also an attractive feature of this model.

Interpretation of Psychological Distances

Several models for the analysis of cognitive structure have been used. These models can be broadly categorized into two types: hierarchical clustering models and multidimensional Euclidean space models. Some subject areas seem to have concepts which are by logical necessity organized hierarchically; for example, physics. For other subject areas this organizational pattern does not appear to have such pedagogic importance. This organizational feature of content structure has relevance for determining how the corresponding cognitive structure is measured and the type of interpretations that can be made (Shavelson & Stanton, 1975). Holman (1972) contends that content structure is a critical variable for determining the method used for interpreting psychological distances. In a mathematical proof, Holman (1972) showed that the distances among a set of stimulus concepts in a cognitive structure can be related to either distances in a hierarchical clustering model or a Euclidean space model, but not to both. A multidimensional scaling procedure will be utilize to investigate the structure of data generated by this study.

Multidimensional Scaling

Multidimensional scaling (MDS) is a set of mathematical techniques used to investigate the structure of data (Kruskal & Wish, 1978) from the interrelationships of the units that comprise the data. The units used for the comparisons may be of any type and the distance measurements may be in terms of perceived similarities or dissimilarities between objects. The interrelationship between two units is referred to as a proximity, a number which identifies the "distance" between the objects or units. Pairwise comparisons among a group of objects using mutlidimensional scaling techniques make possible the derivation of a dimensional configuration and visual representation of the interrelatedness of the objects.

For example, if one were interested in the geographic relatedness of the states of California, Washington, and Nebraska, proximity data could be used to generate a visual depiction of their geographic relationship. The proximities of these states would consist of judgments about the closeness of the states when the states were presented in all possible pairs (perhaps in terms of the distance in miles between the states). The application of multidimensional scaling techniques to the proximity data would yield a dimensional configuration of the three states. In other words, the application of MDS techniques would provide a graphic representation or a recognizable "map" of their locations.

Multidimensional scaling techniques allow investigation of the hidden structure of the data. By examining the spatial configuration of units on the map, the investigator may be able to construct theoretical explanations concerning the underlying meanings of the spatial relationships. "When multidimensional scaling yields useful insights, these generally result from examining the configuration. One of the most important methods of examination is simply to look at the arrangement of points . . ." (Kruskal & Wish, 1978, p. 9).

The usefulness, for the purpose of this study, of results generated by MDS procedures depends on two underlying assumptions. The first of these assumptions, and the one of primary importance for this study, is a common space condition. The second defining assumption is the diagonality condition. Although all the computational models for MDS take these conditions into theoretical consideration, most do not provide for a test of them. A notable exception to this is the COSPA computer program (Schönemann, Carter, & James, 1979). This program is based upon Horan's (1969) "subjective metrics model" (p. 143) and provides a test of both the commonality and diagonality assumptions. The commonality or common space condition assumes that if subjects are asked to perform pairwise comparisons between units (stimuli), the subjects will view the units as existing in a common Euclidean space. In other words, subjects will not make relationship assessments on the basis of a common knowledge of the units. This is an important assumption for MDS procedures. If subjects do not have a common space for making judgments, then the group map generated will not represent any common process within the group. Interpretation of the relationships depicted might therefore be invalid.

The Schönemann et al. (1979) algorithm provides for statistical testing of the common space assumption. The testing of the hypothesis of a random relationship between the individual subject's coordinate system and the group coordinate system is the basis for this test. A statistic, v, is computed for each subject which describes how well the coordinate system of the individual subject fits the group coordinate system based upon data from all subjects. These statistics are then compared to critical values derived from computer simulation of the behavior of the v statistic, and rejection of the hypothesis for an individual is interpreted as the individual's agreeing with the group at large. A binomial test for the complete group is then made using the number of subjects for which the random hypothesis was rejected in the prior step.

This two-step procedure can also be used for comparing subject coordinate systems with an external coordinate system. The external coordinate system might, for example, be derived from another group or from known relationships among the objects involved.

The second assumption of Horan's (1969) model is the diagonality condition. This assumption is important when attempting to interpret the underlying dimensions for concept coordinate spaces. If this assumption is satisfied, each dimension may be interpreted independently of all others. The Schönemann et al. (1979) program provides for the testing of the assumption; however, a dimensional interpretation was not attempted in this study.

Content and Cognitive Structures in the Classroom Setting

The hypothetical cognitive structure has little relevance for the classroom setting unless it can satisfy at least three obvious conditions. First, both content and cognitive structure should be available to manipulation which might facilitate a greater degree of correspondence with content structure. The final condition is that cognitive structure should be shown to be related to measures of academic achievement; for example, class grades.

Cognitive Structure: Change and Relation to Achievement

Fenker (1975) examined the effects of instruction on cognitive structure. A group of 20 subjects was exposed to a semester of statistics instruction. Prior to the beginning of the instructional period subjects were given a paired-comparisons task. The stimuli consisted of 21 concepts which had been selected as key concepts by a group of experts. Following the course the subjects were again administered a paired-comparisons task which utilized the same 21 concepts. A multidimensional scaling procedure was used in data analysis. The intervening instruction seemed to effect no greater correspondence between cognitive and content structure. Fenker contends that "standard" classroom teaching techniques appeared inadequate for achieving interpretable correspondence between subjects' cognitive structure and content structure. Subjects did not appear to be making judgments concerning similarity between key concepts which agreed with judgments made by "experts" who were utilized to define course content structure.

"Standard classroom" teaching techniques were not defined by Fenker (1975), but it can probably be assumed that the material was presented using a lecture and assigned readings format. In part two of Fenker's study a specific learning set was created by having the subjects focus on stimulus concepts. Emphasis on the learning of stimulus concepts led to a cognitive structure that was interpretable within the framework of content structure.

Stasz et al. (1976) also found that instruction in social studies resulted in greater correspondence between a post-test measure of cognitive structure and the content structure of the course. Achievement pre- and post-test measures were also taken and a significant increase of mean scores across tests resulted. There was an apparent correspondence between course instruction, increase in similarity of cognitive and content structure, and achievement.

Shavelson (1972) investigated the question of correspondence between content and cognitive structure. Using 14 concepts from physics identified by Johnson (1964), high school students were administered achievement and word association pre-tests. The pre-test was followed by instruction in a segment of physics. The word association test was readministered following the instructional period on each of five days. Shavelson reported a significant increase in achievement scores from pre-test to post-test. Analysis of word association data, as a measure of cognitive structure, showed that exposure to the physics material increased both the number and quality of responses to the stimuli. Further, the median relatedness-coefficients, as determined by the degree of overlap of associations to key concepts, increased over repeated measures. While correspondence between cognitive and content structure was less than perfect, cognitive structure appeared to correspond more closely to content structure after exposure to instruction. In summary, cognitive structure changed as a function of exposure to instruction in physics and accompanying the change was a significant increase in achievement scores.

The studies cited above appear to indicate that: a) both content and cognitive structures are amenable to representation and measurement, b) cognitive structure can be manipulated to achieve greater similarity with content structure, and c) cognitive structure can be shown to be related to achievement.

A study by Stanners and Brown (in press) introduced a possible educational application of MDS that has apparently not been addressed in previous studies. The study of these authors investigated the validity of utilizing MDS techniques to represent content and cognitive structure. A group of undergraduate psychology students and a group of psychology graduate students were asked to make similarity ratings for pairs of concepts taken from personality theory. Using an MDS procedure (Shönemann et al., 1979) to analyze their data, Stanners and Brown used a pair of three-dimensional maps to depict the configuration of concepts. The examination of the configuration of the concepts provided several interesting pieces of information. First, the test of the common space condition showed that the two groups of students had made judgments based on common knowledge of the concepts. Also, the maps of both groups appeared, according to Stanners and Brown, to be similar to content structure. The authors contend, however, that there was not perfect correspondence between the students' cognitive structure and the investigators' judgment, based on knowledge, of content structure. Stanners and Brown further contended that the similarities and differences were interpretable. This appears to be a vital assumption for the use of MDS procedures as a possible diagnostic and remedial tool. If MDS techniques can be utilized to detect specific areas of understanding and misunderstanding concerning content structure, then perhaps methods can be devised which will address these areas and facilitate more effective teaching and learning. In a later study, Brown and Stanners (in press) further investigated this premise. Using the Schönemann et al. procedure to analyze data, Brown and Stanners investigated the issue of cognitive structure change as a function of a specific teaching intervention. Subjects from an introductory psychology course were given instruction in a unit on simple learning. Administration of a rating task followed. The task was composed of 13 key concepts considered as basic to simple learning theory. The researchers, both experimental psychologists, used themselves as experts for the purpose of defining content structure. After performing the same rating task as the subjects, the coordinate space for the experts was scaled using the Schönemann et al. procedure. This provided the reference coordinate space against which the subjects' coordinate space was compared. Brown and Stanners found a highly significant ($p<.001$) degree of intragroup consistency (common space) for judgment ratings of the subject group. This was crucial if interpretations of graphical results were to be attempted. Of particular interest to the authors was the degree of consistency between the students' ratings and the ratings made by the authors. To this end the authors utilized a feature of the Schönemann et al. procedure which allows for testing how well an individual's coordinate system fits an externally supplied coordinate system. This test did not yield significant results. The students' coordinate systems did not fit the coordinate system of the authors.

The two-dimensional scaling solution was used to generate graphical depictions of concept interrelationships for the data of the students and those of the investigators. Visual inspection of the graphs along with examination of mean ratings of concept pairs provided the authors with specific information as to the nature of the discrepancies between the students' data and their own. A lecture aimed at restructuring the coordinate system of the student was then designed.

Sixty-four students were assigned to one of two groups (intervention, nonintervention) on the basis of their obtained $\underline{v}$ statistics. Approximately equal numbers of students with either low, medium, or high $\underline{v}$'s were included in each of the two groups. When the intervention lecture was delivered the nonintervention group was dismissed from class attendance. One week following the intervention, both groups were administered the rating task for the second time. Results showed no significant group-by-trial (pre-post) interaction effect. However, a significant main effect for trials (pre-post) was found. The mean $\underline{v}$ score for both groups increased from pre- to posttest. An assessment of the relationship between the learning unit quiz grade and the initial rating task showed a modest, significant correlation, $\underline{r} = .351$.

The absence of a significant group-by-trial interaction means that the 45 minute intervention lecture was not sufficient to facilitate significant changes in the cognitive structure of the intervention group relative to change in the nonintervention group. Two possible explanations for this were advanced. One, the intervention may have been inadequate in terms of length of time for the quantity of material covered, and two, student involvement in the learning process may have been too passive.

A second experiment by Brown and Stanners (in press) attempted to address the two possible reasons for the lack of positive results. The replication focused on the intervention procedure. There were three major changes in the second experiment. First, remediation of cognitive structure was limited to a smaller subset of concept interrelationships; fewer concept pairs were targeted for the intervention procedure. Second, the amount of time devoted to the intervention was doubled. Third, an intervention procedure aimed at more active student participation was used.

A group of 60 students enrolled in one of the author's introductory psychology courses was administered the ratings task. As in Experiment 1, the ratings task was performed one week after the subjects had taken a unit quiz on learning and memory. Visual comparison of the map generated from the multidimensional scaling of the subject data with the reference map led to the selection of eight target concepts from the pool of the 13 original concepts. Students' ratings for the 28 pairs representing all possible combinations of the eight selected concepts were scaled using the COSPA procedure. A second scaling of this data using the reference coordinate system (for the same eight concepts) was also made. These two scalings provided two sets of v scores; one set based on the students' coordinate system and one set based on the reference coordinate system. The two sets of v scores were used to assign subjects to either an intervention or a nonintervention group.

The intervention group was involved in a two-session teaching procedure. At the initial session the subjects received a 10 minute lecture review of the subset of eight concepts. The remaining time, as well as the second class session, was devoted to a novel participating procedure. The instructor, one of the authors, presented a series of paired concept names to the class. After each concept pair was presented, subjects were allowed approximately one minute to rate the pair. The students then had to display their ratings by holding up a card bearing a number which indicated their judgment value for the concept pair. In instances of wide group-response variability, additional time was spent discussing the specific concept pair. Each concept pair was composed of the name of one of the eight targeted concepts and the name of one of five concepts (all related to basic learning theory and, especially, to the eight target concepts) which did not appear on the rating forms. The latter procedure was followed to eliminate the possibility of memorization of pair ratings and to enhance the possibility of actual cognitive restructuring.

Subjects were then given the original rating task for the second time. Multidimensional scaling of the ratings for the 28 pairs containing the eight target concepts against the reference coordinates showed a significant and substantial change for the intervention group. The change (manifested by a significant group-by-trial interaction) represented a move of the subjects' coordinates towards the reference coordinate system. In other words, after the specially designed intervention procedure, concept interrelationships changed in the direction of greater agreement with the interrelationship judgments made by the authors. An analysis of data based on the set of 13 concepts, however, did not yield significant effects. Apparently, the significant change in the interrelationships among the subset of eight concepts was not sufficient to produce significant changes for the overall 13-concept data set.

The results of the Brown and Stanners (in press) study provides interesting implications for the application of multidimensional scaling to educational psychology. The use of the COSPA procedure provides for the statistical testing of the degree of consistency with which a group of individuals makes stimuli comparisons. Brown and Stanners utilized this feature in conjunction with other features of the COSPA procedure for purposes of diagnostic interpretation. The diagnostic interpretations were then used to formulate a unique and successful remediation technique.

CHAPTER III

STATEMENT OF PURPOSE

This research investigated the potential diagnostic and remedial implications of multidimensional scaling solutions for classroom settings. Specifically the study was designed to utilize cognitive maps obtained from students to design a specific course of instruction which would facilitate the development of cognitive maps more similar to a pre-determined expert-defined map. The basic purpose of this study was therefore to replicate the study of Brown and Stanners (in press). There were, however, four differences or additions in this study. The first difference was that the samples in this study were composed of subjects from two different academic institutions, which differed in size and in student body composition. Second, the semantic domain sampled in this study--drug use--was different from the domain sampled by Brown and Stanners. Third, pre-testing of subjects was done prior to, rather than following, a period of initial instruction. Given the topic, it seemed likely that the students would already have some pre-existing cognitive structure for the subject matter. A pre-existing relevant conceptual system should facilitate the learning of new, related material. Finally, pre-test data were utilized to design the initial instructional format rather than a remedial intervention procedure.

Hypotheses of the Study

Hypothesis 1. There will be a differential change in the pre-post mean v scores for subject groups. Following the intervention procedure, intervention groups will show a significantly greater increase in the magnitude of mean v scores than will non-intervention groups.

Hypothesis 2. Pre-intervention cognitive structure will differ from the reference coordinate system for all of the subject groups. While students may have some prior knowledge of drugs and drug usage, it is unlikely that they will be as knowledgeable as the experts who will provide the reference condition. It is also likely that the students will have some misunderstandings about the topic.

Hypothesis 3. Post-intervention cognitive structure will show agreement with the reference system for both of the experimental groups but not for either of the control groups. On the basis of studies cited earlier it appears that cognitive structure can be changed through exposure to some type of instructional intervention. If this is a valid assumption, then it seems probable that subjects who are exposed to a specific instructional intervention should show a different measured cognitive structure than would subjects not exposed to the intervention.

CHAPTER IV

METHODOLOGY

Subjects

Four sections of introductory psychology students from two state universities served as subjects. A total of 89 undergraduates participated in the research. At the larger, predominantly White state university, 25 subjects made up the experimental group, while 26 subjects from another section made up the control group. The larger university has a student enrollment of approximately 22,000. At the smaller, predominantly Black institution, student enrollment numbered approximately 1,000. The experimental group was composed of 22 subjects, while there were 16 subjects in the control group.

Materials

Twelve concepts related to the area of substance use were selected (see Appendix A). Assistance in the selection of the concepts was provided by a group of four experts in the area of substance use. One of the experts was a medical doctor with considerable experience and interest in abuse of chemical substances. One expert was a substance abuse counselor. Another was a psychologist, and a fourth was a program specialist in drug education.

Each of the 12 concepts was paired with every other concept, yielding 66 pairs of concepts. The concept pairs were arranged in three different random orders in rating booklets with the restriction that no statement appear in more than two consecutive pairings. Rating booklets (labeled A, B, and C) were typed with one member of each pair directly above the other. The upper and lower positions of a pair were assigned randomly for each of the three forms. Each concept appeared in the upper and lower positions of a pairing approximately an equal number of times. To the left of each pair was a blank for the subject's rating. A rating scale of 1-7, with "1" indicating that the pair of concepts was "very closely connected" and "7" indicating that the pair was "quite unconnected," was used. A cover sheet containing detailed rating instructions accompanied each booklet. A shortened form of the instructions also appeared at the top of each form (see Appendix B).

In addition to these rating booklets an additional list of concept pairs was constructed for use during the intervention procedure. This list was composed of 81 pairs of concept names. Each pair contained the name of one of the original nine concept names and the naem of one of nine related concept names not included on the original rating forms (see Appendix D). As the intervention procedure included a "practice" rating task, the related concepts were utilized to prevent changes in post-test scores due to memorization of concept pair ratings during the intervention procedure.

An approximately 30 minute lecture was also prepared. The lecture consisted of basic drug information including drug classification effects, history, etc. This lecture was part of the intervention procedure.

Procedure

The procedure for the present study consisted of:

1. Collecting data from the experts.
2. Administering pre-intervention instrument to subjects.
3. Designing the intervention procedure.
4. Executing the intervention procedure.
5. Administering post-intervention instrument to subjects.

Each of the four experts was interviewed separately. The purpose of the interview was the compilation of the specific concepts to be used for the similarity ratings task. Each expert was supplied a list composed of 17 concepts drawn from materials relevant to chemical substance use and abuse (see Appendix C). The experts were asked to do two things: 1) decide if the list included concepts that might be considered basic to a general introduction to drug usage and 2) through additions and/or deletions select 12 concepts that appeared to be most basic to the topic. After this information was obtained from all experts, the 12 most consistently agreed-upon concepts were put into the booklet form described above. Once in booklet form, the ratings task was completed by the experts and their data were analyzed using the Schönemann et al. (1979) procedure. The coordinate system generated served as the reference condition.

The students at each university were then given the similarity ratings task. Prior to the task, subjects were asked for their voluntary participation in a research project which was investigating the feasibility of alternative teaching techniques for college classrooms. Students at the larger university were offered an incentive of three extra credit points for their participation. This technique for providing incentive was chosen because it was an accepted procedure in the psychology department of that university. The technique for incentive was different for the smaller university, where there was no established procedure for providing incentives for student participation in experimental research. The incentive for participation was worked out between individual instructors and the investigator. Since the course was organized by topic units, students who participated were allowed to count participation in the research as a completed class unit.

After completing the ratings task one group at each university was arbitrarily designated the experimental group and the other the control group. Both experimental groups were told that in approximately one week the investigator would replace their regular instructor for a one week period. During that week, subjects were told that classes would meet as scheduled. For experimental subjects at the larger university (experimental group A) regularly scheduled classes met two times a week in sessions of approximately 75 minutes. Experimental subjects at the smaller university (experimental group B) met three times per week in 50 minute sessions. Control groups at both schools were excused from class attendance for that week.

Pre-test data collected from the four groups were analyzed separately using the Schönemann et al. (1979) procedure and compared to the reference map. The visual inspection showed many qualitative differences between the subjects' maps of cognitive structure and the reference coordinate system. Among the differences, however, were two very striking ones. The positions of two of the concept names ("Dependency" and "Tolerance") were markedly different on the reference map and on the maps of cognitive structure. Since these two concepts appeared to be fairly central ones in the reference system, it was decided that the focus of the intervention would be on the concepts of Dependency and Tolerance.

In order to identify those concepts which the experts considered strongly related to Dependency or Tolerance, means were computed for each pairing of Dependency and Tolerance with every other concept. A mean value of 3.0 or less (Table I) was chosen as a cut-off point for selecting concepts which would be covered in the instructional sessions.

TABLE I

MEAN VALUES FOR CENTRAL CONCEPTS WHEN PAIRED WITH ALL OTHER CONCEPTS

	Dependency	Tolerance
Tolerance	3.50	--
Impaired Judgment	2.75	3.75
Impaired Reflexes	3.25	4.00
Physical Harm	2.00	2.50
Withdrawal Symptoms	2.50	3.00
Barbiturates	1.50	3.00
Amphetamines	2.00	2.00
Alcohol	1.25	1.25
Opiates	1.00	1.75
Marijuana	3.50	3.25
Nicotine	3.50	3.75

The choice of the cut-off value was arbitrary. Since the range of the scale used was 1-7, it was felt that a value of 3.0 was indicative of a rather strong relationship. From the original list of 12 concepts, nine were used as the core around which the teaching intervention was structured. The same intervention procedure was used for both experimental groups. The original nine concept names were then translated into nine closely related concept names (see Appendix D) and pairs formed as previously described. A rating for each combination was obtained by taking the mean value assigned by the experts to the corresponding original concept pair on the rating booklets. For example, a pair presented to the subjects in the intervention session as "Alcohol" - "Addiction" would be given the feedback value which was equal to the mean rating assigned by the experts to "Alcohol" - "Dependency" on the pre-test rating form. These average values were used as feedback information by the investigator during the practice sessions.

The experimental session, though conducted separately for each of the experimental groups, followed the same format. During the first 30 minutes of the initial session, the prepared lecture was given. At the end of the lecture students were given several sheets of paper and read the following instructions:

> I am going to read pairs of terms. Using the rating scale of 1-7 with 1 indicating that the terms are very closely connected to 7 which indicates that the terms are quite unconnected, please rate each pair of terms. (The rating scale was written on the chalk board at the front of the classroom.) On a sheet of paper write the number that in your judgment reflects the degree of similarity or dissimilarity among the terms. After you have finished rating the pair of terms, please hold up your sheet of paper. After each rating I will call on one or two of

> you to explain why you rated the pair as you did. Afterwards I will tell you how I rated the pair and why. Are there any questions?

The remainder of the initial session and all subsequent sessions proceeded as indicated in the instructions to the subjects. In all sessions subjects were allowed to ask questions. Of the total time of approximately 150 minutes, subjects received 30 minutes of formal lecture and spent about two hours performing the ratings task, explaining ratings, getting feedback, and asking questions. Three days after the last experimental session, experimental and control subjects again completed the same rating task as they did prior to the instructional period.

CHAPTER V

RESULTS

The analysis of data using group coordinate systems was made to determine if the map generated from each group's data was a valid representation of a common group process. As discussed earlier, if the common space condition is not met, interpretations of group maps are invalid.

In the context of a two-dimensional scale solution, three of the four experts obtained v statistics which met or exceeded the .10 level for rejection of the randomness hypothesis. Using a binomial test, the probability of three of four events meeting the .10 level is less than .01. Therefore, the experts did show common space. This suggests that there is a common perception of content structure which is shared by people knowledgeable in the area of drug usage. The test of the diagonality assumption resulted in a proportion of 3/4, $p<.01$, indicating that the scaling dimensions were independent of each other. Figure 2 illustrates the solution in map form. Additional information was embedded in the map by connecting concepts with mean ratings of 2.5 or less by a solid line (Appendix E). The 2.5 value was arbitrarily selected as the cut-off criterion. This value provided information not apparent from visual inspection while avoiding maps that appeared "cluttered." On the students' map an additional threshold of 2.8 was used and concept pairs with

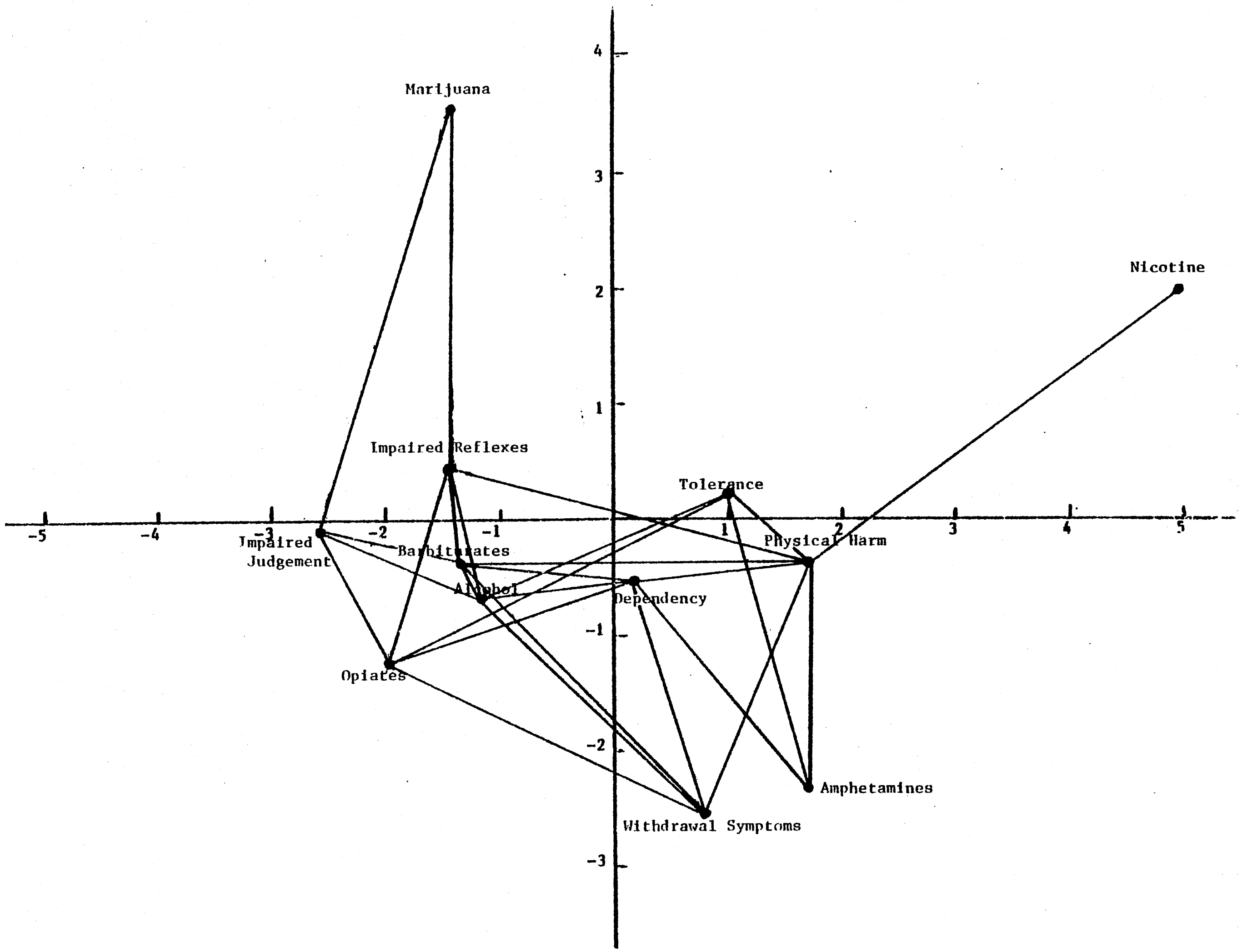

Figure 2. Reference Coordinate System

mean ratings between 2.5 and 2.8 were connected with a broken line. The additional threshold was added to the subjects' maps to provide information on concept pairs that were only slightly less related than those for the experts.

The pre-test data for experimental group A and control group A were analyzed separately. First, v statistics were computed for each subject using the coordinate system for the group of which the subject was a member. Sixteen of 25 subjects in experimental group A obtained a v statistic which met or exceeded the .10 level for rejection of the randomness hypothesis ($p<.001$). The diagonality condition was also met (12/25; $p<.001$). In the control group, 18 of 26 subjects obtained v statistics sufficient to reject the randomness hypothesis ($p<.001$). The diagonality condition was met (14/26; $p<.001$). Both groups showed common space individually. Subjects in each group appeared to be making judgments based on some perception, common that group, of the concepts' interrelatedness.

Pre-test data for experimental group B and control group B were analyzed using their respective coordinate systems. The common space analysis (using vs for the two-dimensional colution) of pre-test data for experimental group B showed that both the common space (9/22; $p<.01$) and the diagonality (9/22; $p<.01$) conditions were met. Common space (5/16 = $p<.05$) and diagonality (14/16 = $p<.001$) conditions were also met for control group B.

Examination of pre-test data therefore showed that all four groups satisfied the common space and diagonality conditions. This supported the validity of the group maps in the context of multidimensional scaling for purposes of possible interpretation.

Because of several possible sources for confounding, data were analyzed separately by institution. Not only did the institutions vary in terms of racial composition but also in terms of geographic location (urban-rural), size, socioeconomic status, etc. A 2 (intervention-nonintervention) x 2 (pre-post-test) analysis of variance showed a significant main effect ($F_{1,49}$ = 10.0, p<.001) for test trials and also a significant groups-by-trials interaction effect ($F_{1,49}$ = 15.0, p<.001) for experimental and control groups A.

TABLE II

ANALYSIS OF VARIANCE TABLE - EXPERIMENTAL GROUP A AND CONTROL GROUP A

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Critical F (1% Level)
Between Subjects	.40	50			
Groups	.03	1	.03	3.95	7.31
Subjects w/Groups	.37	49	.0076		
Within Subjects	.15	51			
Trials	.02	1	.02	10.00	7.31
Groups x Trials	.030	1	.030	15.00	7.31
Trials x Subjects w/ Groups	.10	49	.0020		

It had been hypothesized that v statistics for subjects in an intervention group would increase from pre- to post-test, and that this increase would exceed any change for the corresponding control group. Dunn's (1961) method was used to control Type I error rate for the pair of directional tests. There was a significant increase in the size of the mean v statistic from pre- to post-test ($\bar{v}_{pre}$ = .23, $\bar{v}_{post}$ = .30; t_{24} = 7.865, $p<.001$) for experimental group A. Control group A showed a significant decrease in the mean value of the v statistics ($\bar{v}_{pre}$ = .26, $\bar{v}_{post}$ = .22; t_{25} = -4.545, $p<.05$).

Comparison of the difference scores for the two groups showed the hypothesized difference ($t_{.025/49}$ = 4.0, $p<.001$) in the degree of change. Therefore, the value of the mean v statistic for experimental group A increased significantly from pre- to post-test and that difference was significantly greater than the change for the control group.

Analysis of post-test data for experimental group B and control group B produced results similar to those for experimental group A and control group A. A 2 (intervention-nonintervention) x 2 (pre-post-test) analysis of variance showed a significant main effect ($F_{1,36}$ = 11.75, $p<.01$) for test trials as well as a significant trial by group interaction effect ($F_{1,36}$ = 7.5, $p<.01$) (Table III). For experimental group B the mean v statistic was significantly higher (t_{21} = 5.926, $p<.001$) on the post-test ($\bar{v}_{post}$ = .27) than on the pre-test ($\bar{v}_{pre}$ = .19). The value of the mean v statistic for experimental group B increased significantly from pre- to post-test and the degree of increase was significantly greater when compared to the pre-post data of the control group ($t_{.025/36}$ = 2.367, $p<.05$).

Three of the four groups, experimental group A (5/25; $p<.05$) experimental group B (3/22; $p<.50$) and control group B (1/16; $p<.80$)

manifested pre-intervention cognitive structures that differed from the reference coordinates. Control group A showed significant agreement (8/26; $p<.05$) reference coordinate system, though the fit was far from perfect.

TABLE III

ANALYSIS OF VARIANCE TABLE - EXPERIMENTAL GROUP B AND CONTROL GROUP B

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Critical F (1% Level)
Between Subjects	.297	37			
Groups	.070	1	.07	1.06	7.31
Subjects w/Groups	.227	36	.066		
Within Subjects	.230	38			
Trials	.047	1	.047	11.75	7.31
Groups x Trials	.030	1	.030	7.50	7.31
Trials x Subjects w/Groups	.153	36	.004		

When post-intervention data were analyzed with the reference coordinate system, 15 of 25 subjects in experimental group A obtained v statistics sufficient for rejection of the randomness hypothesis ($p<.001$). Control group B showed common space with the reference coordinates also (9/26; $p<.05$). Further experimental group B showed common space (10/22; $p<.001$) with the reference coordinate system, while control group B did not (2/16; $p<.5$).

CHAPTER VI

DISCUSSION

As stated earlier, the current study was an attempt to replicate the Brown and Stanners (in press) findings. There were four groups of questions that this investigation attempted to answer:

1. Would the procedures used by Brown and Stanners be effective with a different group of subjects at the same institution? Further, would the procedure used at a relatively large, predominately White university be effective at a much smaller, predominantly Black university? The answers to both questions were affirmative. The procedures of Brown and Stanners were effective at the same institution with different subjects and also at the smaller, predominately Black university. Further, the mean increase in $\underline{v}$ scores was comparable for both experimental groups.

2. Would a change in semantic domain (subject area) produce similar results? The results indicated that the areas of simple learning theory and drug usage can both be studied using MDS procedures, and that the structural understanding of both areas can be successfully altered using Brown and Stanners' intervention procedure.

3. Would concept comparisons obtained prior to, rather than following, a period of instruction show group consistency? In the Brown and Stanners study, the initial rating task was performed

following a two week course unit and quiz. In the present study, the initial rating task was performed without prior class instruction. The group maps were based on memory representations which the students already possessed--in other words, their entry-level knowledge. As reported previously, there was consistency in the ratings within all four groups.

4. Could Brown and Stanners' teaching technique be effectively used as a "primary" rather than a "secondary" intervention? In the Brown and Stanners' study the intervention was aimed at changing misconceptions that were present after a course unit. The intervention in this study preceded course exposure to the subject matter. The results were positive.

The major difference in results between the two studies was the behavior of the v scores for one of the control groups. In Experiment two of Brown and Stanners the mean v score for the control group increased. This might be explained by practice effects. In this study the mean v score for control group A decreased significantly from pre- to post-test. A possible explanation might be that the group was more motivated during the pre-test than during the post-test, as they had been told that they could earn three points extra credit for participation. When they were subsequently dismissed from class for a week after having been informed that the three points extra credit would be awarded for being present for the post-test one week later, perhaps they believed that their ratings were not being evaluated or, at most, that they were not very important. This could have resulted in lowered motivation at the time of the post-test.

It is important in interpreting MDS data to visually inspect the MDS configuration (Kruskal & Wish, 1978). Inspection of the reference map of concept names (Figure 2) showed that "Dependency" appeared to be central; the concept was connected to five other concepts ("Barbiturates," "Alcohol," "Opiates," "Amphetamines," "Physical Harm") by a proximity mean equal to 2.5 or less. Three of the four subject groups' pre-intervention maps (Figures 3, 4, and 6) showed wide discrepancies with the reference map in regard to the location of "Dependency." However, experimental group A (Figure 3) and control group A (Figure 5) did perceive it as rather closely related (as on the reference map) to "Amphetamines," "Opiates," and "Barbiturates." Subjects did not seem to perceive "Dependency" as a pivotal concept. Subjects seemed to consider "Amphetamines," "Opiates," and "Barbiturates" as part of some classification system, related by the concept "Dependency," that did not include "Alcohol."

"Alcohol" was also connected to five other concepts ("Dependency," "Barbiturates," "Impaired Reflexes," "Impaired Judgment," "Tolerance") on the reference map. The pre-intervention maps for experimental group A (Figure 3) and control group A (Figure 5) both showed four concepts ("Impaired Reflexes," "Impaired Judgment," "Withdrawal Symptoms," "Physical Harm") closely connected to "Alcohol." The pre-intervention map for experimental group B (Figure 4) showed only one concept closely connected to "Alcohol" "Physical Harm." Control group B's pre-intervention map (Figure 6) showed two concepts: "Physical Harm," and "Impaired Reflexes" closely related to "Alcohol." While the reference map did not show a close (threshold ≤ 2.5) relationship between "Alcohol" and "Physical Harm," all of the subject maps did.

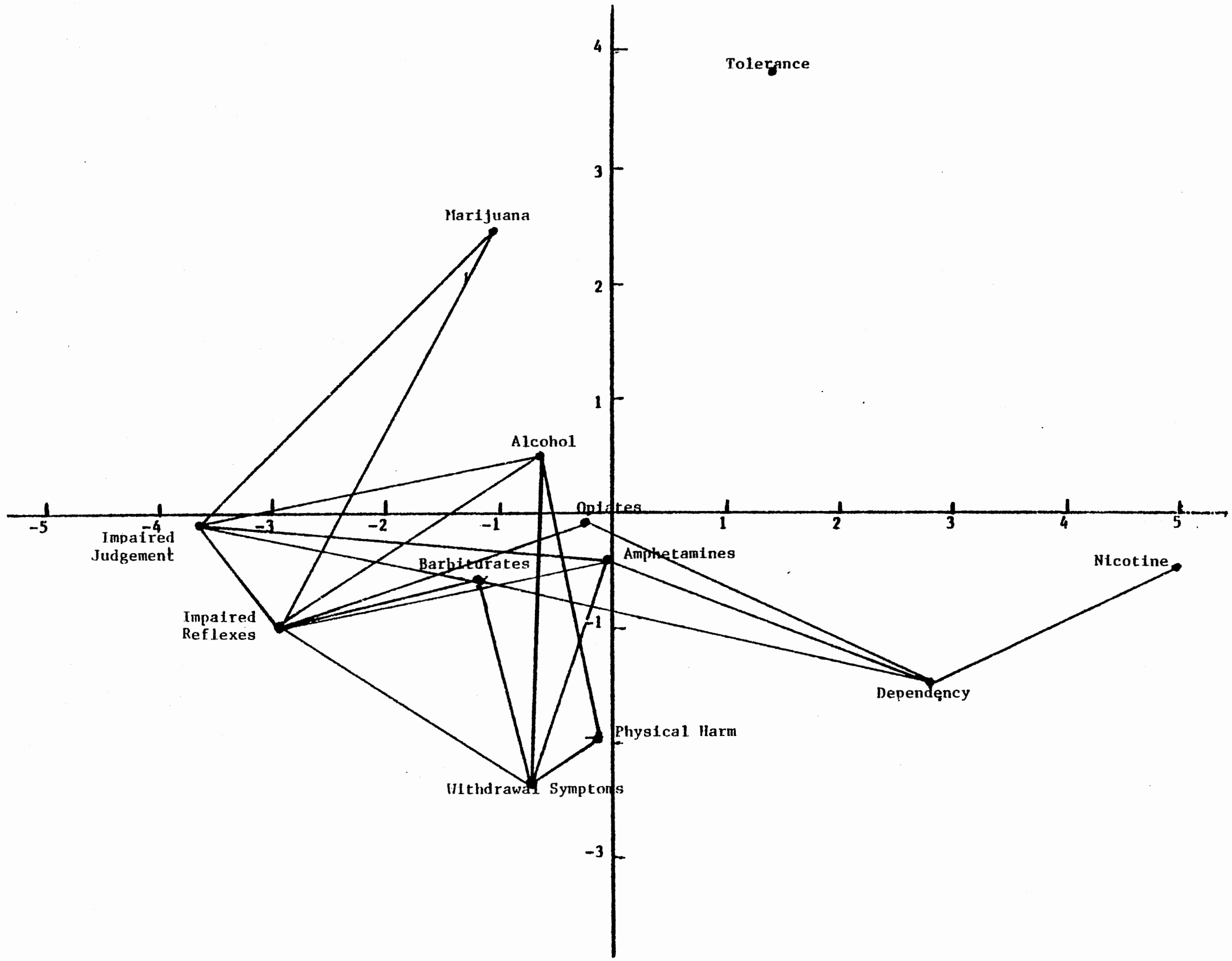

Figure 3. Experimental Group A - Pre-Test Coordinate System

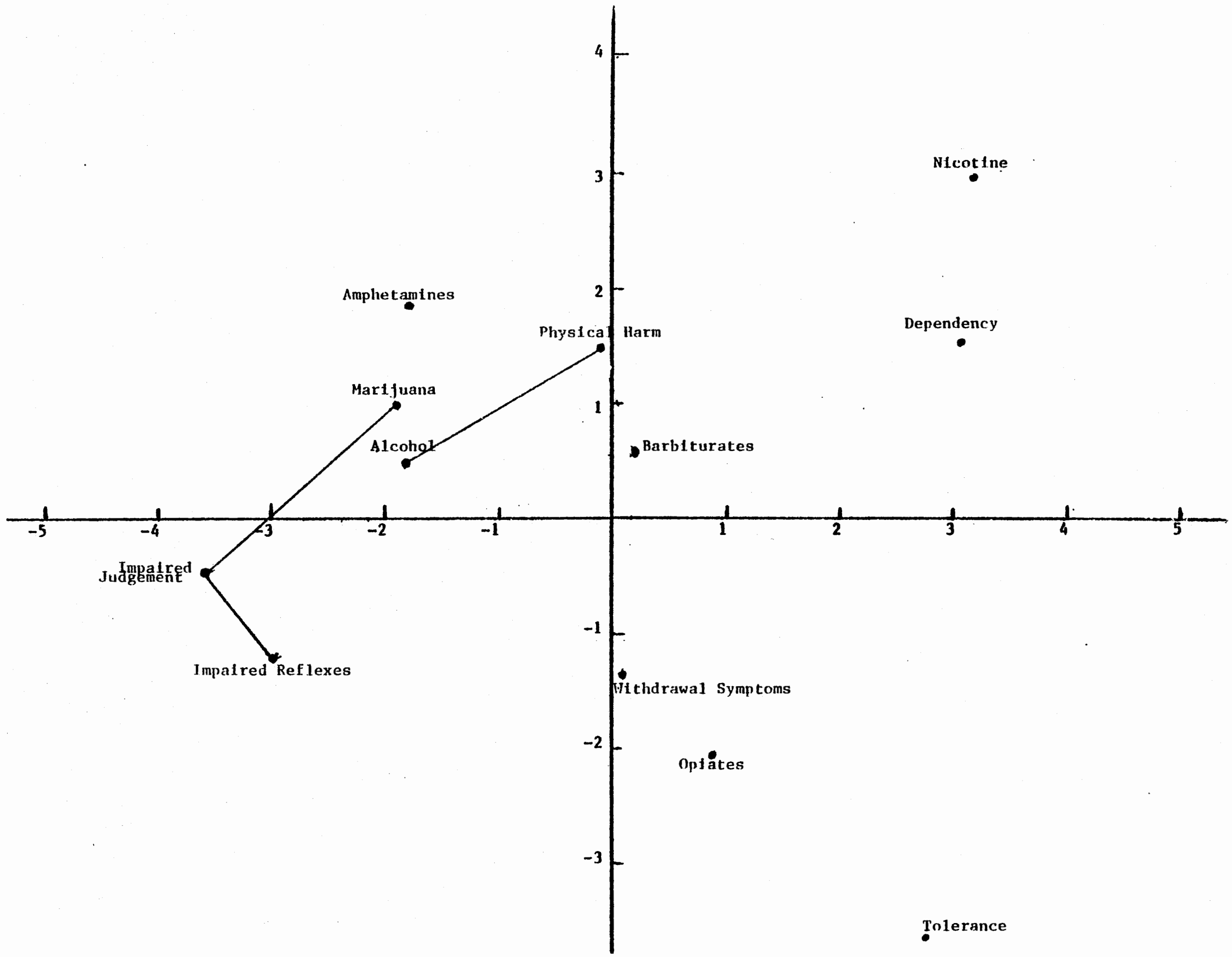

Figure 4. Experimental Group B - Pre-Test Coordinate System

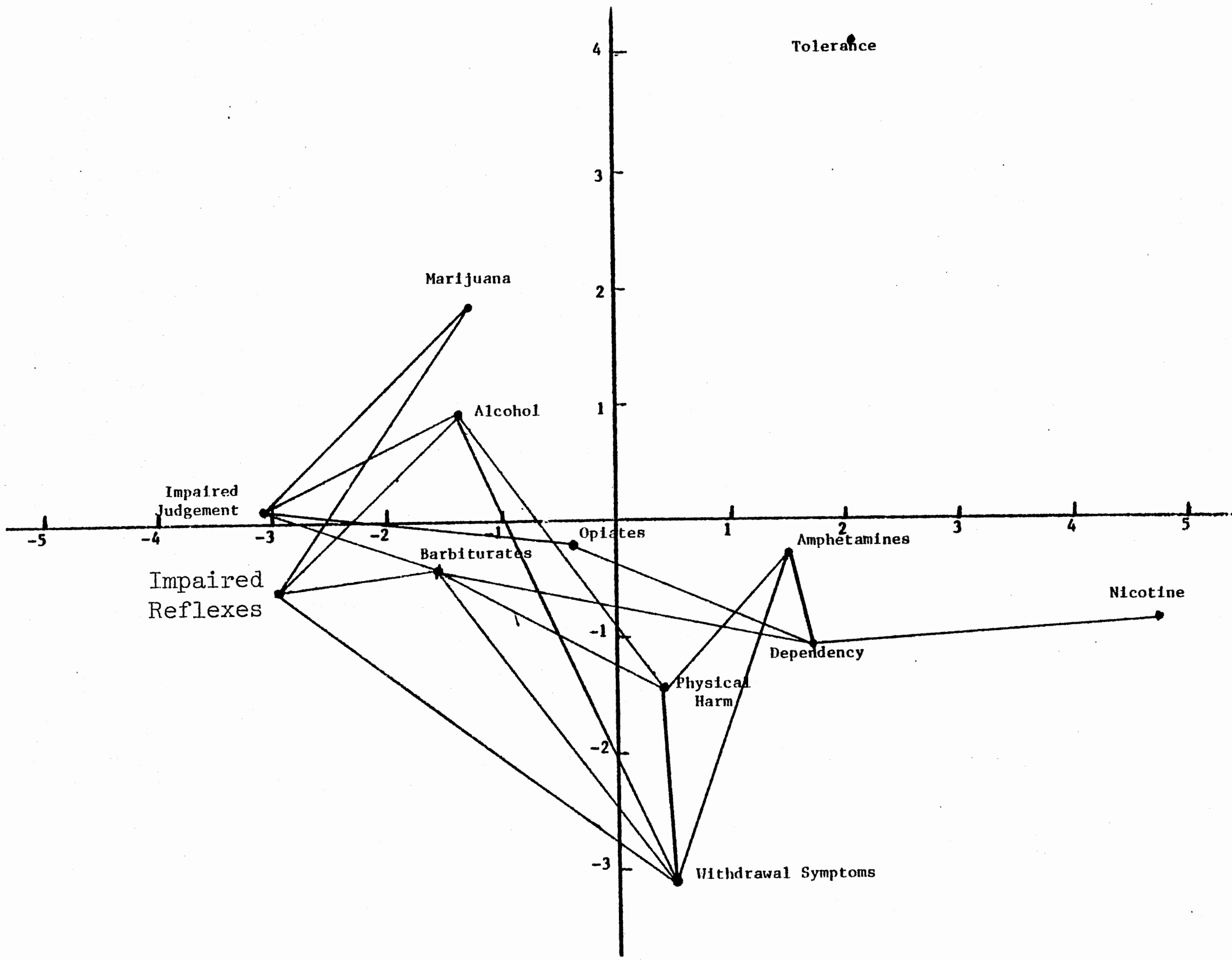

Figure 5. Control Group A - Pre-Test Coordinate System

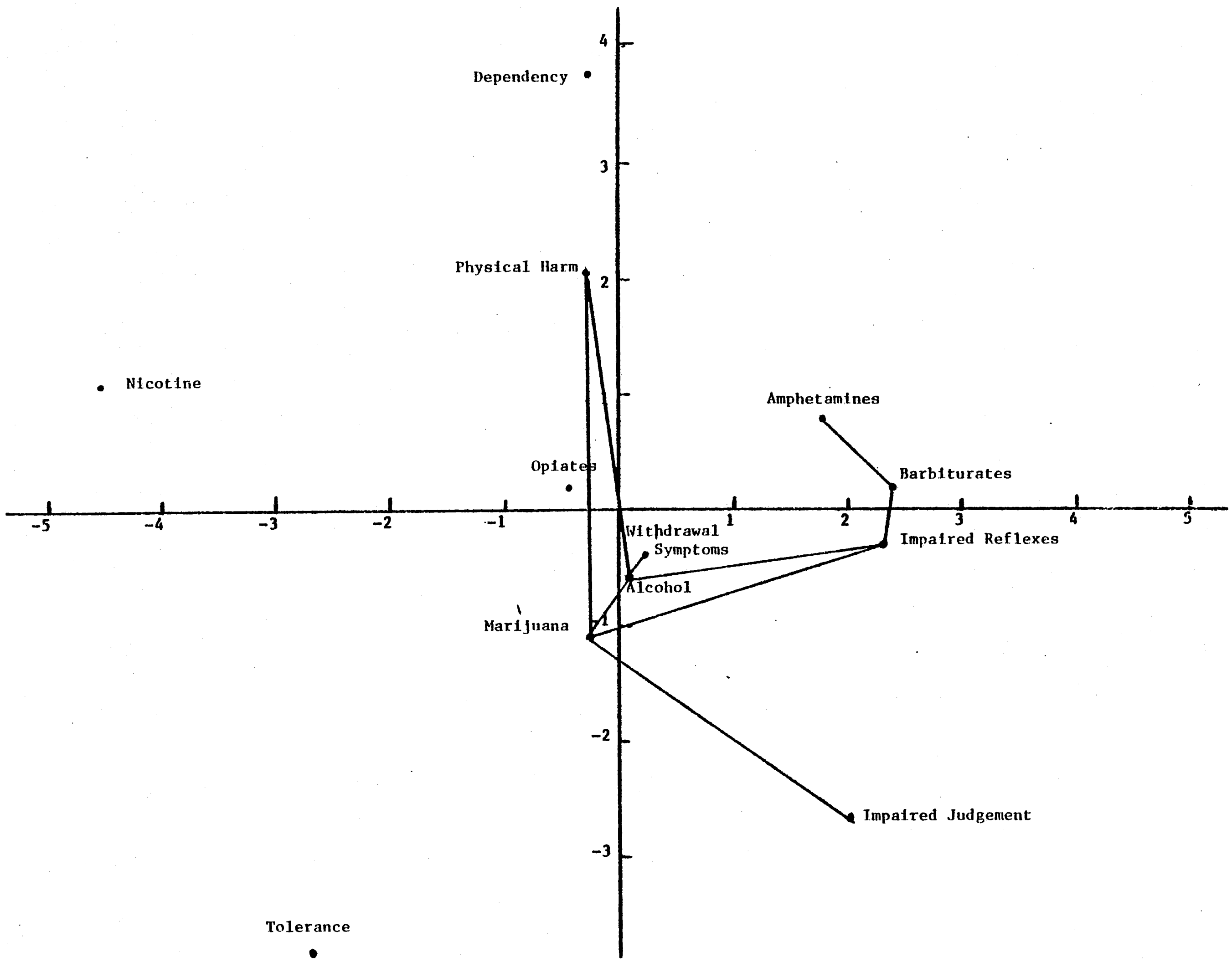

Figure 6. Control Group B - Pre-Test Coordinate System

Two pre-intervention group maps (Figures 3 and 5) showed the relationships between "Alcohol," "Impaired Judgment," and "Impaired Reflexes" to be similar to those on the reference map. Subjects did not perceive "Barbiturates," "Dependency," or "Tolerance" as closely related to "Alcohol." In the case of "Barbiturates" subjects did not appear to be using the variable of drug class in making their ratings. This may indicate that subjects were unaware that both drugs (alcohol and barbiturates) are central nervous system depressants which exhibit cross-tolerance and have similar side effects. As previously stated, subjects also did not perceive "Dependency" as closely related to "Alcohol." It does not seem probable that the subjects were unaware of the meaning of the concept since two of the groups perceived "Dependency" as closely related to "Amphetamines," "Opiates," and "Barbiturates." For some reason, subjects appeared unaware of alcohol's potential for addiction.

"Tolerance" appeared to be one concept which was troublesome for all subject groups prior to the intervention. None of the groups connected the concept with any of the other concepts.

Because the intervention was made with only two of the groups, the maps for these groups were scrutinized more closely for areas of disagreement with the reference map. In addition to differences already mentioned, the two experimental groups had pre-intervention maps on which concept names were for the most part widely scattered.

A comparison between the maps of experimental group A (Figure 3) and experimental group B (Figure 4) showed experimental group B to have fewer closely related concepts (as shown by connecting lines) than experimental group A. For experimental group B, "Alcohol" was closely related to "Physical Harm;" "Marijuana," was closely related to "Impaired Judgment," and "Impaired Judgment" was related to "Impaired Reflexes." (A slightly higher criterion, 2.8, did produce some additional connections.) With the exception of these three concept pairs, there were no other relationships meeting the 2.5 criterion. Experimental group A's map showed only one concept ("Tolerance") that was not closely related to any other concept.

Post-intervention maps for all groups (Figures 7, 8, 9, and 10) showed changes in some areas. However, the focus of this discussion will be the representations of cognitive structures for the two intervention groups. The map for experimental group B (Figure 8) showed a greater number of lines connecting concept names. "Tolerance" moved into closer configuration with other concept names and became connected with "Alcohol." "Dependency" moved closer to a more central position and connected with "Alcohol" and "Amphetamines" at the 2.5 threshold and with "Opiates" and "Barbiturates" at the 2.8 threshold. "Alcohol" became more closely related to "Impaired Reflexes," "Impaired Judgment," "Withdrawal Symptoms," "Tolerance," and "Dependency." The changes for "Alcohol" brings the map more in line with the reference map. Experimental group A (Figure 7) showed fewer changes than did experimental group B. Overall, concept names showed less scatter for both experimental groups. The concept "Tolerance" remained isolated, or at best only remotely related to other concepts, on the map of experimental group A.

While the concept configuration changed for both experimental groups, the changes appeared to be different for the two groups. The changes in the map for experimental group A appeared to consist

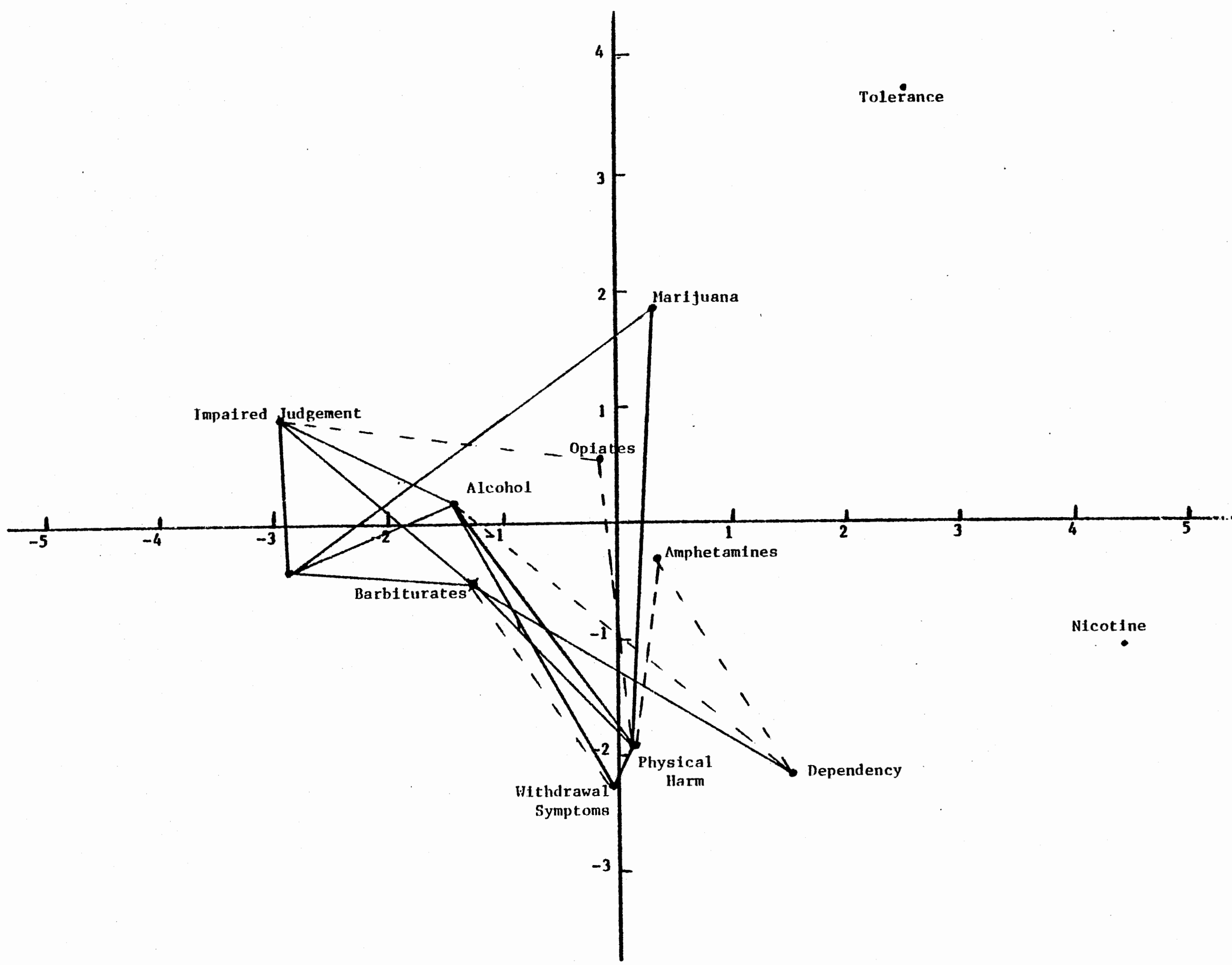

Figure 7. Experimental Group A - Post-Test Coordinate System

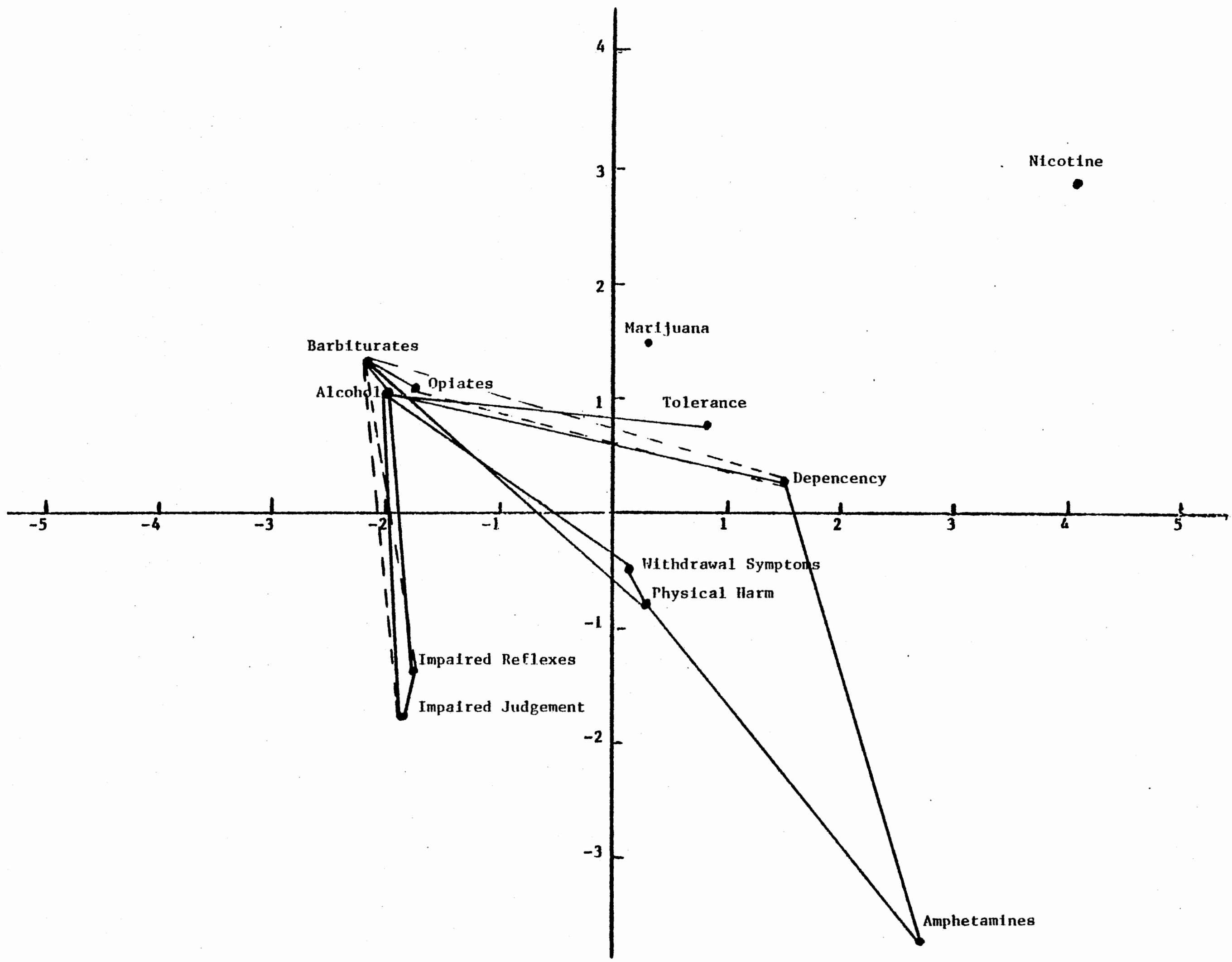

Figure 8. Experimental Group B - Post-Test Coordinate System

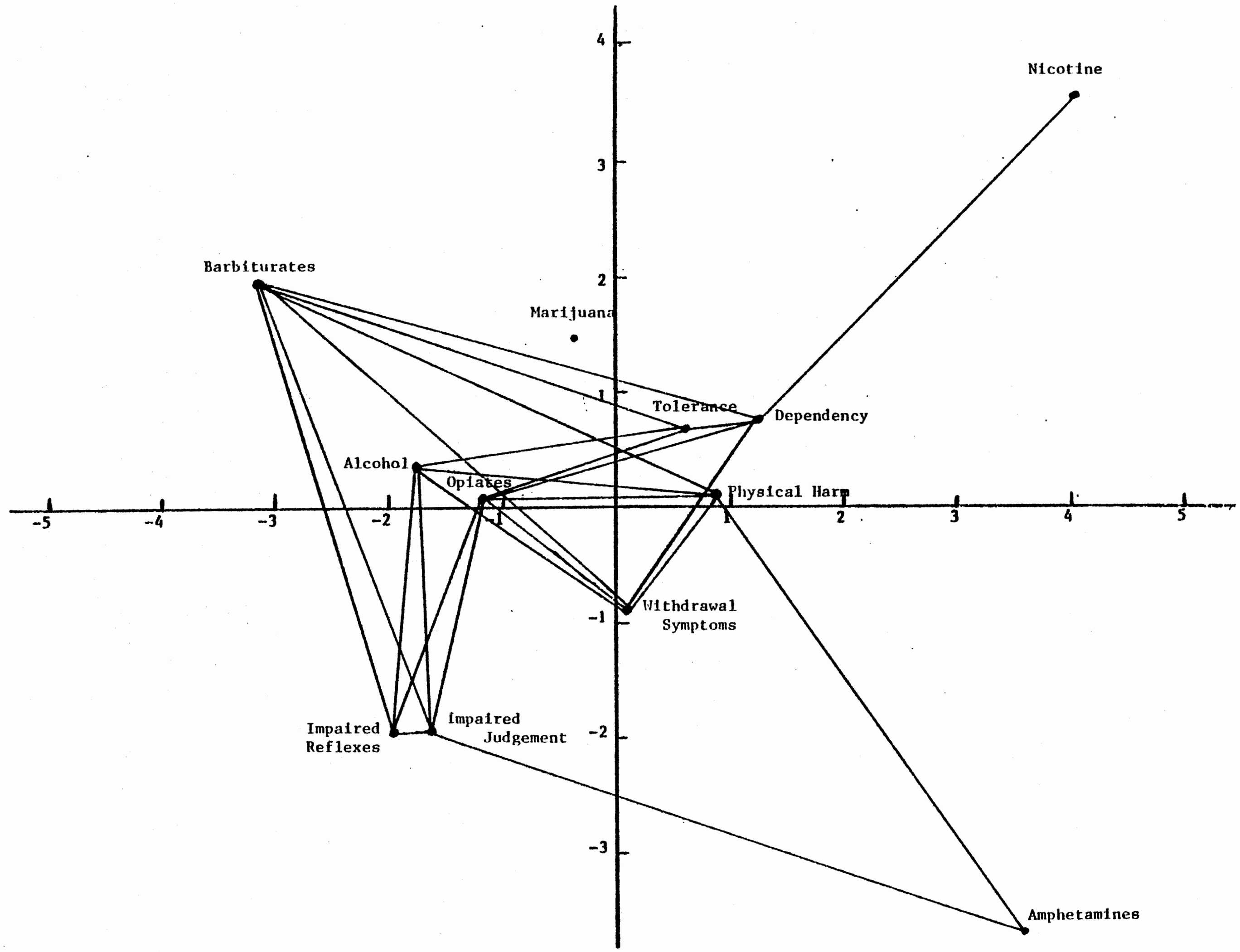

Figure 9. Control Group A - Post-Test Coordinate System

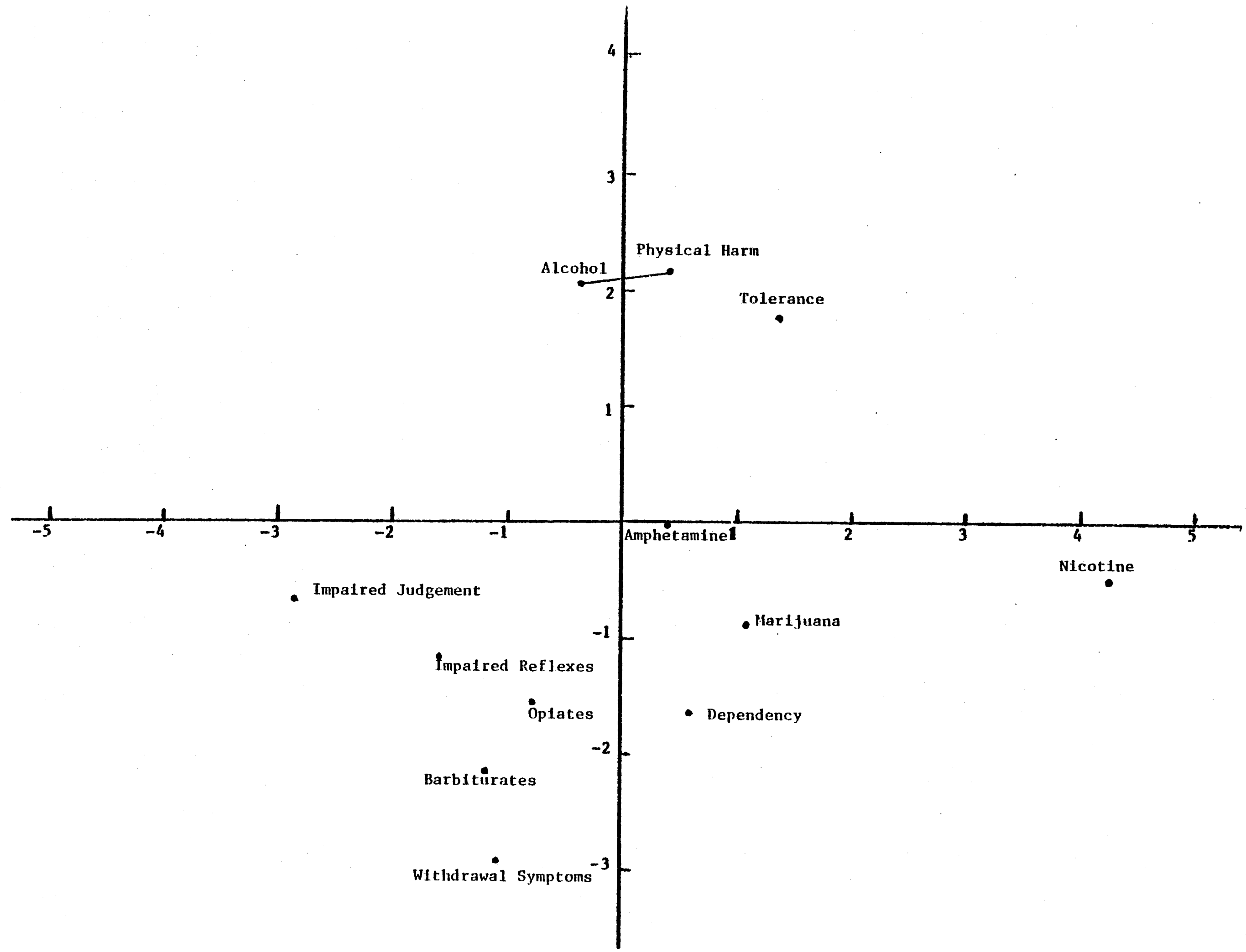

Figure 10. Control Group B - Post-Test Coordinate System

primarily of a "bunching" of concept names, while with experimental group B the change involved not only a tendency to move closer together but also a marked increase in the number of close connections made between concepts. This may be understandable, given that the map for experimental group B showed very few close interrelationships prior to the intervention procedure. That the concept "Tolerance" changed positions on the map for experimental group B but not A may suggest that it is easier to facilitate change in a conceptual system that is less tightly structured than it is in a system where concepts are more closely interrelated.

Although both experimental groups met the common-space condition when evaluated against the reference coordinate system, there are areas that still need improvement. Both groups still seem to need further instruction in relation to the concepts of "Tolerance," "Withdrawal Symptoms," "Opiates," and "Dependency." More specifically, the subjects seem to lack basic definitional information about the concepts. Further, they appear to need help in integrating the definitions. For example, the subjects did not seem to make use of the information that withdrawal symptoms are an indication that "Tolerance" has developed for a substance, or even that "Opiates" are highly addicting.

Brown and Stanners (in press) suggested that further research would be required to validate the efficacy of the concept-comparison intervention techniques. This study adds some support to its usefulness. A different type of study should be undertaken, however, to provide more definitive support. For example, the effects of a lecture comparable in length to the concept-comparison technique might be investigated. Subjects matched by v score could be assigned to one of four different groups--a no-treatment control group, a lecture only group, a lecture group where students would write down their rating but would not display it. Without seeing the subjects' ratings the instructor would reveal the "correct" rating. A fourth group would participate in the intervention procedure used in this and the Brown and Stanners study. There is some similarity between this technique and programmed instruction techniques. Both procedures include relatively immediate feedback. The concept-comparison technique incorporates the unique feature of involving the student in active participation. The student must not only respond but also must be prepared to explain and justify that response.

The usefulness of MDS in the academic setting merits additional investigation. The results of this and previously cited studies suggest that techniques of multidimensional scaling may be useful in supplementing other classroom assessment procedures. Further research might appropriately include, as did the Brown and Stanners (in press) study, efforts to correlate performance on MDS tasks with other measures of achievement.

Future research might also investigate the usefulness of MDS for clinical diagnostic purposes in the area of mental health. Diagnoses are made and treatment plans formulated on the basis of diagnostic categories. For these categories to be meaningful and most useful the labels should communicate a consistent process which is in some way unique to that categorization. It would be interesting to attempt to determine if the common-space condition could be utilized in making differential diagnoses. Could a multidimensional scaling task be devised that might generate a coordinate system representative of a specific diagnostic category? If patients are labeled, should that label not suggest that there is some common cognitive process, some consistently identifiable cognitive structure? Our current diagnostic systems imply this but behavioral scientists are hard pressed to demonstrate it. Techniques that make clinical diagnoses more accurate and precise should facilitate the continued development of clinical psychology towards the goal of a more exact science.

MDS is certainly not the panacea for the problems that concern education and the behavioral sciences. It may only stimulate more questions and further research. If it serves that function, however, it will be of value to these and other disciplines.

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APPENDIXES

APPENDIX A

LIST OF CONCEPTS

1. Dependency
2. Tolerance
3. Impaired Judgment
4. Impaired Reflexes
5. Physical Harm
6. Withdrawal Symptoms
7. Barbiturates
8. Amphetamines
9. Alcohol
10. Opiates
11. Marijuana
12. Nicotine

APPENDIX B

RATING BOOKLET

The questions I would like you to answer are in the form of connections between different drug-related terms. I would like you to make a judgment of the closeness of each connection and give a rating based on your judgment. Use the numbers 1, 2, 3, 4, 5, 6, or 7 for your ratings. If you feel that the terms you are judging are very closely connected, then use a "1" to indicate this. If you feel that the two terms you are judging are quite unconnected, then use a "7" to indicate this. Use the numbers 2, 3, 4, 5, and 6 to indicate levels of connection which fall between the extremes.

Sometimes the connections you are asked to judge may seem rather peculiar, but go ahead and give your best judgment in each case. Use your own understanding of drug-related terms to make your decision on how closely connected each pair is. Do not go back and reread to make your judgment. It is a good idea to scan the list of pairs before you begin to get an idea of how to use the scale. Also, feel free to change a judgment if you feel it is wrong.

Name______________________________________

A "1" indicates a very close connection between two items, and a "7" indicates a very distant connection. The other numbers ("2," "3," "4,"' "5", and "6") should be used to indicate levels of connection between the extremes. Put the number indicating your judgment on the line above the pair you are judging. Scan down the list before starting to get an idea of how to use the scale.

1. ___

   Opiates

   Nicotine

2. ___

   Opiates

   Impaired Reflexes

3. ___

   Opiates

   Marijuana

4. ___

   Withdrawal Symptoms

   Physical Harm

5. ___

   Nicotine

   Withdrawal Symptoms

6. ___

   Barbiturates (Reds, Yellows, Downers)

   Dependency

7. ___

   Withdrawal Symptoms

   Tolerance

8. ___

   Marijuana

   Barbiturates (Reds, Yellows, Downers)

9. ___

   Alcohol

   Impaired Reflexes

10. ___

Impaired Judgment
Tolerance

11. ___

Tolerance
Impaired Reflexes

12. ___

Alcohol
Impaired Judgment

13. ___

Opiates
Dependency

14. ___

Barbiturates (Reds, Yellows, Downers)
Tolerance

15. ___

Barbiturates (Reds, Yellows, Downers)
Withdrawal Symptoms

16. ___

Dependency
Alcohol

17. ___

Dependency
Tolerance

18. ___

Withdrawal Symptoms
Impaired Reflexes

19. ___

Alcohol
Withdrawal Symptoms

20. ___

Alcohol

Physical Harm

21. ___

Barbiturates (Reds, Yellows, Downers)

Impaired Judgment

22. ___

Opiates

Barbiturates (Reds, Yellows, Downers)

23. ___

Withdrawal Symptoms

Impaired Judgment

24. ___

Withdrawal Symptoms

Dependency

25. ___

Impaired Reflexes

Dependency

26. ___

Marijuana

Amphetamines (Dexies, Double-Cross, Speed)

27. ___

Amphetamines (Dexies, Double-Cross, Speed)

Nicotine

28. ___

Marijuana

Physical Harm

29. ___

Physical Harm

Impaired Reflexes

30. ___

Amphetamines (Dexies, Double-Cross, Speed)
Impaired Judgment

31. ___

Impaired Judgment
Opiates

32. ___

Alcohol
Barbiturates (Reds, Yellows, Downers)

33. ___

Amphetamines (Dexies, Double-Cross, Speed)
Barbiturates (Reds, Yellows, Downers)

34. ___

Tolerance
Nicotine

35. ___

Impaired Reflexes
Impaired Judgment

36. ___

Amphetamines (Dexies, Double-Cross, Speed)
Tolerance

37. ___

Physical Harm
Opiates

38. ___

Nicotine
Alcohol

39. ___

Nicotine
Dependency

40. ___

Nicotine

Barbiturates (Reds, Yellows, Downers)

41. ___

Opiates

Alcohol

42. ___

Alcohol

Tolerance

43. ___

Impaired Judgment

Marijuana

44. ___

Marijuana

Impaired Reflexes

45. ___

Marijuana

Alcohol

46. ___

Impaired Judgment

Dependency

47. ___

Nicotine

Marijuana

48. ___

Amphetamines (Dexies, Double-Cross, Speed)

Physical Harm

49. ___

Alcohol

Amphetamines (Dexies, Double-Cross, Speed)

50. ___

Physical Harm
Dependency

51. ___

Opiates
Amphetamines (Dexies, Double-Cross, Speed)

52. ___

Marijuana
Withdrawal Symptoms

53. ___

Marijuana
Tolerance

54. ___

Nicotine
Physical Harm

55. ___

Physical Harm
Tolerance

56. ___

Physical Harm
Impaired Judgment

57. ___

Opiates
Tolerance

58. ___

Opiates
Withdrawal Symptoms

59. ___

Impaired Judgment
Nicotine

60. ___

Barbiturates (Reds, Yellows, Downers)

Physical Harm

61. ___

Dependency

Amphetamines (Dexies, Double-Cross, Speed)

62. ___

Barbiturates (Reds, Yellows, Downers)

Impaired Reflexes

63. ___

Dependency

Marijuana

64. ___

Nicotine

Impaired Reflexes

65. ___

Amphetamines (Dexies, Double-Cross, Speed)

Impaired Reflexes

66. ___

Amphetamines (Dexies, Double-Cross, Speed)

Withdrawal Symptoms

APPENDIX C

LIST OF CONCEPTS FROM WHICH THE TWELVE CONCEPTS

USED IN STUDY WERE SELECTED

1. Dependency
2. Tolerance
3. Narcotics
4. Barbiturates
5. Amphetamines
6. Psychoactive
7. Alcohol
8. Opiates
9. Cross-Tolerance
10. Impaired Reflexes
11. Impaired Judgment
12. Marijuana
13. Nicotine
14. Withdrawal Symptoms
15. Physical Harm
16. Hallucinogens
17. Cocaine

APPENDIX D

NINE TARGET AND RELATED CONCEPTS

Target Concepts

1. Dependency
2. Tolerance
3. Impaired Judgment
4. Physical Harm
5. Withdrawal Symptoms
6. Barbiturates
7. Amphetamines
8. Alcohol
9. Opiates

Related Concepts

1. Addiction
2. Increased Dosage
3. Reduced Awareness of Performance
4. Poor Physical Condition
5. Confulsions and Cramps
6. Sedatives
7. Stimulants
8. Depressants
9. Narcotics

APPENDIX E

MEAN VALUES TABLE FOR ALL CONCEPT PAIRS

TABLE IV

MEAN VALUES FOR ALL CONCEPT PAIRS

Dependency	Experts	Pre/Post Experimental Group A	Pre/Post Control Group A	Pre/Post Experimental Group B	Pre/Post Control Group B
Tolerance	3.5	4.90/4.54	4.61/2.27	4.45/2.7	5.0/3.44
Impaired Judgment	2.75	4.93/4.19	3.82/3.08	4.69/3.63	4.43/4.25
Impaired Reflexes	3.25	4.42/3.73	3.89/3.15	4.72/3.23	3.33/3.12
Physical Harm	2.0	3.32/2.96	2.57/2.81	4.52/2.91	3.14/3.19
Withdrawal Symptoms	2.5	2.87/2.77	2.53/2.35	4.17/2.72	3.52/2.69
Barbiturates	1.5	1.93/2.46	1.93/2.08	3.24/2.63	2.76/3.75
Amphetamines	2.0	2.16/2.59	2.0/2.11	3.34/2.36	2.71/2.75
Alcohol	1.25	2.58/2.58	1.71/1.85	2.93/2.0	3.23/2.75
Opiates	1.0	2.45/3.15	2.21/1.54	3.79/2.89	2.71/3.0
Marijuana	3.5	3.52/3.04	2.68/3.46	4.52/3.77	3.09/3.01
Nicotine	3.5	1.61/2.58	2.0/2.15	3.41/2.88	3.09/3.81
Tolerance					
Impaired Judgment	3.75	5.26/4.77	5.03/3.19	3.89/3.41	4.0/3.50
Impaired Reflexes	4.0	5.13/4.69	5.14/3.38	4.48/3.27	4.0/3.19
Physical Harm	2.5	5.13/4.61	4.32/3.23	4.52/3.72	4.57/3.87
Withdrawal Symptoms	3.0	4.58/4.54	5.18/3.04	4.10/3.5	4.28/4.06
Barbiturates	3.0	3.74/3.96	3.82/2.38	4.34/3.04	3.76/3.0

TABLE IV (Continued)

Tolerance (Cont.)	Experts	Pre/Post Experimental Group A	Pre/Post Control Group A	Pre/Post Experimental Group B	Pre/Post Control Group B
Amphetamines	2.0	3.80/3.89	3.53/2.73	5.07/3.09	4.38/3.81
Alcohol	1.5	2.93/3.31	2.75/1.69	4.41/2.22	3.57/3.06
Opiates	1.75	3.80/3.77	4.11/2.23	3.69/3.18	3.33/3.56
Marijuana	3.25	3.64/3.38	3.86/3.08	4.72/3.04	3.09/3.6
Nicotine	3.75	4.32/3.54	4.07/3.19	4.52/3.41	3.52/3.31
Impaired Reflexes					
Physical Harm	2.5	2.93/2.69	2.57/3.08	3.24/3.18	2.71/3.43
Withdrawal Symptoms	3.0	2.29/3.04	2.28/2.54	3.45/2.91	2.89/2.94
Barbiturates	2.0	2.0/2.31	1.46/1.73	2.83/2.58	2.42/3.25
Amphetamines	3.25	2.48/2.88	2.78/2.58	3.10/2.73	2.98/3.50
Alcohol	1.25	1.35/1.77	1.07/1.46	2.59/1.82	2.19/3.19
Opiates	2.25	2.48/2.96	2.82/1.96	3.31/2.68	2.62/2.81
Marijuana	2.5	2.22/2.31	1.78/2.77	2.65/2.82	2.33/3.0
Nicotine	5.25	5.68/5.08	5.36/5.58	5.03/5.04	4.23/4.06

TABLE IV (Continued)

Physical Harm	Experts	Pre/Post Experimental Group A	Pre/Post Control Group A	Pre/Post Experimental Group B	Pre/Post Control Group B
Withdrawal Symptoms	1.75	2.39/2.38	1.93/2.38	3.31/2.41	3.33/3.62
Barbiturates	1.5	2.59/2.11	2.03/2.11	2.72/2.45	2.62/2.81
Amphetamines	2.5	2.93/2.58	2.28/2.23	2.93/2.41	2.90/2.56
Alcohol	1.75	2.13/2.35	2.36/1.61	2.18/1.77	2.14/2.25
Opiates	3.25	2.84/2.73	2.64/1.88	3.41/2.95	2.95/3.50
Marijuana	4.25	3.19/2.92	3.0/3.69	3.14/3.77	2.48/3.19
Nicotine	2.0	3.22/2.77	2.61/2.69	2.72/3.41	3.0/3.62
Withdrawal Symptoms					
Barbiturates	2.0	2.22/2.73	2.39/2.15	2.79/3.09	3.28/3.31
Amphetamines	2.75	2.55/2.73	2.43/2.58	3.72/3.04	3.52/3.06
Alcohol	1.75	1.90/2.38	2.35/1.73	3.03/2.14	2.42/3.50
Opiates	1.75	2.90/3.08	2.64/1.85	3.48/2.91	3.66/2.81
Marijuana	5.25	4.45/3.65	4.11/4.92	4.0/4.5	3.43/3.25
Nicotine	3.25	2.64/2.88	2.68/3.85	4.03/3.45	3.19/3.62

TABLE IV (Continued)

Barbiturates	Experts	Pre/Post Experimental Group A	Pre/Post Control Group A	Pre/Post Experimental Group B	Pre/Post Control Group B
Amphetamines	4.5	3.84/4.11	4.50/6.61	2.93/5.0	2.47/3.0
Alcohol	2.5	3.35/3.04	2.82/2.58	2.59/2.61	3.38/2.87
Opiates	3.25	3.61/3.58	3.75/3.58	3.31/2.36	2.57/3.12
Marijuana	3.5	4.03/3.46	3.5/4.08	3.52/4.23	3.05/3.19
Nicotine	5.25	5.22/4.54	4.71/4.96	3.58/4.68	4.57/4.19
Amphetamines					
Alcohol	4.75	4.42/3.88	4.03/5.19	3.59/5.36	3.52/2.81
Opiates	4.5	3.87/3.88	3.75/5.19	3.76/4.81	3.48/3.12
Marijuana	5.0	4.22/3.85	4.0/5.19	3.55/4.68	2.85/2.9
Nicotine	4.75	4.99/3.88	3.89/4.88	4.0/4.64	3.71/3.75
Alcohol					
Opiates	3.5	4.19/3.81	3.68/3.58	3.55/3.18	3.14/3.25
Marijuana	3.0	3.68/3.88	3.39/4.11	3.03/3.73	2.19/3.12
Nicotine	4.75	4.16/4.58	4.71/4.5	3.86/4.68	3.38/3.81

TABLE IV (Continued)

Opiates	Experts	Pre/Post Experimental Group A	Pre/Post Control Group A	Pre/Post Experimental Group B	Pre/Post Control Group B
Marijuana	3.75	4.0/3.69	3.97/3.81	3.72/3.64	3.14/2.94
Nicotine	6.0	4.68/4.31	4.64/4.59	4.14/4.68	3.43/3.81
Marijuana					
Nicotine	4.5	4.64/3.46	4.36/4.15	3.24/3.59	3.05/3.12

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