A VALIDATION STUDY OF THE BLACKY ANALOGIES TEST

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CHAPTER I

ANXIETY AND COGNITION

Overview

A better understanding of the effects of anxiety is of interest to psychologists for both theoretical and practical reasons. The concept of anxiety is of central importance to theories of personality which postulate that many forms of human behavior, particularly abnormal behavior, can be explained in terms both of disruptive effects of anxiety and attempts to cope with it. Practically, this knowledge would aid in the remedial and preventive treatment of psychological disorders and would enable researchers to devise measures to screen individuals who are likely to be less effective under stress conditions.

The object of the present research is a test which has been designed to be of value in studying the effects of anxiety on problem-solving ability and for selection of individuals who are able to maintain their effectiveness in anxiety-arousing situations. This new psychological instrument is called the Blacky Analogies Test (BAT).[1] In this measure cartoons from the Blacky Pictures (Blum, 1950) are used as alternatives for solving analogies and are presumed to evoke anxiety which may have a disruptive effect on test performance. While some research has been carried out using the BAT,[2] further work needs to

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[1] See Appendix A for a copy of this test.

[2] This research is reported in Chapter II.

be done to determine its construct and predictive validity. The major emphasis in this study will be on determining the extent to which intellectual factors account for performance on the BAT and the degree to which the test is able to predict success in a situation presumed to be anxiety arousing, namely, academic achievement.

The research is in two parts: the first is a factor analysis of the BAT included with a battery of tests designed to measure a variety of intellectual aptitudes; the second reports the results of a predictive study relating it to criteria of academic success.

In this chapter a review of the most pertinent literature on the effects of anxiety-arousing stimuli on cognitive performance is presented, followed by a brief discussion of previous attempts to take into account personality variables in predicting academic success.

Effects of Anxiety-Arousing Stimuli on Cognitive Processes

In the last decade a great deal of interest has been stimulated by the publication of studies of perceptual defense. While these studies have been criticized by some writers, the research does indicate that an individual is capable of inhibiting the receiving and processing of threatening stimuli. In spite of the amount of work carried out on perceptual defense, little attention has been devoted to the closely related area of the effects of threatening stimuli on cognitive processes. Some research has been carried out on the impact of anxiety-arousing stimuli on memory, but their effects on other aspects of cognition such as problem-solving, learning, and reasoning have not been explored extensively. Various tasks have been employed in experiments in this general cognitive area and

many kinds of abilities tapped. The present discussion will take up these experiments according to the cognitive process with which they deal. The terms "threatening," "conflictual," "anxiety-laden" as applied to stimuli are used synonymously to refer to stimuli which arouse anxiety in individuals by activating memory traces associated with anxiety.

Memory

Most of the studies dealing with the effects of anxiety-provoking stimuli on recall of these stimuli have been concerned with demonstrating the validity of the psychoanalytic concept of repression. One of the earliest approaches (Colgrave, 1898) was the questionnaire method in which subjects were asked to state whether they remembered more pleasant or unpleasant incidents from their life experiences. A refinement of this method required persons to recall experiences from a specified time period (Wohlgemuth, 1923; Cason, 1932). Despite their obvious methodological weaknesses, the conclusion was drawn from these studies that pleasant events are more likely to be retained than unpleasant ones.

In other studies to demonstrate the existence of repression, subjects were asked to recall material associated with pleasant and unpleasant sensory stimuli (Gordon, 1925; Kenneth, 1927). Although the results indicate that associations to pleasant sensory stimuli were generally recalled better, the findings do not cast much light on the question of recall of conflictual material since unpleasant sensory stimuli are not necessarily ego-threatening. Word association tasks (Griffitts, 1920; Stagner, 1931) have also been used in an attempt to gain a better understanding of the process of repression. While the results of these studies indicate that subjects generally retain more pleasant than unpleasant associations, they also suggest

that many other factors are involved in memory for affectively laden stimuli. One of these factors—the attitudes of the subjects—has been studied by Bartlett (1932) and others. They find that people tend to remember statements which agree with their attitudes better than statements which do not conform to existing attitudes.

After reviewing the research on the effects of conflictual material on memory, Zeller concludes that "no test of repression can be considered adequate until the removal of the repression factor has resulted in the restoration to consciousness of the repressed material" (1950a, p. 46). That neutral stimuli are recalled more frequently than unpleasant stimuli may be explained in terms of learning, set, or motivation and need not necessarily imply repression.

Zeller himself (1950b) carred out a study showing that previously forgotten material could be remembered if the conditions which led to repression in the first place were removed. Subjects were required to learn paired-associate lists of nonsense syllables. Another task was then introduced which experimental subjects were caused to fail. He found that subjects who had experienced failure remembered fewer nonsense syllables than did control subjects. After a success experience was introduced the experimental subjects recalled more syllables than they had previously.

Zeller's experiment neglects another aspect of the psychoanalytic concept of repression, i.e., that associations are not repressed merely because they are unpleasant, but because they evoke anxiety. In his experiment, the nonsense syllables are only associated to the failure experience by contiguity. Zeller does not demonstrate that the syllables themselves are anxiety-arousing. It is difficult to see why the anxiety over failure on one task should necessarily generalize to the previous task. It seems quite likely

that failure on the interpolated task induced frustration in the subjects which affected their motivation to recall the nonsense syllables. The later success experience may have increased motivation to recall the nonsense syllables by counteracting frustration.

Blum (1955a) did a study in which defense preferences and amount of over-all conflict were related to recall of the Blacky pictures. These stimuli might be expected to conform more closely to psychoanalytic notions concerning the kind of material likely to be repressed. While intensity of over-all conflict was not found to be related to recall, subjects for whom avoidance was the preferred mode of defense did significantly poorer on recall of Blacky pictures than did those employing other defenses. This finding suggests that the way in which the individual characteristically attempts to defend himself against experiencing anxiety is an important variable in predicting the repression of threatening material. In the same experiment Blum determined the relationship between association value of Blacky pictures and the frequency with which they were recalled. The association value of a picture refers to the tendency for one picture to call to mind another similar picture and was measured by the frequency with which a picture was paired with another picture in the recall series. Pictures with high association value were forgotten less readily than pictures with low association value. Blum also found that the best predictions of recall of pictures could be made by taking into consideration both their association value and the characteristic mode of defense of the subject.

Rapaport (1942) in his summary of the literature on recall of pleasant versus unpleasant material, concludes that evidence points to the better recall of any affectively charged stimuli than neutral ones, while pleasant stimuli seem to be recalled better than unpleasant. If affect has a tendency to increase the strength and

vividness of memories, then repressive mechanisms are acting in an opposite direction. The difference in the balance of these two factors in different individuals may be one source of the conflicting results which are reported. Some evidence for this is seen in exploratory work by Blum (1959) in which anxiety to one of the Blacky pictures was experimentally induced by means of hypnosis. Even after the subject had learned the pictures perfectly the anxiety picture was found to be generally delayed in recall. However, when the subject was told under hypnosis that he would experience no feelings and was then asked to recall pictures, the anxiety-laden picture generally came earlier in the recall series. This finding suggests that when the counterbalancing influence of repression was removed, the affective experience attached to the picture made it more vivid than the relatively more neutral pictures.

Learning and retention

Though many of the studies assessing the effect of threatening stimuli on memory have required the subject to learn the material befor testing recall, the relative efficiency of the learning of anxiety-provoking stimuli has not been the focus of attention. In one of the few studies comparing the learning of threatening and neutral material, Kott (1955) attempted to determine whether words having sexual meaning were more difficult to learn and retain than words having unpleasant connotations or neutral words. Differential performance of normals and hospitalized neurotics on these three tasks was studied. In order to overcome reluctance to verbalize words having sexual meaning, these three lists of words were learned to nonsense syllables so that the subject was not required to produce the sexual word. He found no significant difference between the groups or within the lists in length of time taken to learn the paired-associates

to a criterion, and no over-all significant difference between groups or among lists in recall was found. An analysis of variance of the data, however, disclosed an interaction between group and type of word. The anxiety group (neurotics) was more efficient in learning and retaining associations to sexual words than to neutral or unpleasant words. Kott suggests that this difference was due to a breakdown of repression in the hospitalized group.

In Kott's study, as in most of the studies of recall, there was no attempt to determine whether the "conflictual stimuli" were actually perceived as threatening to the subject. Heilizer, Axelrod, and Cowen (1955) attempted to select words which were specifically threatening to each subject on the basis of his responses to the Bills, Vance, McLean Index of Adjustment and Values. In addition, a second, neutral list of words was devised. The authors found that all subjects took significantly longer to learn pairings of nonsense syllables to the conflictual list than to the neutral list.

Babladelis and Galinsky (1953) studied the relationship between psychosexual conflict as measured by the Blacky Pictures and ability to learn and recall short stories written about these pictures. Two sets of stories were used. In one set conflict was openly expressed (strong stories), and in the second conflict was not expressed (weak stories). Few consistent differences in learning and recall were found between subjects having conflict and those having no conflict. There was, however, a tendency for conflict groups to learn and recall strong stories better than weak stories while non-conflict groups tended to learn and recall weak stories better.

This result is similar to that reported by Kott. It may have been, however, that strong stories reflected interpretations of the pictures which were more similar to those made by the subjects with

conflict. The stories might have been recalled better because they fitted the subject's existing frame of reference. A similar explanation might be used to explain the tendency for subjects without conflict to recall neutral stories better.

Laffal (1952) found that subjects took a significantly longer time to learn the association between disturbing words and neutral pictures than between neutral words and pictures. On the other hand, there were no differences in recall of the two types of words. The author attempts to explain the differences in results between learning and recall by suggesting that anxiety associated to disturbing words resulted in an inhibition which disrupted learning. The eventual learning of the association, however, served to reduce its anxiety and removed the inhibition of recall. An alternative interpretation of these findings stems from Laffal's use of a word association test to determine words which were disturbing and non-disturbing for each subject. A word was classified as disturbing for a person if there was evidence of disruption in his associations to it, for example., delayed reaction time. Since the subjects produced many more different associations to the disturbing words, it is possible that the delayed reaction time reflected the existence of competing response tendencies rather than anxiety.

This brief review shows that the evidence for the effects of anxiety-provoking stimuli on learning is inconclusive. In two of the experiments described, conflictual material was found to be learned somewhat better by anxious subjects than was neutral material, while in two other studies the learning of conflictual material was poorer. Results reported by Kott and by Babladelis and Galinsky suggest a possible reconciliation of these differences. These findings indicate that individual differences in tendency

to respond with anxiety to stimuli may be an important determinant in the way in which the presence of these stimuli will affect learning. None of the studies described has attempted to assess the role of conflict and defense in determining the effects of threatening stimuli on learning. Certain defenses such as isolation would not be expected to disrupt cognitive processes in learning and recall while other defenses (e.g., withdrawal and denial) might be expected to have a disrupting effect on learning.

Problem-solving

The research to be discussed in this section deals with problem-solving in which the problem involves affect-arousing stimuli. Davis and Harrington (1957), for example, found that schizophrenics and normals did not differ in ability to solve problems when dealing with relatively abstract stimuli such as numbers, letters, or colors. They did differ, however, in their ability to utilize information to solve problems involving pictures of people. The authors conclude that the schizophrenic's difficulty with problem-solving is not a general one but rather is dependent on the nature of the stimuli involved.

In another study (Jones, 1957) performance of normals and schizophrenics was compared on four tasks of verbal ability. The tasks used were these: (1) synonyms, (2) sentence construction, (3) word association, and (4) recall. Each used the same set of twenty words, ten of which were neutral and ten disturbing. Schizophrenics were found generally to show more disruption on tasks involving emotional words than did normals, and both groups generally showed greater disruption on emotional tasks than on neutral tasks.

Both of the above studies compared the effects of threatening stimuli on schizophrenics and normals. Heath's research (1956)

sheds some light on differences in reactions to various problem-solving stimuli within a group of schizophrenics. Using male hospitalized patients, he obtained scores on two sets of arithmetic word problems and two sets of dissected sentences which were to be arranged to make coherent sentences. One set of each employed themes which were threatening while the other set was neutral. He found no difference in performance between threatening and non-threatening arithmetic problems, which he explains as being due to the overlearning of arithmetic techniques. There was, however, a significant difference in performance between the two dissected-sentences tasks. Subjects were found to exhibit the most disorganization on problems employing themes which had been assessed as most threatening for them. The results indicate the degree of disruption in task performance under anxiety conditions was inversely related to abstract conceptualizing ability as measured by the Goldstein-Scheerer Sorting Test.

Helfman's findings (1957) also suggest that differences in level of skill are important in determining the effect of threatening stimuli on problem-solving. The task used in this study was the Problem-Solving Instrument (PSI). The PSI is an apparatus which has nine lights serially numbered, arranged in a circle, and a tenth light in the center. The problem is to light the center light using some combination or sequence of the lights arranged around it. The threatening stimuli, Blacky pictures, and neutral stimuli (pictures of Bugs Bunny) were affixed beside the lights and were used in place of numbers to identify them. While the number of subjects was too small to evaluate the statistical significance of findings, the evidence suggests that the effect of threatening stimuli on performance depends on the level of skill of the subject in solving problems. Highly skilled persons and those with moderate skill tended to perform better

when Blacky pictures were used, while low skill subjects showed no difference in performance. Helfman suggests that the improved performance of highly skilled subjects represented a defense against the anxiety generated by the Blacky pictures. Individuals with a high degree of skill might be expected to have developed this defense to a greater degree than low skill individuals because of more frequent reinforcements of this defense in the past in similar achievement-oriented situations.

Degree of conflict and defense preference have also been found to be important in determining the effects of threatening stimuli on problem-solving. Blum (1955b) devised a word-completion and anagram task which could be solved in either a positive (relevant to conflict dimension on the Blacky pictures) or a neutral fashion. As predicted, the existence of conflict, together with preference for avoidance as a defense, was associated with neutral word solutions. These findings, together with those discussed earlier in the sections on memory and learning, suggest that both stimulus and personality variables must be considered simultaneously in explaining cognitive performance. The degree to which a particular stimulus is perceived as threatening and has adverse effects on memory, learning, and problem-solving depends on the nature of the individual's psychic conflicts and his characteristic modes of defense.

Logical reasoning

The studies reported in this section have dealt with the effects of strongly held opinions on logical reasoning. Though they appear less relevant to the present discussion, they are reported because strongly held attitudes are thought to be emotionally laden.

Janis and Frick (1943) asked college students to judge the vaildity of syllogisms and also to note whether they agreed or

disagreed with their conclusions. They found that individuals tended to make more errors in judging validity when the syllogism was invalid but they agreed with the conclusion, or was valid and they disagreed with the conclusion. The findings indicate that the attitudes and beliefs of the individual may greatly influence reasoning.

Lefford (1946) performed a similar study using two sets of syllogisms. One (emotionally toned) had premises and conclusions concerning minority groups, while the second (neutral) had statements concerning factual material. College students were asked to judge the validity of each syllogism and to note whether they agreed or disagreed with the conclusion. Scores were determined for each subject: (1) accuracy—the number of syllogisms judged correctly, and (2) partiality—the number of syllogisms agreed with which were rated as valid and the number of syllogisms disagreed with which are rated as invalid. The results indicate little relationship between accuracy and partiality scores for either type of syllogism. The results suggest, however, that the order of presentation of syllogisms had an effect on judgments. Presenting non-emotional subject matter first tended to establish a set for reasoning which increased the relationship between accuracy and partiality scores.

Thistlethwaite (1950) obtained judgments of validity of neutral and emotional arguments from 559 college students from 7 universities including northern, southern, and western colleges, as well as one Negro college. Students from the southern colleges were found to make significantly more distortions in reasoning on arguments concerning Negroes and Jews.

While the studies discussed demonstrate rather conclusively the effects of attitudes on reasoning, none of them show that

statements contrary to existing attitudes arouse anxiety. The results can be more simply attributed to resistance to change in cognitive structure rather than to anxiety disrupting the reasoning process.

Summary

In summary, it seems that the presence of threatening stimuli can have a disrupting effect on cognitive processes. The evidence is most clear-cut for memory and problem-solving ability while further research is required in the areas of learning and logical reasoning. The evidence indicates that disruption in cognitive performance is greatest when the threatening stimulus and personality variables are considered together in the experimental design. Individual differences in defense preferences and degree of training or skill in the particular cognitive task have also been shown to be important in determining the effect of conflictual stimuli on performance.

The finding that problem-solving is adversely affected by the presence of anxiety-provoking stimuli lends support to the rationale underlying the BAT. The analogies which compose the test can be regarded as problems, while the Blacky pictures, from which the subject must choose the solution to the analogy, are assumed to represent threatening stimuli. Evidence for the latter assumption is found in studies by Blum (1954) and Berger (1957). Their results indicate that the Blacky pictures can induce changes in GSR and heart rate (Berger, 1957), produce perceptual defense (Blum, 1954), inhibit recall (Blum, 1955a), and restrict problem-solving ability (Blum, 1955b). Although it remains to be seen whether the mere presence of the Blacky pictures does arouse anxiety which affects ability to solve the analogies, the test administration procedure is designed to maximize the likelihood that conflictual associations will be evoked.

Subjects are told to look at each picture for 20 seconds in order to fix it firmly in mind, and the title of each picture is given the subject to insure recognition of its content.

Studies Relating Personality Factors to Academic Achievement

If the assumptions about the constructs being measured by the BAT are correct, this instrument would be of value in predicting the success of individuals performing intellectual tasks under conditions of aroused anxiety. Success in college is one possible example of such a situation. College students are subjected to a fair amount of stress in carrying out their academic program. There are pressures on them to meet deadlines, the stress of examinations, and greater competition with their fellow students than they encountered in high school. Furthermore, college represents for many students their first experience away from home and is a step toward independence which for many may be a source of anxiety and conflict. Some stress may stem from the subject matter of courses as they are being exposed to new ideas and values which may conflict with those of their families. Always present, of course, are underlying intrapsychic conflicts not peculiar to the academic situation but which may become increased by the stress induced by the situation.

The ability of students to cope with the anxiety arising from these various sources and maintain intellectual control may be an important factor in academic achievement. The BAT, therefore, may show some relationship to measures of academic performance.

Some previous attempts have been made to predict academic success from measures of anxiety or emotional adjustment. Interest in these personality measures has arisen primarily because of the

failure of traditional tests of aptitude to account for the major portion of variance in academic achievement. One of the instruments most widely used for this purpose is the Minnesota Multiphasic Personality Inventory (MMPI). This test is relatively easy to administer and to score and has several scales, so that patterns of performance may be analyzed.

Frick (1955) administered the MMPI along with the ACE to 267 freshman women at Santa Barbara College. He then related the test scores to grade-point averages and obtained an empirically derived prediction formula. The ACE accounted for about 23 per cent of the variance in grade-point average, but when scales on the MMPI were added, the amount of variance accounted for increased to 41 per cent. The most heavily weighted MMPI scales were Hs (described as indicating immaturity and lack of insight), Pd (asocial and disinterested attitudes), Sc (existence in a fantasy world), Ma (hypomanic behavior), and Pa (paranoid tendencies). The first four scales were weighted negatively while Pa was weighted in a positive direction.

A later cross-validation study carried out by Frick and Keener (1956) on another sample of 200 freshman women found that the amount of variance accounted for by the prediction formula dropped to 29 per cent, which suggests capitalization on chance factors in the first study.

Schofield (1953) used the MMPI in predicting success in medical school. He administered the test twice, once during the freshman year in medical school and again at the end of the junior year. The Hy, Pd, and Sc scales were found reliably to discriminate students matched on ACE scores in the upper and lower quarter of grade-point average. Ninety per cent of individuals showing elevations on these three scales obtained scholastic averages below the

median of the group not showing these elevations. Students having profiles with an elevation on only one of these scales did not have significantly different mean grade-point averages but did have significantly greater variability than those with no elevations.

Hoyt and Norman (1954) attempted to follow up this finding. They used three groups of male freshmen: (1) with two scales higher than 70 on the MMPI excluding Mf, (2) with one scale score higher than 70, and (3) with no scale score above 70. They also obtained scores on the ACE and Ohio State University Psychological Examination. The obtained correlation between the Ohio Examination and grade-point average was the highest for the normal subjects, intermediate for group 2 (moderately deviant) and lowest for group 1 (most deviant). The obtained r's between ACE and grade-point average did not show significant differences. It was explained that the students had originally been selected for admission to college on the basis of their ACE scores.

Attempts to predict college performance from anxiety measures have generally yielded disappointing results. Matarazzo, Ulett, Guze, and Saslow (1954) and Sarason (1956) report insignificant correlations between the Taylor Manifest Anxiety Scale and grade point average for college students. As has been pointed out before, however, the effects of anxiety on performance may depend on the nature of the defense mechanisms employed by the individual. Anxiety may increase the performance of certain persons and decrease the performance of others. If the assumptions concerning the BAT are correct, it does not measure just susceptibility to anxiety but represents an actual sample of performance under anxiety-arousing conditions. Therefore, the BAT should reflect the resultant degree to which anxiety and defenses will interfere with intellectual performance.

The BAT has an advantage over self-report personality inventories. One of the major problems with the latter in predictive batteries is the possibility that the subjects will not be completely frank and open in their responses. This problem is of particular concern when these tests are used for selection, as the individual is highly motivated to appear in the best light. Instead of asking the subject how he performs, the BAT measures a sample of his intellectual performance in what is assumed to be an anxiety-producing situation.

CHAPTER II

PRELIMINARY EXPLORATIONS OF THE BLACKY ANALOGIES TEST

Description of the Test

The Blacky Analogies Test is an analogies test of the usual form except that the alternatives to the analogies are Blacky pictures instead of words. A copy of the test is in Appendix A. Eight of the Blacky pictures are used, four at a time, in solutions to the analogies: Oral Eroticism (A), Oral Sadism (B), Anal Retentiveness and Expulsiveness (C), Oedipal Conflict (D), Masturbation Guilt (E), Castration Anxiety (F), Sibling Rivalry (G), and Guilt Feeling (H), Identification Process, Ego Ideal, and Love-Object were omitted for several reasons. First, these pictures have generally been found to arouse less anxiety than the other pictures and do not as clearly represent conflict areas. Second, it was difficult to devise items for these pictures that were not obvious or did not involve unusual interpretations of the pictures.

Originally an attempt was made to obtain subscale scores on each of the eight conflict dimensions. It was found, however, that the scores thus obtained were unreliable due to the relatively small number of items in each scale. Consequently, items for each of the pictures were combined yielding only a total test score.

The items themselves are of several different types. Some are the types usually found on analogies tests and are based on a

conceptual relationship existing between pairs of words, e.g., item 1—Rusty : Oil :: Parched : A (depicting Blacky nursing). Others involve manipulating letters in words, e.g., item 3—Chew : Hew :: F (depicting a dog's tail being chopped off); Hop. In some cases less common meanings of the words in the pari must be thought of in order to solve the analogy, e.g., item 37—Relief : Relieve :: Charity : C (Blacky is "relieving himself").

Test Construction

The original form of the BAT was devised in the fall of 1955, by a group of graduate students[1] with G. S. Blum acting as adviser. An initial screening of the items was done by this group to select items with the following characteristics: (1) items must discriminate among a college population, (2) solution must involve a readily agreed upon interpretation of the picture, and (3) only one alternative must be correct.

The resulting test (Form A) was administered to a volunteer group of psychology graduate students. Item difficulty and internal consistency scores were computed, and the test revised by eliminating or modifying items and adding new ones.

The second form (Form B) was administered to a group of undergraduate male subjects and revised on the basis of the same conditions as described above. After several more revisions the present form (Form F) was devised, consisting of 40 items arranged roughly in order of increasing difficulty. The time limit was set at

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[1]Howard Goldsmith and Yona Guttman collaborated with the author and Gerald S. Blum in constructing the original form of the test. Justin L. Weiss assisted on one of the later revisions.

25 minutes which permitted most subjects to complete the test. It was felt that some time pressure would facilitate the arousal of anxiety but that the limit should allow most subjects to attempt all items. The instructions are such that the test can be self-administered. Before attempting the analogies, subjects are told to concentrate on the pictures one at a time. Associations evoked are expected to increase the likelihood that anxiety will be aroused to affect performance on the analogies.

Previous Research Using the BAT

In various administrations of preliminary forms of the BAT, information regarding its relationship to other measures of intellectual ability and certain personality dimensions has been collected. This information will be briefly summarized here under three headings: (1) relationship to measures of intellectual ability, (2) relationship to criteria of academic success, and (3) relationship to personality variables. Most of the relevant data are presented in the tables, but some interpretation of these results will also be included.

Relationship of BAT to intellectual measures

Table 1 summarizes the relationships which have been found between the BAT and the Miller Analogies Test, the American Council on Education Psychological Examination (ACE), and the Concepts Mastery Test. It seems clear from these results that the BAT is measuring verbal reasoning and verbal comprehension. All of the correlations are positive with 10 of 11 being statistically significant. The lower correlations between the BAT and the Miller Analogies Test for psychology graduate students undoubtedly reflects restriction of range resulting partly from the use of the MAT in selection.

TABLE 1

CORRELATIONS OF BAT AND INTELLECTUAL MEASURES

Test	Subjects	Correlation	p (one-tailed test)
Miller Analogies	23 graduate psychology students[a]	.28	N.S.
	34 undergraduate and graduate students[a]	.66	<.01
	36 graduate psychology students[a]	.34	<.05
	89 undergraduate students (Kelly et al., 1958)	.63	<.01
ACE Total	47 undergraduate students (all males) (Goldsmith, et al., 1956)	.32[b]	<.05
Linguistic		.36[b]	<.01
Quantitative		.29[b]	<.05
Total	15 undergraduate students (Helfman, 1957)	.73	<.01
Concepts Mastery Test	55 undergraduate students (all females)[a]		
Total		.58	<.01
S-O		.45	<.01
Analogies		.62	<.01

[a]Results of pilot studies.

[b]Rank order correlations, all others are product-moment.

In addition to the data presented in the table bearing on the relationship of BAT to intellectual abilities, Helfman (1957) found BAT scores to be positively related to solution of problems on the Problem Solving Instrument, whereas ACE scores were negatively related to success in solving these problems. This further suggests that the BAT is measuring something beyond what is measured by the ACE. This finding, however, is based on a very small N and is only suggestive.

Relationship of BAT to measures of academic success

Undergraduate students with high grade-point averages were found to have significantly higher BAT scores than those with low grade-point averages. Only the upper and lower thirds of grade-point average were used in this analysis.

Incoming graduate students in psychology in the fall of 1957 were given one of two forms of the BAT (D_1 or D_2). Performance on the BAT was related to performance on the Masters' Comprehensive Examinations. Table 2 presents the results of this analysis. Miller Analogies scores, on the basis of which students were selected, showed no correlation with the Comprehensives. It must be pointed out, however, that the subtests on the Comprehensives have very low reliability. The negative correlation between the BAT and Comprehensive scores is interesting and difficult to interpret. As the Comprehensives require memory of facts from various fields of psychology, it may be that individuals who tend to bind anxiety through compulsive accumulation of facts are not able to perform as well on a complex task such as the BAT, which requires flexibility of thought.

TABLE 2

CORRELATION OF BAT AND MASTERS' COMPREHENSIVE EXAMINATION SUBTESTS

Subtests	BAT, D_1	BAT, D_2	D_1 and D_2 (Combined)
Sensory	-.02	.10	.11
Learning	-.30	-.53**	-.51**
Physiology	-.49**	-.11	-.25
Social	-.26	-.13	-.17
Personality	-.40**	-.02	-.18
History	-.23	-.31	-.25
Quantitative	.16	-.38	-.23
Measurement	.07	-.47*	-.43*
Developmental	-.45*	.27	-.03
Abnormal	-.23	.01	-.12

*Significant at the .05 level (two-tailed test).

**Significant at the .01 level (two-tailed test).

These BAT scores were not significantly correlated with the average of the two semester grades in Basic Concepts or Statistics. The students, however, represent a very highly selected sample of individuals, and the lack of a positive relationship in this study does not necessarily imply that the BAT would not correlate with grades on a population of more widely varied ability.

Relationships between BAT and personality variables

Table 3 presents the data obtained in a study concerned with the effects of tranquilizing drugs on behavior (Kelly, Miller, Marquis, Gerard, and Uhr, 1958). Unfortunagely the total number of significant correlations only slightly exceeds that expected by chance so that any interpretations of the relationships which were found would be highly speculative.

In a study carried out by Goldsmith, Gutman, and Workman (1956) on 47 male college students the BAT was given with the usual Blacky Picture battery and Defense Preference Inquiry. Conflict scores on each dimension were obtained as well as over-all patterns of conflict and defense preferences. There were no clear-cut relationships found between measures of conflict and the BAT. There was a tendency for individuals who chose avoidance as a defense to have lower BAT scores and for individuals who chose intellectualization as a defense to have higher BAT scores. These results suggest that individuals who characteristically avoid conflict areas have difficulty on a test which requires the ability to deal with affective stimuli in order to arrive at a correct answer, while individuals who tend to use intellectualization as a defense are able to isolate the affective properties of the stimuli and deal with them on a cognitive level.

TABLE 3

CORRELATION OF BAT AND PERSONALITY VARIABLES[a]

Variable	r	p (two-tailed test)
MMPI		
Hypochondriasis	.06	N.S.
Psychopathic deviate	-.11	N.S.
Masculinity	-.03	N.S.
California Personality Inventory (CPI)		
Socialization	-.01	N.S.
Tolerance	-.19	N.S.
Intellectual efficiency	-.17	N.S.
Flexibility	-.15	N.S.
Edwards' Personal Preference		
n Ach	.25	<.02
n Deference	-.24	<.05
n Exhibition	.05	N.S.
n Autonomy	.03	N.S.
n Introception	.11	N.S.
n Consistency	.10	N.S.
16 PF		
E Dominance	.03	N.S.
M Bohemianism	-.01	N.S.
Q Radicalism	.03	N.S.

[a]Kelly et al., 1958)

Goldstein (1958), in a study of the effects of psychological stress, related conflict and defense measures from the Blacky Pictures, the Defense Preference Inquiry, and four ego-strength measures (Barron, Thomas M and U Scales, and Eriksen) to decrement in performance on the BAT under stress. He found no significant relationships between any of these measures and BAT under stress. It should also be noted that the four ego-strength measures did not correlate with each other.

In an unpublished study (Braunstein, Lahn, Oppenheimer, and Saxe, 1957) the BAT was compared to the following measures of rigidity: Concept Formation, CPI Flexibility Scale, Einstellung Ambiguous Pictures, F-Scale, Muller-Lyer. It showed significant but low correlations with Einstellung, Muller-Lyer, and CPI Flexibility Scale, suggesting that subjects with high BAT scores are less rigid than those with low BAT scores.

CHAPTER III

METHODOLOGY

The purpose of this study is to determine some aspects of the validity of the Blacky Analogies Test. There are many kinds of validity, as the Committee on Test Standards of the APA has pointed out (1954). The two types relevant for the present study are construct and predictive validity. Although demonstrations of predictive validity may also answer some of the problems of construct validity, these will be discussed separately.

Construct Validity

The construct validity of an instrument refers to the degree to which it actually measures the trait or construct which it purports to measure. This kind of validity is inferred from indirect sources of evidence that support the hypothesis that test performance is related to some specified trait or construct. One method of determining the construct validity of a test is to ascertain the relationships existing between it and other indicators of the construct such as other tests or external criteria. Evidence that the test scores vary from person to person or situation to situation as theory would predict is also relevant.

Difficulties arise in attempting to assess the construct validity of the BAT, for it does not measure a unitary trait. As we

have said, performance on the test is conceived as a resultant of the interaction between degree of anxiety aroused by the pictures, mode of handling this anxiety, and intellectual capacity. Thus, a low score may be the result of inferior intellectual capacity or the result of a great deal of interference from anxiety and defenses. Since there is no existing measure which purports to measure the resultant of this kind of interaction, it is not possible to determine the construct validity of the BAT by relating it to an already validated instrument.

It would be possible, however, to relate the BAT to measures of the various abilities and personality characteristics which are assumed to affect its total score. BAT scores could be related to existing tests of intellectual abilities, conflicts, and defenses, and in this way the constructs which it measures could be determined. This approach would require a large battery of tests to measure both relevant intellectual abilities and relevant personality dimensions. Because subjects' time would be available for only two hours of testing, selection of measures was necessary to gain maximal information. Personality tests, especially projectives, generally take considerable time to administer, so that concentration on these would prohibit studying the intellectual aspects of the test.

It was decided to limit the present study to determining the intellectual factors underlying BAT performance. The intellectual components were chosen for initial investigation in preference to the personality variables because of the greater availability of validated measures of the former whose factor structure is fairly well known. Relating the BAT to a number of factorially pure intellectual measures would provide a general idea of the magnitude of the role played by anxiety-related components. If the intellectual

factors account for all of the variance on the test, it would appear doubtful that anxiety influences test performance.

Another aspect of this study bearing on construct validity of the BAT concerns the internal consistency of the test items. As has been noted, analogies of many different types have been included in the BAT. To determine the extent to which these items may be regarded as tapping a single dimension, the test items themselves were first submitted to a factor analysis.

Predictive Validity

The second part of this study deals with the predictive validity of the BAT. In addition to the practical importance of predicting academic achievement, it is felt that this predictive study may shed some light on the construct validity of the instrument. Evidence that the BAT is a better predictor of academic success than standard intellectual aptitude tests might be regarded as supporting the assumptions about its anxiety-related components.

Procedure

Selection of tests

There were several considerations in choosing tests to include in the battery administered with the BAT: (1) the tests should cover a wide variety of intellectual areas—the greater the number of intellectual abilities tapped the more certain one could be that all the intellectual factors involved in the BAT would be identified; (2) for practical reasons of subjects' availability, the total test battery could not exceed two hours, so in order to gain the maximum amount of information it was necessary to choose tests having relatively short

time limits; and (3) because of the time restrictions and resulting necessity to be quite selective in the choice of tests, it was important to make some a priori decisions about the kinds of abilities likely to be of most relevance to performance on the BAT.

Previous research sheds some light upon the kinds of abilities which are involved. Correlations with verbal tests such as Concepts Mastery suggested that verbal comprehension and some kind of verbal reasoning are important. The BAT differs from the usual analogies test, however, in that pictures instead of words must be chosen to complete the analogy. In one administration of the BAT, subjects were asked to solve the analogies out loud, giving some valuable information about the kind of approach taken in solving them. It was noted that subjects typically tended to attempt to figure out the relationship between the given words, supply their own word to complete the analogy, and then look for the picture which was best described by this word. This suggested that ability to come up with appropriate associations might be an important variable. Two intellectual abilities identified by Taylor (1947), Guilford (Guilford and Christensen, 1956), and others which seemed to fit this hunch were ideational fluency (ability to produce associations in a limited time period) and associational fluency (ability to produce words conforming to specific restrictions).

Inasmuch as the BAT is made up of many different kinds of items which require different approaches to solve them, it was felt that ability to shift set might be an important variable in test performance. Subjects having flexibility in thought process might be less inclined to attempt to apply approaches found to be successful in solving one analogy to subsequent analogies of a different type.

In addition to the intellectual measures it was also felt to be important to include an anxiety test in the battery. If the BAT

is measuring an anxiety factor, it might be related to an anxiety measure. Problems arise in selecting an anxiety test as measures have shown low correlations with one another, suggesting the concept of anxiety itself is probably not unidimensional.

The following tests were selected for inclusion in the battery. They are listed in order of presentation in the administration. For copies of the tests see Appendix A.

1. Blacky Analogies Test.

2. Hidden Figures.[1] In this test the task is to identify one of five basic figures in each of a series of complex geometrical designs. (Parts: 2; items per part: 15; working time: 12 minutes; Score: number correct.)

3. Word Matrix.[1] The subject must discover relationships in rows and columns of a 2 x 3 matrix of words and choose the missing word from five alternatives. (Parts: 1; items per part: 10; working time: 6 minutes; Score: number correct.)

4. Logical Reasoning.[1] In this task the subject must judge whether the conclusion drawn from a set of premises is valid. (Parts: 2; items per part: 15; working time: 10 minutes; Score: number correct.)

5. Associations III.[1] The task is to produce a word similar in meaning to two given words. (Parts: 2; items per part: 15; working time: 12 minutes; Score; number correct.)

6. Camouflaged Words.[1] To solve this task the subject must find within a sentence a group of contiguous letters that spell the

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[1]I am grateful to Dr. P. R. Merrifield of the Psychological Laboratory of the University of Southern California for permission to use these tests.

name of a sport or game. (Parts: 2; items per part: 10; working time: 8 minutes; Score: number correct.)

7. Brick Uses.[1] The subject is to list uses for a common brick. (Parts: 1; items per part: 1; working time: 10 minutes; Score: number of responses.)

8. Things Round.[1] The task is to list things that are round or could be called round. (Parts: 1; items per part: 1; working time: 3 minutes; Score: number of responses.)

9. IPAT Anxiety Scale.[2] (Test booklets are labeled Self Analysis Form.) The subject is asked to check one of three responses to a series of statements according to the degree to which the statements are true of himself. (Parts: 2; items per part: 20; working time: no limit; Score: weighted number of responses checked which indicate anxiety.)

The total time of administration for the whole battery including instructions was two hours.

Other available test scores

Certain other test scores were available for subjects. These were the tests which had been administered by the University to all incoming freshmen. Included in this battery were scores on the American Council on Education Psychological Examination for College Freshmen (ACE) and American Council on Education Cooperative English Test: Test C_2 Reading Comprehension. It was felt that the most information could be gained from the ACE by scoring each

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[1]Permission to use these tests granted by P. R. Merrifield.

[2]A copy is not in Appendix A as it is a published test.

subtest separately. Tests on which scores were available are described below. Copies of these tests are not included in the Appendix as they are readily available. Sample items are given below.

A. American Council on Education Psychological Examination for College Freshmen (1949).

Linguistic portion:

1. Completion. A definition and five letters are presented. The subject is to select the letter corresponding to the first letter of a word that fits the definition. (Parts: 1; items per part: 30; working time: 5 minutes; Score: number correct.)

   Sample item: A contest of speed

   B F M P R

2. Same-Opposite. The task is to select the word which is same or the opposite of the given word. (Parts: 1; items per part: 50; working time: 5 minutes; Score: number correct.)

   Sample item: many (1) ill (2) few (3) down (4) sour

3. Verbal Analogies. In this subtest the testee must select the word correctly completing the analogy. (Parts: 1; items per part: 40; working time: 5 minutes; Score: number correct.)

   Sample item: foot-shoe hand- (1) thumb (2) head (3) glove (4) finger (5) clasp

4. Arithmetic. The subject is to solve arithmetic problems. (Parts: 1; items per part: 20; working time: 10 minutes; Score: number correct.)

Sample item: How many pencils can you buy for 50 cents at the rate of 2 for 5 cents? (a) 10 (b) 20) (c) 25 (d) 100 (3) 125

5. Figure Analogies. The subject must select the figure correctly completing the analogy. (Parts: 1; items per part: 30; working time: 5 minutes; Score: number correct.)

Sample item: 

6. Number Series. Select number which continues series of numbers. (Parts: 1; items per part: 30; working time: 8 minutes; Score: number correct.)

Sample item: 1. 2 4 6 8 10 12 Next number 10 11 12 13 14 (a) (b) (c) (d) (e)

B. American Council on Education Cooperative English Test: Test C2 Reading Comprehension (Davis and Willis, 1943).

Part I: Vocabulary. Select word or phrase most nearly corresponding in meaning to stimulus word. Parts: 1; items per part: 60; working time: 15 minutes; Score: number right minus weighted number wrong).

Sample item: 1. Competitor
a. debtor
b. creditor
c. businessman
d. clerk
e. rival

Part II: Reading. Answer multiple choice questions about short paragraph. (Items per part, 90; working time: 25; Score: number right minus weighted number wrong.) Scores available from the test are: (1) Vocabulary, (2) Speed of Comprehension, and (3) Level (accuracy) of Comprehension.

Many of the tests described in the preceding sections have been included in several factor analytic studies and the factors most important in performance on these tests have been tentatively identified. Table 4 presents the factors on which these tests have been found to load and identifies some of the studies in which these factors have been reported.

The factor structure of the IPAT Anxiety Scale is not shown in the table. Cattell (1957a) has thoroughly described the test in several articles.[1] This particular anxiety test was selected because of its unusually careful construction. It takes only five minutes to administer and is easy to score. The factor structure of the test consists of a second order general anxiety factor. Five source factors representing unitary dimensions have been identified as underlying the second order factor. These are:

1. Self Sentiment Development Q_3. "This factor apparently shows the degree of motivation to integrate the individual's behavior about an approved, conscious, self-sentiment and socially approved standards" (Cattell, 1957b, p. 4).

2. Protension or Paranoid Trend L. Cattell suggests that the loading of this factor on general anxiety may be due to either of two reasons: (1) paranoid tendencies tend to generate anxiety by their effect on the environment, or (2) "the score represents the contribution of social insecurity to anxiety" (Cattell, 1957b, p. 5.

3. Ego Strength C. This factor "represents the well-known concept of ego strength, the capacity immediately to control and express ergic tensions in a suitably realistic way" (Cattell, 1957b, p. 5). It has a negative loading on the anxiety factor.

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[1]For a complete description of the IPAT and a description of validation studies see the test manual (Cattell, 1957b).

TABLE 4

TEST FACTORS IDENTIFIED IN PREVIOUS STUDIES

Test	Factor	References
Hidden Figures	Adaptive Flexibility Structural Redefinition	(Guilford, Frick, Christensen, and Merrifield, 1957)
Word Matrix	Eduction of Conceptual Relations	(Guilford, 1957)
Logical Reasoning	Logical Evaluation	(Guilford, Hertzka, Berger, and Christensen, 1953)
Associations III	Eduction of Conceptual Correlates	(Guilford, Frick, et al., 1957)
	Associational Fluency	(Guilford, Kettner, and Christensen, 1957)
Camouflaged Words	Structural Redefinition Verbal Comprehension	(Guilford, Frick, et al., 1957)
Brick Uses	Ideational Fluency	(Guilford, Frick, et al., 1957; Taylor, 1947; Rogers, 1953; Guilford and Christensen, 1956)
Things Round	Ideational Fluency	(Ibid. (all references for Brick Uses))
ACE: Same-Opposite	Verbal Comprehension	(Guilford, 1957)
Completion	Associational Fluency	(Taylor, 1957; Fruchter, 1948)
Verbal Analogies	Eduction of Conceptual Relations	(Guilford, 1957)

TABLE 4 (Continued)

Test	Factor	References
Figure Analogies	Eduction of Figural Relations	(Guilford, 1957)
Arithmetic	General Reasoning	(Guilford, 1957)
Number	None	—
ACE Reading Comprehension		
Vocabulary	Verbal Comprehension	(Guilford, 1957)
Reading Comprehension (Speed and Accuracy)	Verbal Comprehension	(Guilford, 1957)

4. Guilt Proneness O. The central characteristic of this factor "is a feeling of unworthiness, anxiety, and depression, with proneness to guilt feelings" (Cattell, 1957b, p. 5).

5. Ergic Tension Q_4. This factor "represents the degree to which anxiety is generated by id pressure—by excited drives and unsatisfied needs of all kinds" (Cattell, 1957, p. 5).

Cattell has found slight age and sex differences and provides corrections for these in the test manual. As all subjects in this study were of approximately the same age and the sexes were analyzed separately, raw scores were used throughout.

Criterion variables for predictive study

The main criterion of academic achievement used in this study was grade-point average. There are obvious difficulties with this criterion. Many of these arise from the lack of comparability in difficulties of different fields of study and courses. It remains, however, the most commonly used criterion of academic success because of the lack of any good convenient substitute. In this study the grade-point average was computed by multiplying the course grade (expressed in honor points) by the number of credit hours of the course and dividing the total of these computations by the total number of hours carried.

Two other criteria were also available: (1) High School Percentile Rank (Raw Score) obtained by dividing the subject's standing in his class by the number in the class, and (2) High School Percentile Rank (Percentile Score), the percentile rank of the above score compared with the high school standing of other incoming freshmen. These two criteria, however, are not, strictly speaking, criteria for predictive validity since scores represent past rather than future performance. Validity established with this kind of criterion has been called status rather than predictive validity (APA Committee on Test Standards, 1954).

Administration of Test Battery

Description of subjects

One hundred and eighty-seven female and 114 male freshmen enrolled in the University of Michigan and ranging in age from 17 to 21 years received the test battery. The entire female sample and 72 of the males were drawn from introductory psychology courses and participated to fulfill a course requirement. The remaining 42 male

subjects were volunteers from other freshman classes. Table 5 presents the mean scores and standard deviations of the volunteer versus nonvolunteer male subjects on the tests. As seen from this table volunteers obtain slightly higher mean scores on most tests. Standard deviations do not show these trends.

Subject contact

Subjects from the introductory psychology pool were notified by letter that they had been selected to participate in this experiment. A copy of this letter is in Appendix B. Male subjects who volunteered for the experiment were notified by letter of the time and place of the experiment.

At the end of the experiment all subjects received letters describing the nature of the experiment. The male subjects were also told when they could make individual appointments to receive information on their own test performance.[1] About half of the male sample availed themselves of this opportunity.

Administration procedure

All administrations were in groups varying in size from 9 to 50. Each subject was given a folder containing all the tests and answer sheets in order of presentation. The experimenter acted as examiner for all administrations. In the larger groups an assistant was also present. The examiner introduced herself and the assistant(s) and made a brief introduction describing the purpose of the study and giving the following initial instructions:

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[1] In order to secure male volunteers for this experiment it was necessary to offer individual feedback of scores.

TABLE 5

MEANS AND STANDARD DEVIATION OF TEST SCORES: VOLUNTEERS VERSUS NONVOLUNTEERS

Test	Volunteers[a]		Nonvolunteers[b]	
	Mean	S.D.	Mean	S.D.
1. Quantitative	52.47	8.06	47.52	7.42
2. Linguistic	81.69	14.46	74.45	13.19
3. Vocabulary	30.33	10.30	25.34	10.54
4. Speed	34.06	13.15	25.64	8.71
5. Accuracy	72.94	15.33	68.73	13.04
6. BAT	25.00	5.74	23.41	5.74
7. Hidden Figures	23.36	5.92	22.27	6.08
8. Logical Reasoning	23.33	3.00	21.53	4.24
9. Word Matrix	7.97	1.50	7.31	1.75
10. Things Round	24.19	6.93	23.64	7.87
11. Brick Uses	27.97	9.75	27.20	11.22
12. Camouflaged Words	11.22	4.24	9.48	4.00
13. Associations III	17.81	4.24	15.67	4.12
14. IPAT	32.03	12.41	31.45	11.31
15. GPA	2.80	.75	2.22	.63

[a] N = 42 males.

[b] N = 72 males.

We do not have time this evening for me to go into any detail about the purpose of this study. You will receive a letter before the end of the semester describing it. Briefly, we have designed a test called the Blacky Analogies Test which we hope will be useful in predicting success in college. In this study we are interested in finding out what kinds of abilities are needed to perform well on this test. For this reason, we have included a number of tests measuring different kinds of aptitudes. We are also interested in the relationship between this test and measures of academic success such as grade-point average. Therefore, we will need your name written on the test. However, I wish to assure you that your test scores will be kept entirely confidential. Your instructors will have no access to them. Unfortunately we will not be able to give you your test scores as we will be testing large groups of students and are not equipped to give out individual scores to this large number of people. (Male subjects were told they could receive individual feedback.)

Please do not discuss the tests with anyone outside of this group as it would bias our results if individuals were familiar with the tests before they took them.

Do not open your folders or go ahead to tests until told to do so and stop immediately when told the time is up.

Are there any questions?

The examiner read the instructions for each test out loud while the subjects followed along on their copies of the instructions (see Appendix A). All tests except the IPAT were timed. When subjects had finished this last test they turned in their folders and were free to leave.

Scoring of tests

In all cases, except where otherwise noted, the score was the number of items answered correctly. See Appendix A for keys to the tests. On tests having two parts, each part was scored separately and the part scores added to yield a total score. On the BAT, each item score was recorded in addition to scores on odd and even items and the total test score.

Statistical Analysis

Statistical procedures for this study were carried out on the IBM 650 Magnetic Drum Data Processing Machine of the Statistical Laboratory of the University of Michigan. The specific statistical analyses for the three phases of this study will be discussed separately.

Factor analysis of the BAT

Phi coefficients were computed between all pairs of items on the BAT[1] and entered into a 38 x 38 matrix which provided the input for the factor analysis. The program employed for factor analysis is based on the Thurstone centroid method. Rotation of factors was by the Varimax program which results in an orthogonal solution. Data for each sex were analyzed separately (N = 114 males and 187 females).

Factor analysis of the test battery

In all cases where part scores were available, both scores were entered into the analysis rather than the total score. This was done because the test battery was limited, and it was not possible to include several tests of each factor. Including two parts from a test made it possible for these to form a factor. It was thought this would make the factor structure of the battery more easily identifiable and would provide the opportunity for the BAT to

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[1]Since the program used to compute phi coefficients could take only 38 variables it was necessary to drop two items from this analysis. The two items (1 and 5) which were omitted were seldom failed by subjects and consequently had low variance.

load on these factors. The raw scores were entered into a program and Pearsonian r's were computed. These were entered into a 24 x 24 matrix and provided the input for the factor analysis. The method of factor analysis was the same as described above. Because scores on entrance examinations were not available for some subjects the N for this analysis was reduced (N = 171 females and 100 males).

Prediction analysis

Intercorrelations (Pearsonian r's) were computed between test variables and grade-point average. Part scores and subtest scores were not used for this analysis since they were felt to be less reliable. Scores on Linguistic and Quantitative subtests from the ACE were entered separately. Multiple correlations were computed between variables correlating with grade-point average and not having high correlations with one another. Though selection of variables in this manner tends to maximize chance correlations, a check on the reliability of these correlations was possible as each sample was analyzed separately. Three and four variable multiple correlation formulas were used. The formulas employed derived the multiple correlation coefficient from zero-order coefficients. They are to be found in Handbook of Statistical Nomographs. Tables and Formulas by Dunlap and Kurtz (1932, p. 131).

Correlations of the BAT against High School Percentile Ranks (both scores) and grade-point average were also computed (N = 121 females and 61 males).

CHAPTER IV

RESULTS AND DISCUSSION

In this chapter the results of the study are presented. First, a factor analysis of the BAT items was carried out to determine whether the items themselves fall into separate factors. Next a factor analysis of the test battery including the BAT was performed to discover the intellectual factors involved in the test. The final section is concerned with the instrument's predictive validity for college grades.

Reliability Estimates

Information concerning the reliability of the BAT is necessary in order to evaluate the findings. Split-half reliability estimates were obtained for male and female samples. These reliabilities, corrected by the Spearman-Brown Prophecy Formula, are .77 in both cases (N = 100 males, 171 females).

An estimate of average item reliability was computed using the following formula:

$$r_{ii} = \frac{r_{tt}}{n - (n-1)\, r_{tt}}$$

where r_{tt} is the test reliability (Spearman-Brown) and n equals the number of test items. The average item reliability of the BAT

computed by this formula is .09. Another source of information concerning item reliability is available, however. Communalities obtained from the factor analysis of the test items can be used as an estimate of reliability, on the assumption that a variable cannot have a greater communality than it has reliability. The average communality of items is .21 for the female sample and .27 for the males, suggesting that the .09 reliability previously mentioned is a low estimate.

Factor Analysis of the BAT Items

The item intercorrelations, which provided the input for the factor analysis, are presented in Appendix C. Five factors were extracted for each sample. In view of the low average item reliability a restriction was imposed that each should have at least five items loading .40 or higher to be interpretable. Only one factor in the male sample and none in the female meets this criterion. The complete factor structure for both sexes is given in Appendix C. All nine items in Table 6 necessitate letter transformations of some kind, i.e., addition or subtraction of single letters, prefixes, suffixes, letter reversals, or letter substitutions. This factor seems, therefore, to involve the ability to manipulate structural rather than conceptual aspects of words. It is called Letter Manipulation.

Two of the female factors (I_F and V_F) approached the criterion of interpretability, each with four items loading .40 or higher (see Table 7). These are singled out for attention primarily because of their similarity to I_M. Two items from I_F (20 and 24) and three from V_F (12, 15, and 10) loaded on Factor I_M. The two female factors appear comparable to one another, and it may be that they

TABLE 6

BAT ITEM FACTOR L_M

Item	Factor Loading
24. Train : Lice :: Strain : F	.75
20. Long : Oblong :: Serve : D	.71
12. E : Essex :: Turn : Return	.63
15. C : Secretion :: Exclusion :: Seclusion	.56
23. Spatial : G :: Space : Part	.51
10. Wake : H :: Waker : Quaker	.48
39. Gnat : Loots :: Tang : C	.46
19. Hate : Hat :: Severe : F	.45
27. Parting : Curtail :: Patting : F	.41

TABLE 7

BAT ITEM FACTORS I_F AND V_F

Item	Factor Loading
Factor I_F	
28. Caption : Trivial :: Capon : H	.50
20. Long: Oblong :: Serve :: D	.49
13. Dollar : B :: Drown : Crown	.45
24. Train : Lice :: Strain : F	.42
Factor V_F[a]	
17. Stain : Abstain :: B : Eschew	.57
12. E : Essex :: Turn : Return	.53
15. C : Secretion :: Exclusion : Seclusion	.45
10. Wake : H :: Waker : Quaker	.43

[a]Indicates the factor has been reflected to make high loadings positive.

have been artificially separated by the orthogonal structure imposed on them.

Because of the paucity of clearly identifiable groups of items, the BAT score (number correct) was not broken down into separate factors.

Factor Analysis of the Test Battery

Eight factors were extracted in both samples from the intercorrelation matrices (see Appendix D for matrices and Appendix F for means and standard deviations). It is apparent by inspection that there is a marked degree of similarity between the sexes. The factors are presented below in Tables 8 through 12. Test loadings of .30 or higher are listed, except for the two halves of the BAT which are always included. Lower loadings are included in this analysis because the reliability of the tests is greater than it was for the BAT items.

Factor I: Verbal Comprehension

Table 8 contains the tests and their loadings on a factor identified as Verbal Comprehension. This interpretation stems from the linguistic portions of the ACE (Same-Opposite, Completion, Verbal Analogies) and the Reading Comprehension scores. The factor is similar to one previously given the same name by Guilford (1957).

In general, the loadings are very similar for both sexes. However, Part 2 of Camouflaged Words loads highly only for women. The test may be less of a measure of verbal comprehension for men because of their greater familiarity with names of sports and games.

More important for the purposes of this study are the somewhat different loadings of the BAT for the two samples, Verbal Comprehension being more highly related to performance for men. Since the means and standard deviations for the two samples on this test

TABLE 8

FACTOR I: VERBAL COMPREHENSION

Test	Factor Loadings	
	Male	Female[a]
ACE Reading Comprehension: Vocabulary	.79	.84
ACE Reading Comprehension: Speed	.81	.74
ACE Reading Comprehension: Accuracy	.68	.65
ACE: Same-Opposite	.78	.75
ACE: Completion	.54	.55
ACE: Verbal Analogies	.35	.37
BAT Odd Items	.42	.21
BAT Even Items	.47	.20
Camouflaged Words 2	.02	.45
Associations III, 1	.36	.37

[a]Factor has been reflected to make highest loadings positive.

are not significantly different, this difference could not be due to differences in range of ability. There is no ready explanation for this finding, but speculations concerning it will be discussed later.

Factor II: Preparatory Reasoning

The second factor is presented in Table 9. It does not appear to be a numerical ability factor despite its loadings on Number and Arithmetic from the ACE because of the loadings of Verbal Analogies. Guilford has found arithmetic tests of this type forming a factor he identified as General Reasoning, "the ability to comprehend or structure problems in preparation for solving them" (Guilford, Frick et al., 1957, p. 24). All the tests seem to involve

TABLE 9

FACTOR II: PREPARATORY REASONING

Test	Factor Loadings	
	Male[a]	Female[a]
ACE: Number	.69	.66
ACE: Verbal Analogies	.59	.54
ACE: Figure Analogies	.51	.57
ACE: Arithmetic	.48	.66
Hidden Figures 1	.17	.30
BAT Odd Items	.11	.25
BAT Even Items	.23	.28

[a]Factors have been reflected to make highest loadings positive.

reasoning ability and their similarity may be that each requires an initial structuring before solutions can be arrived at. For this reason the factor is called Preparatory Reasoning. The lower loadings of arithmetic for the men may reflect the fact that arithmetical techniques are more highly practiced by men so that the task is for them more a matter of applying well-learned rules. The BAT has low loadings on this factor in both sexes.

Factor III: Verbal Flexibility

Tests loading on the third factor are reported in Table 10. The tests loading most highly on this factor for the male sample are Camouflaged Words and Associations III. Though factors have been

TABLE 10

FACTOR III: VERBAL FLEXIBILITY

Test	Factor Loadings	
	Male	Female
Camouflaged Words 1	.77	.46
Camouflaged Words 2	.66	.38
Associations III, 1	.39	.20
Associations III, 2	.51	.28
BAT Odd Items	.48	.59
BAT Even Items	.36	.56

identified by Guilford for both these tests, he has not used them in the same study and does not report a common factor for them. In Camouflaged Words, the task involves restructuring of letters already grouped into meaningful words in order to find new words. Guilford has suggested that this involves a flexibility skill which he calls Structural Redefinition (Guilford, Frick et al., 1957). In Associations III, the task is to find a word which has the same meaning as two given words. The stimulus words do not have any meaningful relationship to one another (e.g., recline lie deceive). Guilford hypothesizes that this task involves the ability to educe conceptual correlates, defined as "the ability to produce a response to fit a given or implied conceptual relation" (Guilford and Christensen, 1956, p. 41). It is suggested, however, that this task also involves the ability to produce a number of associations which are synonymous to the stimulus words and to restructure the meanings of the words

thus brought up in order to produce the correct response. To do this requires a facility in manipulating words and a flexibility of thought processes which allows for conceptual restructuring of the words.

This factor is interpreted, therefore, as the ability to restructure words both conceptually and structurally, and for that reason this factor has been labeled Verbal Flexibility. It does not load on Hidden Figures which has been identified as Adaptive Flexibility (Guilford, Frick, et al., 1957) but which requires manipulations of geometric figures rather than words. Guilford (1957) has noted that abilities seem to be relatively specific to the kinds of task involved, i.e., figural, structural, or conceptual. He reports (Guilford, Frick, et al., 1957) a factor loading on Hidden Figures and Camouflaged Words which was not replicated in this study.

Though the same tests appear on this factor for both samples, there is a discrepancy between them in the magnitude of their loadings. It was pointed out earlier that Camouflaged Words loads on verbal comprehension for women but not for men. It may be that for women this test is not as good a measure of structural redefinition as it is for men. The sample employed in Guilford's study (Guilford, Frick, et al., 1957) did not include women. Also, for the male sample, the BAT was seen to involve verbal comprehension ability while it does not load very highly on this factor for the female sample (see Factor I). Thus, the discrepancies in loadings may be a result of the different degree to which verbal comprehension influences performance on these tests.

The loading of the BAT on this factor is quite compatible with this interpretation of the factor. The BAT has items which have similarity to items on both these tests. It requires both

structural and conceptual flexibility and ability to shift easily from each of these approaches.

Flexibility and its opposite pole, rigidity, have been explored a great deal by psychologists. Researchers have measured rigidity in many different areas, e.g., perception, problem-solving, attitudes, and personality. One of the few conclusive findings from this research has been that there is no general trait of rigidity. Relationships between measures even in the same domain have been low. Guilford (Guilford, Frick, et al., 1957), for example, studied flexibility of thinking and isolated several distinct factors within this one area.

It seems necessary, therefore, to attempt to conceptualize more clearly the kind of verbal flexibility presumed tapped by the BAT and to indicate the kinds of rigidity measures to which it might be related.

Flexibility on the BAT seems to involve three different aspects: (1) flexibility in perceiving and manipulating structural characteristics of words, e.g., items requiring the adding and subtracting of letters; (2) flexibility in producing new associations to stimulus words, e.g., items which require thinking of less common meanings of words; (3) ability to change the method of approach to items, e.g., items which appear at first glance to require letter transformation, but which can only be solved by discovering conceptual relationships existing between the stimulus words.

The first aspect seems to be most similar to the ability tapped by the Camouflaged Words test. Guilford has found this test to be related to tests of perceptual flexibility, such as the Street-Gestalt test. The BAT might also be expected, therefore, to show some relationship to this kind of flexibility.

Flexibility in dealing with concepts has not been studied to the same extent as has perceptual flexibility. This aspect might, however, involve ability to produce many diversified associations to a stimulus rather than perseverating on one association. Guilford (Guilford, Frick, et al. 1957) has identified a factor called Spontaneous Flexibility which he feels taps this dimension.

The third type of flexibility involved in the BAT seems most clearly related to ability to shift problem-solving set and might be related to rigidity measures such as the Luchins Water Jar problems.

Some evidence as to the BAT's relationship to various rigidity measures is already available. In the previously cited study by Braunstein, et al. (1957) the BAT was related to the Einstellung Ambiguous Pictures, Muller-Lyer Illusion, and the Flexibility Scale from the California Personality Inventory. The direction of relationship was for greater flexibility to go with higher BAT scores. No relationship was found between the BAT and a concept formation test or the F-Scale. Correlation with the Flexibility Scale from the CPI suggests the possibility that other personality traits might be associated with Verbal Flexibility. For example, individuals who employ repression as a defense to a great degree would be expected to show low spontaneous flexibility since they would have fewer associations available to consciousness.

Factor IV: Eduction of Conceptual Relationships

The factor structure of the two tests loading most highly on Factor IV, presented in Table 11, have been interpreted by Guilford (1957). The dimension underlying the Word Matrix test was identified by him as Eduction of Conceptual Relations which is defined as the ability to discover the conceptual relation implied between

TABLE 11

FACTOR IV: EDUCTION OF CONCEPTUAL RELATIONSHIPS

Test	Factor Loadings	
	Male	Female[a]
Word Matrix	.37	.36
Associations III, 1	.45	.60
Associations III, 2	.39	.58
BAT Odd Items	.23	.24
BAT Even Items	.24	.21

[a]Indicates factor has been reflected to make highest loadings positive.

stimulus words. Associations III appeared on a factor identified as Eduction of Conceptual Correlates, the ability to produce a response to fit a given or implied conceptual relation (Guilford and Christensen, 1956). As ability to comprehend conceptual relationships seems to be the major similarity, this factor is called Eduction of Conceptual Relationships. In both samples, the BAT has a small loading on this factor, suggesting that this ability may be of some importance on the test.

Remaining factors

Table 12 presents the remaining four factors. These are specific factors formed by two parts of the same test. With the exception of IPAT Anxiety (Factor V) the names applied are Guilford's (1957). BAT loadings on each are presented.

TABLE 12

REMAINING FACTORS AND BAT LOADINGS ON THEM

Test	Factor Loading	
	Male	Female
Factor V: IPAT Anxiety		
Cattell IPAT A	.87[a]	.78[a]
Cattell IPAT B	.87	.81
BAT Odd Items	.05	.03
BAT Even Items	.01	.10
Factor VI: Ideational Fluency		
Things Round	.71	.70[a]
Brick Uses	.79	.71
BAT Odd Items	.01	.06
BAT Even Items	.23	.10
Factor VII: Adaptive Flexibility		
Hidden Figures 1	.83[a]	.71[a]
Hidden Figures 2	.78	.66
BAT Odd Items	.19	.11
BAT Even Items	.20	.22
Factor VIII: Logical Evaluation		
Logical Reasoning 1	.74[a]	.69
Logical Reasoning 2	.59	.61
BAT Odd Items	.22	.26
BAT Even Items	.22	.17

[a]Indicates factor has been reflected to make highest loadings positive.

The BAT shows small loadings on Logical Evaluation and Adaptive Flexibility. It will be noted that the hunch that Ideational Fluency might be an important ability for BAT performance was not borne out. It seems that arriving at the correct word to complete the analogies does not depend on ability to associate fluently but more likely on logical deduction.

The BAT does not appear on the factor formed by the IPAT Anxiety Scale. The possibility of a curvilinear relationship existing between the IPAT and the BAT was investigated. Low scorers on the IPAT may be people with anxiety who try to avoid recognizing their anxiety. The mean BAT scores for people in the low, medium, and high range of scores on the IPAT are presented in Table 13. There were no significant differences, and no curvilinear relationship is suggested.

TABLE 13

COMPARISON OF MEAN BAT SCORES FOR SUBJECTS SCORING IN THE LOW, MEDIUM, AND HIGH RANGE OF THE IPAT ANXIETY SCALE

IPAT	Male				Female			
	N	Mean	t	p	N	Mean	t	p
Low	34	24.12			56	22.61		
			1.14	N.S.			.71	N.S.
Medium . .	47	22.60			74	23.31		
			1.38	N.S.			.66	N.S.
High	29	25.12			31	22.65		

Distribution of BAT variance across factors

The total common variance of the BAT accounted for by all factors is represented by its communality (h^2). For the males, h^2 for BAT Odd and Even is .56 and .61 respectively; for the females, .60 and .58. The total amount of reliable variance of each part of the test is estimated by the correlation between the two parts (Odd and Even), .63 in the male sample and .62 in the female sample. Since the proportion of specific variance of a test is equal to the reliability minus the communality, it is clear that the reliable variance of the BAT is almost entirely accounted for by these factors.

Table 14 reports the per cent of common factor variance of the BAT on each factor.

TABLE 14

PER CENT OF BAT COMMON FACTOR VARIANCE ON FACTORS

Factor	Per Cent of Variance			
	BAT: Male		BAT: Female	
	Odd Items	Even Items	Odd Items	Even Items
I. Verbal Comprehension	.32	.36	.07	.07
II. Preparatory Reasoning	.02	.09	.10	.14
III. Verbal Flexibility	.41	.21	.58	.54
IV. Eduction of Conceptual Relationships	.09	.09	.10	.08
V. IPAT Anxiety	.00	.00	.00	.02
VI. Ideational Fluency	.00	.09	.01	.02
VII. Adaptive Flexibility	.06	.07	.02	.08
VIII. Logical Evaluation	.09	.08	.11	.05

The factors accounting for about half of the common factor variance of the BAT for the males are Verbal Comprehension and Verbal Flexibility. For the female sample slightly more than half of the common factor variance appears on Verbal Flexibility. All the common factor variance of the BAT can be accounted for by intellectual factors. Though the possibility remains that the intellectual tasks included in the battery are themselves affected by anxiety, the evidence does not support the hypothesis that the BAT is appreciably influenced by it.

Either anxiety was not aroused by the Blacky pictures or it was aroused but had no effect on performance. There is no way to decide from the data which of these interpretations is correct. Results of previous studies using Blacky pictures (Blum, 1954; Berger, 1957) have indicated that anxiety can be aroused by these pictures, but the techniques they employed were different from those used in the present BAT instructions. It is possible that different administration procedures might be devised to maximize the effect of the pictures on subjects. Greater structuring of the pictures, as was done by Blum (1954) to arouse perceptual defense, might have increased the likelihood of anxiety arousal. In the present study introductory statements to the subjects stressed the intellectual aspects of the test and may have created a set which made it easier to isolate the affective elements of the pictures. College students, particularly, may be very well practiced in this type of defense in achievement-oriented situations.

Similarity of BAT factor structure in male and female samples

Though there was a high degree of similarity between factors found for the male and female samples, some discrepancies were

noted. In the male sample somewhat more than half the common factor variance of the BAT was divided between two factors, Verbal Comprehension and Verbal Flexibility. On the other hand, in the female sample about half of the common factor variance of the BAT was accounted for by Verbal Flexibility and very little of its variance appeared on Verbal Comprehension. Since the difference in factor structure cannot be explained by differences in range of talent of the two samples, a genuine sex difference is indicated. It may be that in females these factors are correlated and the orthogonal structure which was imposed on them violated their real structure. If an oblique solution had been used, the BAT might have shown some greater loading on Verbal Comprehension for women.

Predictive Studies of the BAT

Grade-point average at the end of the first year of college was used as the criterion for predictive validity. There are two sets of data which were related to this criterion; indicators of high school performance and scores from the test battery. Measures of high school performance were not available for many of the subjects and, for this reason, relationships to grade-point average were analyzed separately. BAT scores, however, were intercorrelated with both sets of data.

Prediction of grade-point average by high school performance and BAT

Table 15 reports the correlations between high school percentile rank—raw score (HSPR-RS), high school percentile rank—percentile rank (HSPR-PR), BAT and grade-point average (GPA). Correlations are shown separately for males and females. In order

TABLE 15

INTERCORRELATIONS (R) AND MULTIPLE R'S BETWEEN HIGH SCHOOL PERFORMANCE, BAT, AND GPA[a]

Variable	HSPR(PR)	BAT	GPA
HSPR(RS) (Male)	.93**	.38**	.47**
(Female)	.95**	.17	.18
HSPR(PR) (Male)		.39**	.55**
(Female)		.17	.20*
BAT (Male)			.45**
(Female)			.34**

Multiple R's

Variable	Sample	R
HSPR(PR) + BAT	Male	.69
HSPR(PR) + BAT	Female	.39

*p < .05 (one-tailed test).
**p < .01 (one-tailed test).
[a]N = 121 females and 61 males.

to determine the amount of variance in GPA that could be accounted for using both the BAT and HSPR, multiple correlations were computed. Since the two variables of high school standing are so highly correlated, only HSPR (PR) was included in the multiple correlation. These multiple correlations are also presented in Table 15.

While all correlations are positive, the ones for the females are generally lower than for the males. Both the BAT and the two measures of high school standing show lower positive relationships

with grade-point average for the female group. It will also be noted from Table 15 that the BAT correlation with high school performance is lower for women. The BAT, however, is the best single predictor of GPA for the females, while in the male sample, HSPR (PR) is the best.

Combining HSPR (PR) and BAT considerably increases the prediction of GPA for men. The multiple correlation for women is only slightly better than can be achieved using the BAT alone.

Prediction of GPA by test variables and the BAT

Table 16 presents the test variables which have the highest relationship with grades. The complete correlation matrix for this analysis is in Appendix E.

TABLE 16

INTERCORRELATIONS BETWEEN SELECTED TEST VARIABLES AND GPA[a]

Test	Correlation with GPA	
	Male	Female
ACE Psychological Examination: Q	.44	.23
ACE Psychological Examination: L	.49	.40
ACE Reading Comprehension: Vocabulary .	.55	.45
ACE Reading Comprehension: Accuracy . .	.47	.47
ACE Reading Comprehension: Speed	.58	.39
BAT	.45	.33

[a]N = 171 females, 100 males.

As with the previous analysis, generally higher correlations with GPA were obtained for the male sample than for the female sample. The greatest difference is found in the relationship between the Quantitative scores on the ACE and the criterion. The lower correlation for females probably reflects the tendency for this group to take fewer courses in which quantitative ability is important. The BAT correlation with GPA falls roughly in the same range as most of the ACE Psychological Examination and Reading Comprehension subtests.

Multiple correlations between GPA and combinations of two or three of these test variables were computed to see which combination of tests leads to the best prediction of GPA. Though selection of test scores in this manner tends to maximize the contribution of chance correlations, some evidence for reliability of these prediction formulas is obtainable from comparison of the two samples.

The results of those computations are presented in Table 17. Though Reading Comprehension: Speed was one of the better predictors for men, it was not included in these prediction formulas because of its high correlation with the other scores from this test and because it was not equally as good a predictor in the female sample.

The results presented in Table 17 do not reveal any notable differences in predictive ability of the combination of tests. Multiple correlations obtained from Quantitative and Linguistic subtests, however, are slightly lower than others. Combinations of predictors including the BAT are as good as those employing Quantitative, Linguistic and Reading Comprehension tests.

TABLE 17

MULTIPLE R'S BETWEEN COMBINATIONS OF TEST VARIABLES AND GPA

Test Variables	Multiple R	
	Male	Female
Two Predictors Combined		
Quantitative + Linguistic	.52	.40
Vocabulary + Accuracy	.60	.51
Accuracy + Quantitative	.59	.49
Accuracy + BAT	.56	.50
Three Predictors Combined		
Quantitative + Linguistic + BAT	.57	.43
Vocabulary + Accuracy + BAT	.60	.52
Accuracy + Quantitative + BAT	.61	.52
Vocabulary + Quantitative + Accuracy	.65	.52

Value of the BAT in predicting academic achievement

In summary, the predictive aspect of the study showed that the BAT predicts GPA for females better than does high school standing. For the males, high school standing is more highly related to GPA than was the BAT, but including the BAT in a multiple correlation with high school standing increased the prediction from .55 to .69. For women, there is less relationship than for men between the BAT and high school performance. This is also

true for the relationship between ability as measured by both the BAT and other intellectual measures and college performance. It is possible that this finding reflects differences in the relative importance of abilities and motivation in the academic performance of men and women. Since men are more likely to view college as a means of preparing themselves for a career than women, there may be less variance in their motivation to succeed academically. Consequently, motivational factors might account for a larger proportion of the variance and ability factors, a smaller proportion of the variance in the academic performance of women than men.

The BAT was found to predict GPA about as well as the ACE Psychological Examination and the ACE Reading Comprehension, tests widely used as selection devices. Though it did not make a unique contribution to prediction formulas, its contribution was as great as these tests.

The BAT has some advantages over these tests in ease of administration. It does not require timing or scoring of separate subtests and scoring is easier because of the fewer number of items. When combined with HSPR its prediction of men's grades is as good or better than the prediction achieved by any combination of ACE tests. Use of high school standing and the BAT would be a convenient technique for prediction because of the limited period of subject testing time involved.

One point to be kept in mind in comparing the relative predictive value of the BAT and Reading Comprehension and ACE tests is that these tests were taken under different conditions. Students took the latter tests as part of their entrance requirement to college and knew that their performance on these tests would be available to their advisers. In administration of the BAT, however, subjects were told that their test results would be kept confidential

and were assured they would not be available to their instructors. The relationship between BAT performance and academic achievement might have improved if subjects had been more highly motivated to succeed on the BAT task.

Suggestions for Future Research

1. An oblique rotation should be applied to the centroid factor matrix obtained from the test battery to determine whether the differences in factor structure of the BAT for the two sexes might be clarified. It was suggested earlier in this paper that the factors of Verbal Comprehension and Verbal Flexibility might be correlated for the female sample. An oblique solution might result in a factor structure with even greater similarity between men and women than was obtained in this study.

2. Modification of the administration procedure of the BAT might increase the likelihood of the Blacky pictures arousing anxiety. Certain techniques successfully employed by Blum in other studies (1954, 1959) might be used. One of his approaches was to give additional structure to the pictures by elaboration of the description of the picture to make its conflictual aspects more obvious, while another approach was to have the subject relate his own personal experiences associated to the pictures. These techniques could be incorporated into the BAT instructions.

3. Anxiety may not have had an effect on the BAT because subjects were able to defend against it successfully. It would be interesting to study more extensively the relationship between characteristic mode of defense and BAT performance. A trend was found in a previous study (Goldsmith, et al., 1956) for intellectualization

to be associated with higher BAT scores and avoidance to be associated with lower BAT scores.

4. Another area for investigation is the relationship of Verbal Flexibility to other measures of rigidity and to personality traits.

5. The relationship of the BAT to other types of performance than GPA should be investigated. Of particular interest would be those fields in which verbal flexibility would be an important asset, such as creative writing.

The BAT could be administered to successful and unsuccessful people in various fields (e.g., journalism) to see if test performance differentiates the two groups.

CHAPTER V

SUMMARY

The purpose of this study was to determine some aspects of the construct and predictive validity of the Blacky Analogies Test (BAT). This is an analogies test which uses Blacky pictures instead of words as solutions. It was hypothesized that these pictures would arouse anxiety which would tend to affect test performance. The latter is conceived as the resultant of interaction between intellectual ability, anxiety, and defense.

To determine the construct validity of the BAT, a battery of tests including the BAT, intellectual measures, and an anxiety measure was administered to 187 female and 114 male freshmen at the University of Michigan. Factor analyses of the BAT items and of the test battery were carried out. BAT scores were also related to measures of high school performance and to grade-point average at the end of the freshman year.

The results of the investigation were as follows:

1. Factor analysis of the BAT items for the male sample revealed only one clear factor, identified as Letter Manipulation. This factor was not fully replicated in the female sample, so there was no basis for scoring items on the test separately.

2. Eight orthogonal factors were extracted from the test battery intercorrelations. Four of these factors had several different tests loading on them and were interpreted as Verbal

Comprehension, Preparatory Reasoning, Verbal Flexibility, and Eduction of Conceptual Relationships. The remaining four factors were formed primarily by two parts of the same test. The latter were identified as Ideational Fluency, IPAT Anxiety, Adaptive Flexibility, and Logical Evaluation.

3. The BAT loaded most highly on Verbal Comprehension and Verbal Flexibility for the male sample and on Verbal Flexibility for the female sample. Lesser loadings on other intellectual factors were also noted.

4. It was found that the entire common variance of the BAT was nearly equal to its reliable variance. As the common variance could be accounted for solely by intellectual factors, it was concluded that there was no evidence to support the hypothesis that anxiety appreciably affects performance on the BAT.

5. The correlation between BAT and GPA was .45 (N = 100) and .34 (N = 171) for the male and female samples respectively.

6. The BAT was found to be a better predictor of grade-point average than high school percentile rank for the female sample, and to improve the prediction of grade-point average of men when included in a multiple correlation with high school percentile rank.

7. Prediction of grades from the BAT fell roughly in the same range as predictions from subtests of the American Council on Education Psychological Examination and the American Council on Education Cooperative English Test, C_2: Reading Comprehension. Multiple correlations show the BAT and these other tests to be approximately interchangeable in their predictive efficiency.

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APPENDIX A

TESTS AND KEYS

Instructions for Blacky Analogies Test (Form F)

This is a special kind of analogies test. You may have taken analogies tests before, since such items are used in a number of devices to measure intelligence. Each item contains four elements, three of which are given and a blank which has to be filled in by choosing the correct one of several alternatives.

For example, "Black : White :: Night : _____." You have to figure out what is the relationship presented in the analogy and then select the right answer for the blank. For this illustration the correct answer of course is "Day."

In this particular analogies test, there are also three elements given and one missing. The correct answer, however, is to be chosen from among four selected pictures of a dog named Blacky. These pictures, showing Blacky in a variety of situations, are lettered from A through H. Only four of the eight pictures are presented for each item. Of these four, there is one and only one correct answer.

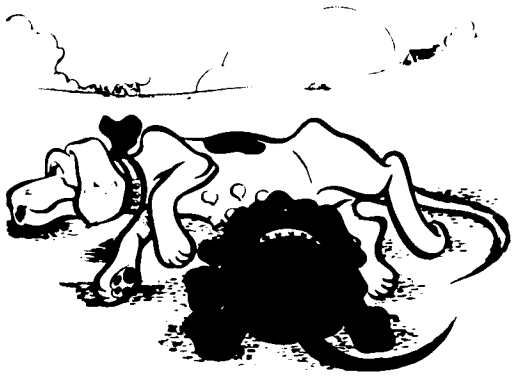
Your task is to decide which of the four pictures is the correct answer and then draw a line through the letter corresponding to that picture on your answer sheet. The letters for each item are to be found on the right hand side of the test sheet. There are 40 items and you will be allowed exactly 25 minutes. The best plan is first to go through the whole test solving whichever items you can do readily, then return and try the ones you skipped originally. If you still have trouble, make a guess anyway. Remember that there is always one and only one correct answer for each analogy.

Before you begin, a few comments about the Blacky Pictures themselves should be made. These pictures are taken from a projective test designed to measure personality disturbance in a variety of important areas. In the course of growing up all individuals are presumed to undergo crucial experiences corresponding to Blacky's, and everyone retains to some extent remnants of these early conflicts in his adult personality. This analogies test, however, does not seek to measure personality disturbance but rather problem-solving ability in dealing with materials which generally have emotional meaning.

In order to perform well on the analogies items, it is first necessary to study the pictures carefully so that you have each one clearly in mind. Now you will have 20 seconds to look at each picture intently before beginning the test. First study Picture A until the signal is given to look at B.

A shows Blacky nursing from Mama
B shows Blacky chewing and shaking Mama's collar
C shows Blacky having a bowel movement
D shows Blacky watching Mama and Papa making love
E shows Blacky discovering sex
F shows Blacky watching Tippy and the falling knife
G shows Blacky watching Mama and Papa pet Tippy
H shows Blacky plagued by conscience

All right, now start with item no. 1 and continue as rapidly as possible until you are told to stop. Remember to draw a line through the letter of the correct answer. When you have finished, check to see that you have answered all the items. You will have exactly 25 minutes to complete the test.

A 



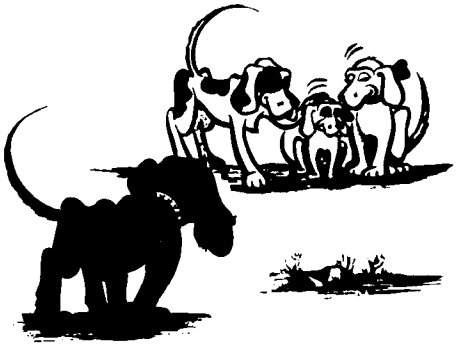
B

C 


D

E 


F

G 


H

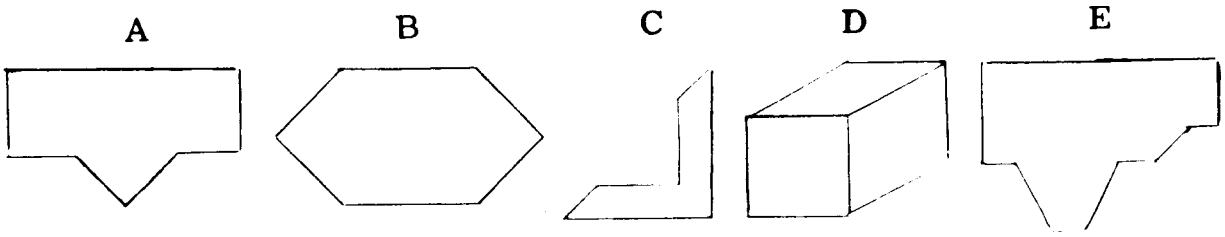
Blacky Analogies Test (Form F)

1.	Rusty : Oil :: Parched : _____	A B C E
2.	Innocent : Inferno :: _____ : Paradise	A B F H
3.	Chew : Hew :: _____ : Hop	A B F H
4.	Yellow : Cowardice :: Green : _____	B F G H
5.	Buoy : Buy :: Envoy : _____	E F G H
6.	Sea : C :: Bee : _____	A B C D
7.	Wood : Smoke :: Food : _____	B C F H
8.	Turk : _____ :: Time : Lime	A B D F
9.	Division : Addition :: Unification : _____	C E F H
10.	Wake : _____ :: Waker : Quaker	A D G H
11.	An eye for an eye : Forbearance :: Turn the other cheek : _____	A B E G
12.	_____ : Essex :: Turn : Return	B C E H
13.	Dollar : _____ :: Drown : Crown	B C F H
14.	_____ : Strange :: Erotic : Exotic	B C E F
15.	_____ : Secretion :: Exclusion : Seclusion	C D E G
16.	Performer : Transgressor :: Applause : _____	A C D H
17.	Stain : Abstain :: _____ : Eschew	B D G H
18.	Knee : Flea :: _____ : Flourish	A B E H
19.	Hate : Hat :: Severe : _____	B D F G
20.	Long : Oblong :: Serve : _____	A B C D
21.	Gnaw : Nick :: Bite : _____	A B D F
22.	Sickness : _____ :: Pathologist : Juror	A E F H
23.	Spatial : _____ :: Space : Part	B C G H
24.	Train : Lice :: Strain : _____	B E F H
25.	Soil : Plant :: _____ : Blacky	A B C E
26.	Beward : Behold :: Be Wary : _____	B C D E

27.	Parting : Curtail :: Patting : _____	C **F** G H
28.	Caption : Trivial :: Capon : _____	A C F **H**
29.	Spine : Less :: _____ : Sop	**A** B D H
30.	Homicide : Suicide :: Romance : _____	B D **E** F
31.	Fawning : Submissive :: _____ : Self-Assertive	A **B** G H
32.	Point : Sharp :: _____ : Keen	B E G **H**
33.	Milk : Shake :: Exploit : _____	A **B** C D
34.	Choose : Guilt :: _____ : Gilt	A **B** E H
35.	Knitting Typing :: Kissing : _____	**A** C D F
36.	Wind : Watch :: Turn Repeatedly : _____	A C **D** H
37.	Relief : Relieve :: Charity : _____	**C** F G H
38.	Beef : Pork :: Steak : _____	A B **F** H
39.	Gnat : Loots :: Tang : _____	A **C** E H
40.	Refuse : _____ :: Reject : Spurn	A **C** E F

Hidden Figures—CAX12A[1]

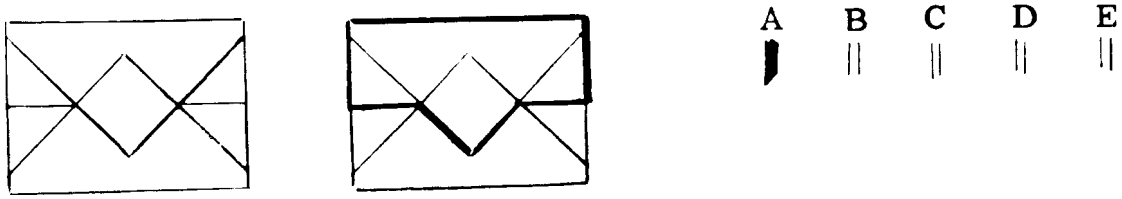
In this test you will be given a series of figures. In each figure there is concealed a Basic Figure, masked by additional lines. The five Basic Figures are shown here, marked A, B, C, D, and E.



In every case, the Basic Figure will be of the same size and in the same position, within the masking figure, as it is shown above.

Your task is to identify the Basic Figure appearing in each masked figure, and to mark under the corresponding letter for each item on the answer sheet.

Look at this example:



The Basic Figure in this case is A, and this letter has been marked at the right as on an answer sheet. Basic Figure A has also been heavily outlined so that it may easily be seen.

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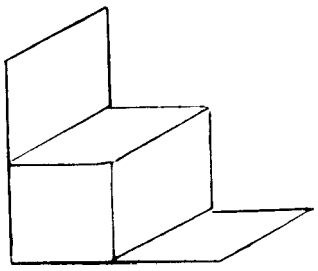
[1]This test was prepared under U.S. Government Contract N6onr-23810.

Here is a sample item for you to try:



A B C D E

Here the Basic Figure D (the box) is shown. You would mark under letter D on your answer sheet.

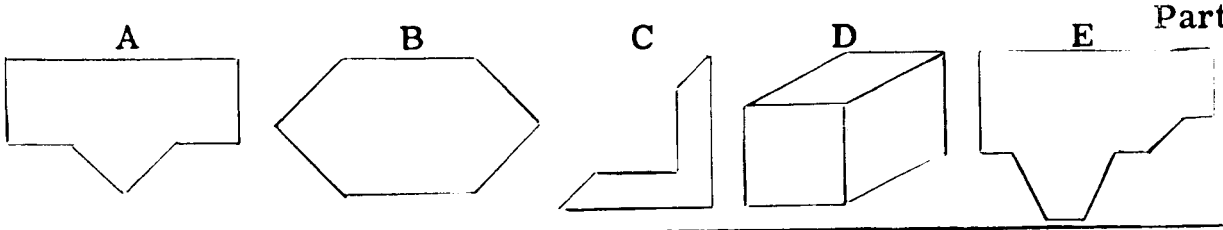
The five Basic Figures are repeated at the top of each page of test items so that you may keep them always in sight. Each test item will have one and one only, of these Figures concealed in it.

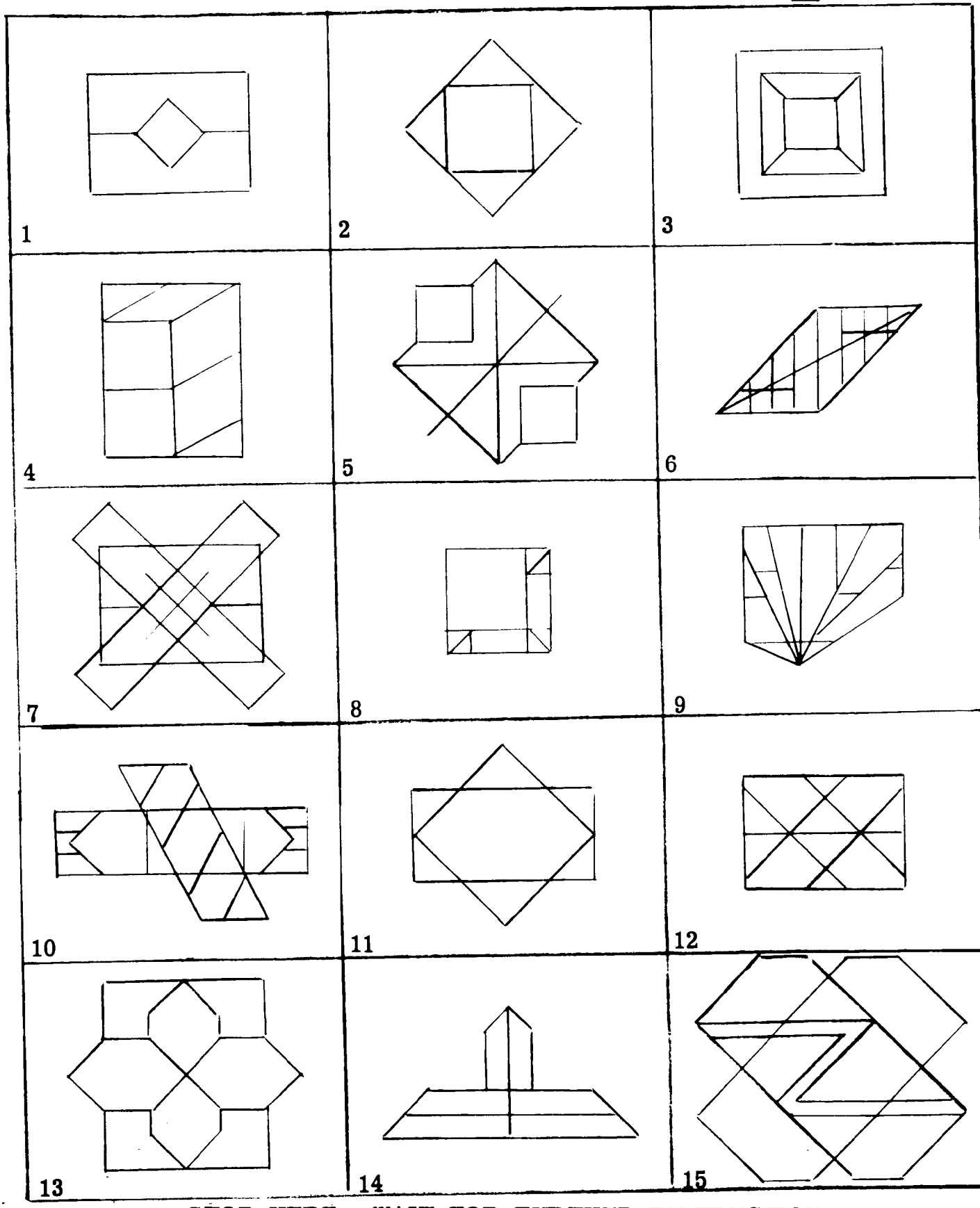
This test consists of two parts. You will have 6 minutes for each part.

Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS

Part I





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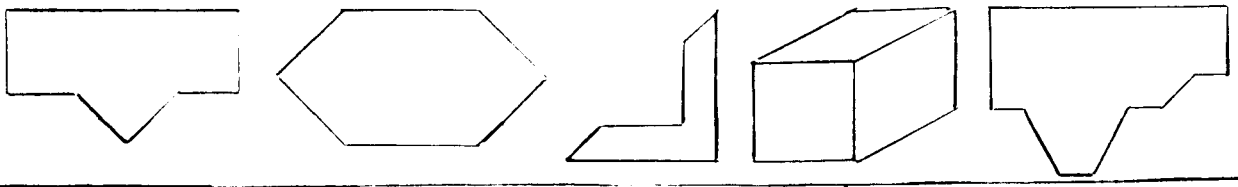
A B C D E



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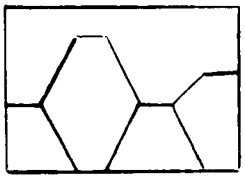

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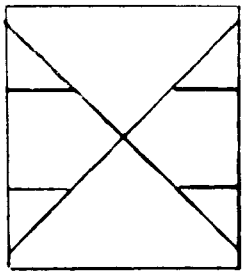

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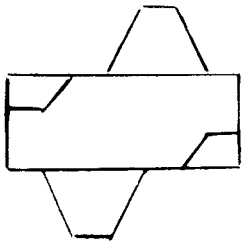

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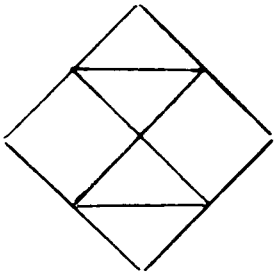

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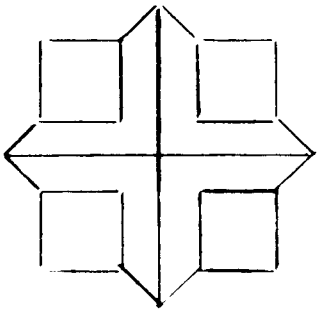

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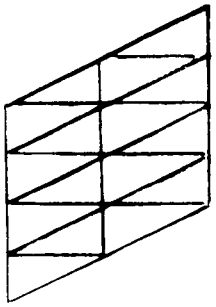

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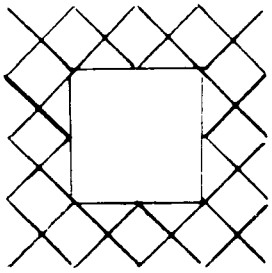

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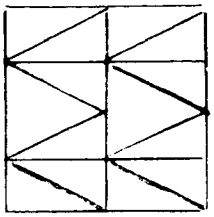

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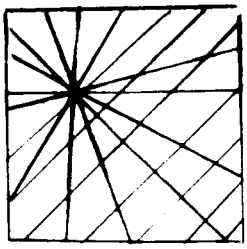

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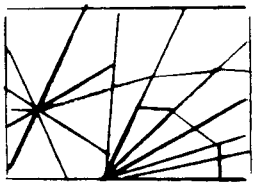

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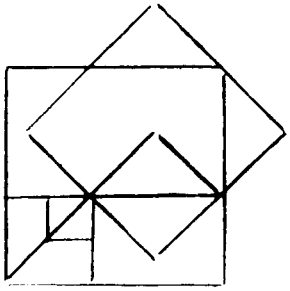

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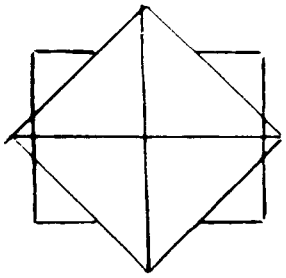

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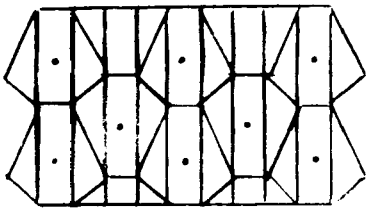

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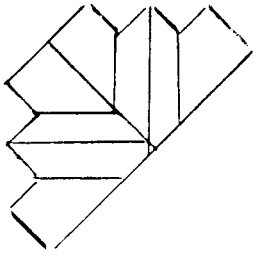

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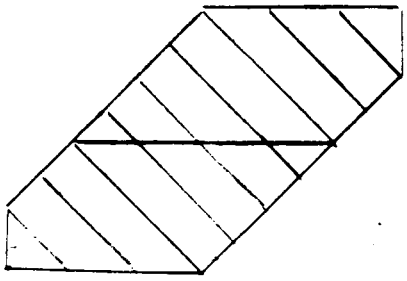

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS

Word Matrix Test

Directions:

A matrix of words will be presented in each item. A matrix is a table composed of columns and rows. Look at the following sample item:

ground	street	automobile
air	route	_____

A. airplane
B. bird
C. kite
D. balloon
E. cloud

Three words forming a sequence are given in the first row, and two words are given in the second row with a blank space. Your task is to examine the matrix to see how the words are related. Then decide what word logically belongs in the blank space and find it among the alternate answers given below the item. The answer to the sample problem is "A" since an airplane completes the second sequence as an automobile completes the first one. In some items, the second word of a sequence will be omitted. In some the blank will be in place of the second word instead of the third. Blacken the space on the answer sheet corresponding to the letter of the word that completes each item.

You will have six minutes working time for this test.

Word Matrix Test

31. color paint brush
song sing _____

A. music
B. voice
C. sweep
D. dance
E. tune

32. stockings shoes galoshes
yolk _____ shell

A. wagon
B. eat
C. hen
D. white
E. egg

33. apple food
terrier dog _____

A. dish
B. horse
C. bone
D. animal
E. Bozo

34. ballet dance theater
automobile _____

A. travel
B. motor
C. street
D. drive
E. Oldsmobile

35. youth beauty life
age _____ death

A. ugliness
B. wisdom
C. disease
D. fear
E faith

36. red yellow
ice water _____

A. ocean
B. canary
C. rain
D. lemonade
E. vapor

37. well water drink
mine coal _____

A. warm
B. shovel
C. heat
D. fuel
E. burn

38. ankle heel toe
shin ankle _____

A. knee
B. heel
C. toenail
D. toe
E. foot

39. hour minute second
week _____

A. Sunday
B. month
C. hour
D. minute
E. year

40. rain flood disaster
tension strife _____

A. war
B. riot
C. injury
D. fear
E. mob

Logical Reasoning[1]—RLR05A

This is a test of your ability to tell the difference between good and bad reasoning. You must judge only the reasoning in the following arguments, because some of the statements are obviously false or ridiculous on the basis of your past experience. If the preliminary statements were true, however, would the conclusion be true or false.

The first argument below is good reasoning and is marked T. The second argument appears similar but is bad reasoning and is marked F.

All bombers are airplanes. All airplanes are heavier than air. Therefore all bombers are heavier than air.

T F

All bombers are heavier than air. All airplanes are heavier than air. Therefore all bombers are airplanes.

T F

The second argument might appear reasonable when it is first read, but consider the same argument put in different words. Examine its relationship with the following words:

~~bombers~~ ~~heavier than air~~ ~~airplanes~~ ~~heavier~~

All sweets are good for you. All apples are good for you. Therefore all sweets are apples.

~~than air~~ ~~bombers~~ ~~airplanes~~

It becomes obvious that the conclusion is false. The fact that both sweets and apples are good for you does not make them the same thing.

---

[1]Patterned after Thurstone's test False Premises.

Notice that the first argument below is bad reasoning, while the second is good reasoning.

Some coins are gold, and all gold is valuable; therefore all coins are valuable.

T F

The first argument starts with the word some which means at least one, and may mean all. It is apparent from the meaning of some, that only those coins which are gold are valuable. There could be other coins which are not gold. If the argument is stated as follows, it is true.

All coins are gold, and all gold is valuable; therefore all coins are valuable.

T F

Mark your answers in the blanks opposite the items on the answer sheet. Mark the T if the reasoning is good and the F if the reasoning is bad.

There are two parts to this test. You will have five minutes working time for each part.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS

Mark the T if the reasoning is good and the F if the reasoning is bad.

41. All mice are rodents, and all rodents have long hairless tails; therefore all mice have long hairless tails.

42. All onions are vegetables; all vegetables are good for you; and all things that are good for you should be eaten; therefore all onions should be eaten.

43. Hackensack has a smaller population than Linden, and Linden has a larger population than Ferndale; therefore Ferndale has a larger population than Hackensack.

44. No sensible men hate women. Some school teachers are sensible men. Therefore some school teachers do not hate women.

45. Some flags a hundred years ago were made of silk. Then, perhaps this flag is made of silk, for it is a hundred years old.

46. If today is Washington's birthday, the banks will be closed. Today is not Washington's birthday; therefore the banks will not be closed.

47. Most farmers live on farms; and most farm hands are farmers; therefore some farm hands must live on farms if there are more farm hands than farmers.

48. All attack planes can function as bombers. Some pursuit planes can function as bombers. Therefore some pursuit planes are attack planes.

49. Since all highways are streets, the straightest highway must be the straightest street.

50. Most old ladies are grandmothers, and most old ladies enjoy knitting; therefore some grandmothers enjoy knitting.

51. Algebra books are not romantic at all, and motion pictures cannot be algebra books; therefore motion pictures are more romantic than algebra books.

52. If television sets were cheaper than radios, I would be a manufacturer; but I am not a manufacturer; therefore television sets are not cheaper than radios.

53. All soldiers below the rank of second lieutenant wear G.I. shoes. This soldier does not wear G.I. shoes; therefore he is not below the rank of second lieutenant.

54. If he has no respect for others, he will not have respect for himself; he has no respect for himself; therefore he has no respect for others.

55. If this country were a communist state, we would live on food; we do live on food; therefore this country is a communist state.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

56. Kings are always the leaders of their country. All dictators are the leaders of their country; therefore some dictators are kings.

57. If fish swim because they have fins, and alligators have no fins, then alligators cannot swim.

58. All automobiles have wheels, and some automobiles are sedans; therefore some sedans have wheels.

59. Since all supervisors are men, the most skilled supervisors must be the most skilled men.

60. Airplanes are not simple at all, and armored trucks cannot be airplanes; therefore armored trucks are more simple than airplanes.

61. All things that hang from the pegs in stockrooms are tools; therefore a saw in a stockroom is a tool.

62. All executives have ability. He has ability; therefore he is an executive.

63. All things that fly are airplanes; therefore a streetcar that flies is an airplane.

64. All welders use torches. He is using a torch; therefore he is a welder.

65. No prime ministers are kings. Only prime ministers are statesmen; therefore no statesmen are kings.

66. All street lamps have bulbs; some street lamps are telephone poles; therefore some telephone poles have bulbs.

67. Some deep thinkers are madmen; but human beings alone are deep thinkers; madmen, therefore, are not always human beings.

68. Some old people are music lovers; and most music lovers are students of harmony; and all students of harmony are good listeners; therefore some good listeners are old people.

69. All bugs are insects; all insects are able to jump; all frogs are able to jump; all frogs are slimy; therefore all bugs are slimy.

70. All pilots are airmen, and all airmen are able to fly. Some females are pilots, and only girls are females. Therefore some girls must be able to fly.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

Answer Sheet

Mark an (X) through the correct answer on the answer sheet.

Hidden Figures

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. A B C D E
16. A B C D E
17. A B C D E
18. A B C D E
19. A B C D E
20. A B C D E
21. A B C D E
22. A B C D E
23. A B C D E
24. A B C D E
25. A B C D E
26. A B C D E
27. A B C D E
28. A B C D E
29. A B C D E
30. A B C D E

Word Matrix

31. A B C D E
32. A B C D E
33. A B C D E
34. A B C D E
35. A B C D E
36. A B C D E
37. A B C D E
38. A B C D E
39. A B C D E
40. A B C D E

Logical Reasoning

41. T F
42. T F
43. T F
44. T F
45. T F
46. T F
47. T F
48. T F
49. T F
50. T F
51. T F
52. T F
53. T F
54. T F
55. T F
56. T F
57. T F
58. T F
59. T F
60. T F
61. T F
62. T F
63. T F
64. T F
65. T F
66. T F
67. T F
68. T F
69. T F
70. T F

Associations III—CN05A[1]

Name (Print) _____ Testing Number _____

Group _____ Date _____

The items in this test consist of pairs of words. Your task is to think of a single word that has a meaning similar to each of the given words of the pair.

Look at the following example.

nonsense ____bunk____ bed

The correct answer is "bunk" since one of its meanings is nonsense and another meaning is bed; therefore, the word "bunk" is written in the space between the two given words.

Try the next example.

recline _____ deceive

The correct answer is "lie" since it has a meaning similar to both given words.

The remaining items in the test should be answered in the same manner. Work rapidly, but be sure that you answer each item with a word that has a meaning similar to both given words.

This test consists of two parts, each containing 15 items. You will have 6 minutes working time for each part. Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS

---

[1]Test prepared under U.S. Govt. Contract N6onr-23810.

Part I

1.	blaze	fire	discharge
2.	remainder	rest	inactivity
3.	hit	pop, smash, punch	fruit drink
4.	autumn	fall	drop
5.	desire	long	lengthy
6.	tiresome	bore	drilling
7.	leap	spring	fountain
8.	curve	bow	fiddlestick
9.	solid	firm	company
10.	foundation	base	dishonorable
11.	tasteless	flat	apartment
12.	socks	hose	tube
13.	crooked	bent	inclination
14.	handle	crank	eccentric
15.	trade	craft	ship

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

Part II

16.	skin	hide, cover	conceal
17.	petticoat	slip	error
18.	healthy	sound	noise
19.	rhythm	beat	defeat
20.	sphere	ball	dance
21.	billboard	sign	omen
22.	skinny	lean	incline
23.	pair	couple	join
24.	speedy	fast	secure
25.	gift	present	here
26.	raise	rear	back
27.	average	intend	mean
28.	land	ground	pulverized
29.	limit	bound	tied
30.	proverb	saw	observed

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

Camouflaged Words—CAX04A[1]

Name (print) _____ Testing Number _____

Group _____ Date _____

In this test you will be given a series of sentences. Concealed in each sentence is the name of a sport or game. The letters of the name of the sport or game appear in their correct order, without intervening letters. They may appear within a longer word, or they may appear as the end of one word and the beginning of another. You are to find the name of the sport or game and make a circle around the letters forming it.

Look at this example:

COWARDICE IS NOT A SOLDIERLY ATTRIBUTE.

In this case the name of the game is DICE, which appears as part of the longer word COWARDICE, and has been correctly marked.

Now try this example:

TO HELP BEAT THE HUN, TIN GOES A LONG WAY.

In this case the name of the sport is HUNTING, made up of the word HUN, the word TIN, and the first letter of GOES. Draw a circle around these letters in the sentence.

Remember, it is the sequence of the letters that makes up the name of the sport or game; punctuation marks are to be ignored.

This test consists of two parts, each containing 10 items. You will have 4 minutes for each part.

Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS

---

[1]This test prepared under U.S. Govt. Contract N6onr-23810.

Part I

1. One could tell he was a Mongol from his costume.

2. "I'm keeping the job I've got, racket or not," said the gangster.

3. She was as graceful as a nymph, and ballet dancing came to her naturally.

4. The Kentucky Colonel found some bad mint on the top of his mint julep.

5. He's not much good, but pitches shut-out games occasionally.

6. We traced the shipment, and found the missing box in Gulfport, La.

7. For a Christmas present, he handed me an "El Ropo," lousiest cigar on the market.

8. I am sorry; I didn't know he was ailing.

9. We used to be good friends, but I haven't seen Lucas in over a year now.

10. In most American colleges a well-rounded education is the standard; arts and sciences dominate the curriculum.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

Part II

11. She got her husband to beat the rug by telling him how good the exercise would be for him.

12. In computing effective lift (hydrogen per square foot), balloonists must consider atmospheric pressure.

13. The white flour in one bin got mixed with the wholewheat flour in another bin.

14. Whenever Maisie gets her diamond ring out of hock, eyes turn to her as if she were wearing a headlight.

15. Willie's mother took one look at the pup he brought home, and said, "Take that hybrid, germ-laden beast out of here."

16. The immigration authorities admitted some extra Cingalese natives to this country last month.

17. The Empire State Building is so tall the roof is hinged to swing out of the way to let the moon go by.

18. Over her eyes, the brim of her hat formed an arc; her years were concealed in its shadow.

19. Although the river was deep, we managed to pull across easily.

20. "Are you hep?" "Oo, love that boogie beat!"

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

Brick Uses

List as many different uses as you can think of for a common brick. Do not think only of the standard uses for a brick but list any possible ways a brick might be used. For example, a brick might be used as a hammer. You will have 10 minutes working time. If more space is needed write on the back of this page.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____

Things Round

List as many things as you can think of that are round or could be called round. Use the back of the page if necessary. You will have 3 minutes working time.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____
36. _____

APPENDIX B

LETTERS TO SUBJECTS

Department of Psychology
University of Michigan
October 21, 1958

Dear Student:

This semester you took part in a psychological experiment as part of your Psychology 31 requirement. I am now writing you to tell you something further of the purpose of this study.

The Blacky Analogies Test which you took is a new instrument which is being developed here at Michigan. We hope this instrument will be used as a selection device in a wide variety of situations but in particular for the selection of students for advanced programs of study. The existing selection devices, which seem to be good measures of potential ability, are not able to predict the actual performance of students as well as we would like. As you know, there is much stress connected with exams, etc., in any program of studies. We are interested in selecting those people who are able to think effectively under stress.

The Blacky Analogies Test is designed to measure ability to solve problems involving emotion-laden stimuli. These stimuli were the Blacky Pictures, taken from a projective that designed to measure disturbances in the various areas of personality. It is thought that everyone has had difficulties in the areas represented by these pictures and thus, that these pictures are emotionally arousing.

Our purpose in the experiment in which you participated was to find out what kind of abilities are needed in order to do well on the Blacky Analogies Test. The other tests you took were designed to measure various kinds of intellectual abilities such as reasoning ability, verbal comprehension, verbal fluency, flexibility of set, etc. We are interested in seeing which of these abilities are being measured by the Blacky Analogies Test. We also included a personality measure, the Self Analysis form, to discover whether certain personality variables affect performance on the Blacky Analogies Test.

Your participation as a subject in this experiment was very valuable. Thank you for your cooperation.

Sincerely yours,

AV:mlp

(Mrs.) Ann Vroom

Department of Psychology
University of Michigan

Dear Student:

Your name has been given to me from the Psychology 31 pool of subjects. I am conducting a study which involves taking a number of paper-and-pencil tests designed to measure various aptitudes. This study will take two hours and will fulfill your requirement to participate in an experiment.

The time and location of this experiment are noted on the enclosed card. If you cannot attend at this time please contact Mrs. Pierce in the mornings at extension 2864 and another time will be arranged. It is very important that you come to the experiment on time as it will take the full two hours.

Sincerely yours,

(Mrs.) Ann Vroom

AV:mlp

APPENDIX C

RESULTS OF BAT FACTOR ANALYSIS

TABLE 18

MATRIX OF PHI COEFFICIENTS: BAT ITEMS (MALE)

	2	3	5	6	7	8	9	10	11
2		-03	16	-08	-07	-11	-04	-12	06
3			10	-05	-13	10	00	12	06
5				30	18	15	16	13	-01
6					05	15	11	12	13
7						-03	-08	05	-02
8							12	33	-05
9								25	-04
10									04
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

TABLE 18 (Continued)

12	13	14	15	16	17	18	19	20	21
08	12	10	-04	-12	07	-03	16	10	-17
03	03	-03	05	06	06	09	24	06	-12
43	31	-20	21	-04	53	12	35	24	-02
21	14	-14	18	-07	15	-02	10	15	-04
10	28	-03	17	-16	15	-02	05	12	03
23	19	-10	25	-04	21	24	16	21	06
39	05	-09	29	-04	03	15	13	21	20
34	15	03	33	16	28	40	21	32	05
05	18	-08	04	08	03	13	09	05	-15
	31	-16	49	19	42	26	37	52	00
		-21	31	09	41	21	34	34	-01
			09	14	-18	-07	-21	-17	-03
				07	29	25	21	34	03
					13	-06	09	18	03
						19	40	35	02
							11	17	10
								50	-11
									02

TABLE 18 (Continued)

	22	23	24	25	26	27	28	29	30
2	-11	04	06	19	-00	05	00	-06	06
3	-08	08	02	09	-03	16	08	-04	13
5	18	24	29	18	23	31	08	02	17
6	23	16	14	07	21	12	16	21	09
7	07	06	03	06	04	08	-14	-08	09
8	04	12	23	-09	-03	18	10	15	32
9	10	21	17	00	16	27	09	01	12
10	13	29	38	03	14	26	17	15	29
11	09	18	-02	-01	04	06	14	03	04
12	14	31	54	09	24	45	12	05	27
13	08	19	24	14	09	32	-02	-01	13
14	-07	-02	-11	03	02	-16	02	08	-09
15	02	26	39	-06	-09	26	03	11	27
16	04	21	14	-16	-03	03	-09	-01	-04
17	12	29	35	19	05	26	10	-02	28
18	-12	29	24	01	04	22	-02	10	18
19	14	30	46	17	15	25	29	02	36
20	10	43	59	11	19	33	25	02	23
21	12	16	02	-06	04	-03	-10	16	-11
22		02	20	17	18	01	11	09	06
23			35	14	14	24	20	08	23
24				09	14	33	25	02	24
25					13	22	-02	-01	08
26						06	20	07	11
27							22	08	16
28								16	20
29									01
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

TABLE 18 (Continued)

31	32	33	34	35	36	37	38	39	40
04	-14	07	06	01	04	-16	16	05	-17
10	-07	01	-01	-01	-09	-01	21	02	04
09	-07	02	19	14	12	03	04	18	17
29	-02	01	03	19	07	-10	-02	13	17
-02	-09	19	04	21	-03	-05	14	08	-14
19	13	05	04	00	09	08	18	-02	06
11	07	06	12	08	07	13	-06	12	-03
36	18	-07	17	07	09	11	08	08	10
19	22	13	07	07	-14	08	02	-02	18
25	02	09	15	20	26	21	09	21	09
09	-03	11	11	16	09	01	10	10	-01
-04	14	-04	-03	01	-09	09	-11	03	-14
19	-03	00	17	09	-02	-02	20	29	-01
23	21	06	-03	01	05	22	09	09	-09
15	-02	-09	21	12	14	08	06	27	02
18	-03	-01	06	11	-07	18	15	10	10
09	05	08	13	22	-04	10	-03	14	11
22	11	18	17	22	10	-10	01	35	02
-04	04	05	-03	01	-15	-02	-02	06	08
13	09	-14	19	23	07	03	-16	17	12
43	22	02	10	07	06	01	-12	14	-08
16	07	-07	28	24	16	-12	-05	36	02
04	-09	-01	06	-09	-02	-05	-14	05	-06
11	-01	03	-01	14	17	15	01	12	11
06	05	09	26	08	18	-04	-04	18	08
10	19	05	19	12	18	-04	11	14	31
11	18	06	01	09	17	-11	09	02	04
25	20	19	08	30	-01	02	-05	12	04
	18	08	07	14	05	08	06	06	11
		02	-02	-12	05	05	-08	-21	04
			05	13	-03	03	07	07	-08
				06	07	00	02	14	05
					-01	05	-14	36	05
						-01	-01	22	01
							12	03	-02
								08	05
									-06

TABLE 19

MATRIX OF PHI COEFFICIENTS: BAT ITEMS (FEMALE)

	2	3	5	6	7	8	9	10	11
2		11	10	11	-04	03	-03	06	05
3			15	05	00	16	07	08	12
5				12	28	23	14	17	09
6					10	08	00	06	00
7						07	03	00	10
8							20	30	10
9								18	24
10									13
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									

TABLE 19 (Continued)

12	13	14	15	16	17	18	19	20	21
03	07	-08	04	10	14	10	12	21	06
11	30	05	07	19	16	06	08	08	16
35	25	00	26	14	30	08	20	26	-13
22	09	02	04	10	16	13	20	03	00
18	00	03	19	13	13	00	11	04	11
28	26	02	04	15	17	13	21	29	03
17	11	04	16	04	23	14	10	05	07
27	30	09	28	08	31	17	22	24	-03
-02	03	07	07	11	12	06	05	-02	02
	38	10	22	17	49	26	20	31	-14
		03	25	08	41	22	36	32	00
			00	04	06	09	08	00	02
				10	31	13	16	15	-08
					23	18	10	10	03
						31	41	36	07
							24	17	00
								32	-06
									-03

TABLE 19 (Continued)

	22	23	24	25	26	27	28	29	30
2	05	00	08	09	-05	08	08	11	-08
3	19	10	24	09	-02	14	12	13	16
5	11	15	20	17	11	23	22	06	23
6	-05	00	10	06	05	02	05	-10	-07
7	13	07	06	11	16	-03	-06	03	13
8	18	03	33	-03	-08	10	17	19	17
9	11	19	09	03	15	-04	00	09	04
10	11	14	13	06	-05	13	13	00	23
11	-02	05	13	08	02	04	00	02	13
12	12	11	18	15	08	15	19	11	02
13	14	27	28	24	06	14	22	03	08
14	18	05	07	-03	02	-04	-13	00	11
15	10	18	03	08	03	07	07	-04	10
16	22	09	13	00	07	07	07	12	02
17	12	16	15	07	09	17	23	13	14
18	18	31	26	04	06	20	23	13	00
19	16	14	16	06	13	05	23	14	08
20	05	08	35	09	13	15	17	11	07
21	05	-03	-03	-06	-05	00	05	-03	-02
22		21	24	-03	02	04	07	19	09
23			12	09	09	12	05	08	09
24				05	09	15	26	05	09
25					05	03	10	-17	13
26						04	13	05	-02
27							28	05	13
28								05	06
29									-02
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									

TABLE 19 (Continued)

31	32	33	34	35	36	37	38	39	40
00	-09	03	-04	16	-17	-06	03	03	00
14	03	20	04	02	05	03	14	17	13
03	03	00	-09	11	16	00	-03	09	16
00	-08	-03	00	00	11	-06	02	08	22
09	00	-04	00	00	10	15	-07	13	07
17	03	-09	03	08	14	06	05	13	17
00	00	05	11	04	-02	-18	09	07	12
18	03	03	16	03	06	00	11	11	06
06	00	03	00	11	10	08	-07	09	05
17	03	03	10	02	05	00	03	08	14
08	10	07	03	-06	12	07	-06	09	09
13	10	11	16	07	22	16	-02	14	05
07	08	00	14	-03	18	-04	03	03	04
13	10	13	12	-02	12	03	-11	16	20
20	03	11	18	06	10	03	09	09	13
11	13	21	21	12	13	00	-03	06	10
10	03	03	11	08	08	03	00	16	17
12	-06	03	16	13	08	03	03	-03	03
-07	06	00	03	-10	05	09	13	-05	08
20	03	05	21	00	-7	08	-02	19	17
05	05	06	15	09	13	03	-02	07	03
11	03	08	21	09	15	05	05	14	20
-03	-03	00	14	05	09	06	-16	-06	06
04	-13	00	16	11	12	16	-09	-05	15
13	00	-03	20	09	22	03	07	16	12
02	-03	-05	09	02	09	05	-04	11	07
12	00	09	07	05	03	03	-02	10	05
13	-03	-03	-09	00	07	03	02	07	10
	08	13	16	-09	00	13	00	21	07
		12	05	10	17	06	03	03	03
			06	-13	-06	00	-05	00	06
				12	18	05	16	00	18
					07	03	16	-02	-05
						20	00	15	05
							11	-06	15
								-10	03
									-05

TABLE 20

ROTATED FACTOR MATRIX: BAT ITEMS (MALE)

Item	I	II	III[a]	IV[a]	V[a]	h^2
2	08	-25	-08	33	-11	20
3	04	21	17	20	-14	14
5	31	15	-13	46	33	45
6	12	02	05	12	50	28
7	14	09	-35	12	-02	17
8	22	37	11	02	08	21
9	30	08	03	-13	22	16
10	48	23	37	-08	08	43
11	01	07	36	25	07	20
12	63	25	-02	15	28	56
13	39	18	-08	43	00	39
14	-05	-12	14	-30	-10	14
15	56	23	-06	01	-01	38
16	30	-02	21	-20	-18	20
17	50	12	-08	38	08	42
18	27	37	20	07	-09	26
19	45	21	07	38	10	41
20	71	05	06	12	13	54
21	06	05	-02	-29	03	09
22	16	-13	-05	-02	41	21
23	51	-01	39	06	06	42
24	75	-11	01	06	15	61
25	10	-18	01	35	02	17
26	08	11	04	01	42	20
27	41	09	08	30	17	31
28	13	-02	28	12	40	27
29	05	01	17	-13	28	12
30	31	35	12	16	12	28
31	28	16	44	-01	22	35
32	04	03	48	-14	07	26
33	01	28	-04	03	05	08
34	26	-08	02	17	13	12
35	26	22	-20	-04	27	23
36	13	-09	-03	-01	36	16
37	03	32	07	-13	-02	13
38	01	45	-07	-02	-08	21
39	46	-01	-25	-04	20	32
40	-11	10	16	14	32	17

[a]Factor reflected to make high loadings positive.

TABLE 21

ROTATED FACTOR MATRIX: BAT ITEMS (FEMALE)

Item	I	II	III[a]	IV	V[a]	h^2
2	36	02	-06	-11	01	15
3	24	35	11	22	-02	24
5	32	-02	46	-08	28	40
6	19	04	19	-19	09	12
7	-02	05	46	-01	09	22
8	25	36	23	-05	12	26
9	-06	07	14	08	37	17
10	11	18	14	04	43	25
11	02	06	30	07	05	10
12	28	18	11	-07	53	41
13	45	15	03	05	37	37
14	-15	24	13	22	07	15
15	04	00	16	07	45	23
16	14	35	17	04	07	18
17	34	20	15	06	57	51
18	31	17	-08	26	34	31
19	36	19	13	-03	33	29
20	49	10	03	03	23	30
21	-02	10	03	17	-15	06
22	04	41	11	18	13	23
23	13	02	02	28	33	21
24	42	30	15	18	02	32
25	21	-20	18	05	10	13
26	15	-12	19	12	06	09
27	32	05	12	20	04	16
28	50	01	07	01	04	26
29	10	33	-07	02	03	13
30	-01	09	34	-01	11	14
31	00	42	06	06	14	20
32	-09	13	-03	24	07	09
33	01	24	-19	14	10	21
34	10	08	-01	45	20	26
35	17	-18	11	20	03	11
36	08	01	33	35	03	24
37	03	08	20	34	-17	19
38	-01	-01	-03	19	03	04
39	07	33	16	-10	05	15
40	11	18	29	11	05	14

[a]Factor reflected to make high loadings positive.

APPENDIX D

RESULTS OF TEST BATTERY FACTOR ANALYSIS

TABLE 22

INTERCORRELATION MATRIX OF TEST VARIABLES: MALES

Test	1	2	3	4	5	6	7	8
1. ACE: Arithmetic		28	50	35	46	38	29	25
2. ACE: Figure analogies . . .			35	26	38	45	36	24
3. ACE: Number				12	19	41	21	11
4. ACE: Completion					63	44	19	26
5. ACE: Same-opposite						48	15	14
6. ACE: Verbal analogies . . .							21	15
7. Hidden figures 1								73
8. Hidden figures 2								
9. Logical reasoning 1								
10. Logical reasoning 2								
11. Word matrix								
12. Things round								
13. Brick uses								
14. BAT odd items								
15. BAT even items								
16. Camouflaged words 1								
17. Camouflaged words 2								
18. Associations III, 1								
19. Associations III, 2								
20. IPAT A								
21. IPAT B								
22. Read. comp., vocabulary . .								
23. Read. comp., speed								
24. Read. comp., accuracy								

TABLE 22 (Continued)

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
32	14	29	17	31	41	40	33	31	39	41	-17	-19	40	43	21
14	22	23	01	01	30	33	21	13	19	21	03	27	33	37	15
08	04	20	-04	02	19	31	25	24	23	35	09	01	16	22	-04
29	25	30	18	24	39	41	09	14	53	42	-17	-09	65	53	34
28	26	35	14	21	43	52	12	10	46	31	-22	-02	82	71	46
29	17	18	10	09	30	37	18	09	22	33	-03	26	40	52	20
21	20	30	08	12	32	34	31	27	41	35	11	01	17	26	34
19	18	34	13	14	29	28	15	19	30	19	10	-01	22	22	27
	51	19	16	11	32	28	06	-02	28	35	08	11	31	39	20
		33	04	10	18	24	11	12	23	14	08	03	22	27	12
			32	00	42	41	22	18	41	35	-03	-13	40	22	22
				65	17	-01	05	09	-02	07	-03	-11	11	16	08
					14	-05	-05	03	13	09	-11	-14	13	23	11
						63	38	32	47	49	07	01	48	40	41
							31	26	51	38	01	05	53	41	39
								57	37	50	10	03	13	13	16
									27	29	01	-10	13	06	12
										50	-09	06	45	37	35
											01	07	29	27	22
												74	-14	-04	-01
													-07	10	08
														66	53
															64

TABLE 23

INTERCORRELATION MATRIX OF TEST VARIABLES: FEMALES

Test	1	2	3	4	5	6	7	8
1. ACE: Arithmetic		48	51	28	29	40	35	28
2. ACE: Figure analogies			41	28	32	47	48	42
3. ACE: Number				33	26	44	25	27
4. ACE: Completion					60	50	29	27
5. ACE: Same-opposite						47	22	25
6. ACE: Verbal analogies							36	32
7. Hidden figures 1								59
8. Hidden figures 2								
9. Logical reasoning 1								
10. Logical reasoning 2								
11. Word matrix								
12. Things round								
13. Brick uses								
14. BAT odd items								
15. BAT even items								
16. Camouflaged words 1								
17. Camouflaged words 2								
18. Associations III, 1								
19. Associations III, 2								
20. IPAT A								
21. IPAT B								
22. Read. comp., vocabulary								
23. Read. comp., speed								
24. Read. comp., accuracy								

TABLE 23 (Continued)

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
17	08	27	-01	00	34	34	32	14	24	19	-03	-05	22	27	19
17	04	16	06	08	32	33	26	20	26	34	-01	05	28	29	23
28	12	14	01	03	28	37	24	12	19	23	-02	03	21	25	08
26	17	36	06	12	40	41	34	36	37	44	-07	-16	56	55	44
23	20	27	05	08	38	44	31	41	42	39	04	-10	78	66	46
32	22	27	08	05	34	37	32	24	25	29	-07	-06	42	48	32
17	08	25	07	11	24	34	21	10	21	30	-01	05	20	18	15
06	02	21	-01	11	25	32	27	25	22	33	04	10	22	18	13
	48	21	12	11	31	22	16	05	15	16	04	05	25	35	26
		20	-01	-04	21	10	11	07	13	20	-01	-01	25	31	24
			05	-03	27	29	18	20	34	28	11	08	37	21	29
				52	02	-04	15	03	05	05	-05	-06	-02	11	-01
					-02	06	18	06	00	02	02	-05	-00	08	-07
						62	40	32	40	39	03	00	39	40	28
							36	28	36	38	-02	-10	40	30	25
								43	25	30	06	02	31	31	26
									31	30	14	05	45	37	28
										55	03	04	53	38	37
											06	01	44	34	28
												64	09	-03	03
													02	-05	01
														64	62
															62

TABLE 24

ROTATED FACTOR MATRICES: TEST VARIABLES

Test	Factor					
	I		II		III	
	M	F	M[a]	F[a]	M	F
1. ACE: Arithmetic	24	13	48	66	38	14
2. ACE: Figure analogies	25	19	51	57	07	15
3. ACE: Numbers	-03	05	69	66	24	17
4. ACE: Completion	54	55	19	26	08	17
5. ACE: Same-opposite	78	75	30	20	04	20
6. ACE: Verbal analogies	35	37	59	54	07	09
7. Hidden figures 1	10	07	17	30	23	06
8. Hidden figures 2	11	12	09	23	09	20
9. Logical reasoning 1	19	13	10	20	05	12
10. Logical reasoning 2	14	18	07	00	04	03
11. Word matrix	21	23	12	15	22	01
12. Things round	07	02	00	06	07	-05
13. Brick uses	10	01	03	01	00	10
14. BAT odd items	42	21	11	25	48	59
15. BAT even items	47	20	23	28	36	56
16. Camouflaged words 1	03	28	14	24	77	46
17. Camouflaged words 2	02	45	11	05	66	38
18. Associations III, 1	36	37	06	12	39	20
19. Associations III, 2	14	26	22	13	51	28
20. IPAT A	-13	05	03	-04	05	05
21. IPAT B	06	-06	-01	03	-03	-03
22. Read. comp., vocabulary	79	84	19	08	07	16
23. Read. comp., speed	81	74	27	23	05	14
24. Read. comp., accuracy	68	65	-13	09	19	03

[a]Factor reflected to make high loadings positive.

TABLE 24 (Continued)

Factor											
IV		V		VI		VII		VIII		h^2	
M	F^a	M^a	F^a	M	F^a	M^a	F^a	M^a	F	M	F
08	06	-21	-03	21	-07	09	15	18	06	56	51
02	11	02	02	-06	04	25	32	07	-04	40	50
08	12	03	-01	-03	00	05	06	03	13	55	49
47	27	-10	-17	22	07	07	14	13	16	62	55
28	14	-11	-06	10	03	-04	10	13	11	82	69
07	08	02	-11	07	05	04	20	12	20	51	53
04	13	05	-02	07	07	83	71	09	08	80	64
11	13	01	07	11	05	78	66	12	-06	67	57
08	03	07	04	12	11	03	00	74	69	63	57
08	09	02	01	03	-02	14	-01	59	61	40	41
37	36	-10	10	-11	-04	28	20	24	22	40	31
-02	06	-03	-04	71	70	05	-03	07	06	53	51
06	-06	-09	-02	79	71	08	10	05	01	66	53
23	24	05	-03	-01	-06	19	11	22	26	56	60
24	21	01	-10	-23	-10	20	22	22	17	61	58
05	08	07	07	01	22	08	09	-01	00	62	42
-01	12	-06	13	06	09	12	08	-02	-11	47	41
45	60	-01	04	01	-02	23	05	17	04	56	55
39	58	07	-01	09	06	09	18	18	05	53	54
-07	02	87	78	-05	-01	10	-01	08	02	79	62
02	02	87	81	-07	-05	-04	04	01	03	76	67
31	25	-10	08	03	-09	04	07	13	13	80	83
-11	04	05	-06	19	08	09	-01	20	27	83	70
-07	13	05	-01	05	-07	24	07	07	21	59	50

APPENDIX E

RELATIONSHIP BETWEEN TEST VARIABLES AND GRADE–POINT AVERAGE

TABLE 25

INTERCORRELATION OF TEST VARIABLES AND GRADE–POINT AVERAGE: MALE[a]

Test	1	2	3	4	5
1. ACE: Quantitative		50	37	46	18
2. ACE: Linguistic			80	74	44
3. ACE: Reading comprehension, vocabulary				66	47
4. ACE: Reading comprehension. speed					65
5. ACE: Reading comprehension, accuracy					
6. BAT					
7. Hidden figures					
8. Logical reasoning					
9. Word matrix					
10. Things round					
11. Brick uses					
12. Camouflaged words					
13. Associations III					
14. IPAT					
15. Grade-point average					

[a]N = 100.

TABLE 25 (Continued)

6	7	8	9	10	11	12	13	14	15
47	31	19	28	05	12	37	46	-04	44
55	20	32	37	20	21	16	51	-12	49
55	19	26	39	11	13	15	43	-11	55
46	25	34	22	16	23	12	38	04	58
37	41	20	23	06	15	15	32	03	47
	37	28	44	09	06	40	60	02	45
		21	29	14	17	24	34	07	27
			32	07	10	06	28	10	15
				03	00	23	44	-09	23
					65	08	02	-08	21
						-01	13	-13	14
							45	-02	32
								01	37
									02

TABLE 26

INTERCORRELATION OF TEST VARIABLES AND GRADE-POINT AVERAGE: FEMALE[a]

Test	1	2	3	4	5
1. ACE: Quantitative		51	30	35	22
2. ACE: Linguistic			72	67	53
3. ACE: Reading comprehension, vocabulary				65	64
4. ACE: Reading comprehension, speed					64
5. ACE: Reading comprehension, accuracy					
6. BAT					
7. Hidden figures					
8. Logical reasoning					
9. Word matrix					
10. Things round					
11. Brick uses					
12. Camouflaged words					
13. Associations III					
14. IPAT					
15. Grade-point average					

[a] N = 161.

TABLE 26 (Continued)

6	7	8	9	10	11	12	13	14	15
40	42	27	21	01	03	29	34	-02	23
49	35	31	36	04	04	44	47	-10	40
47	25	26	38	-03	-01	48	54	03	45
42	24	38	23	15	09	43	42	-04	39
34	19	25	28	-01	-07	33	38	-02	47
	36	33	32	00	-03	42	48	01	33
		11	29	06	11	31	37	01	22
			23	13	08	16	23	05	23
				04	-03	20	36	09	20
					53	13	07	-09	-07
						16	00	01	-01
							39	09	28
								04	28
									18

APPENDIX F

MEANS AND STANDARD DEVIATIONS OF VARIABLES

TABLE 27

MEANS AND STANDARD DEVIATIONS OF TEST SCORES[a]

Test	Male[a]		Female[b]	
	Mean	S.D.	Mean	S.D.
1. ACE: Arithmetic	11.58	3.07	8.94	2.87
2. ACE: Figure analogies	19.66	3.00	19.04	3.02
3. ACE: Numbers	18.05	4.78	15.96	4.68
4. ACE: Completion	20.18	4.32	18.96	4.26
5. ACE: Same-opposite	26.40	8.13	25.89	7.46
6. ACE: Verbal analogies	30.42	4.57	29.43	4.73
7. Hidden figures 1	12.07	2.76	11.56	2.65
8. Hidden figures 2	10.57	3.57	9.30	3.11
9. Logical reasoning 1	10.35	2.29	9.40	2.58
10. Logical reasoning 2	11.61	2.26	10.57	1.98
11. Word matrix	7.54	1.69	7.13	1.64
12. Things round	23.84	7.59	20.16	6.43
13. Brick uses	27.48	10.73	21.14	8.13
14. BAT odd items	12.03	3.29	11.58	2.82
15. BAT even items	11.99	3.20	11.35	3.13
16. Camouflaged words 1	5.55	2.28	5.12	2.17
17. Camouflaged words 2	4.55	2.53	3.65	2.38
18. Associations III, 1	7.49	2.52	6.27	2.46
19. Associations III, 2	8.98	2.53	8.18	2.27
20. IPAT A	16.83	5.58	16.42	5.10
21. IPAT B	14.88	7.05	14.61	6.51
22. Read. comp., vocabulary	27.11	10.66	24.82	9.40
23. Read. comp., speed	28.62	11.29	28.65	9.64
24. Read. comp., accuracy	70.12	14.58	69.53	12.80

[a]N = 100 male. [b]N = 171 female.

TABLE 28

MEANS AND STANDARD DEVIATIONS OF TEST VARIABLES AND GRADE–POINT AVERAGE

Variable	Male		Female	
	Mean	S.D.	Mean	S.D.
1. ACE: Quantitative	49.30	8.06	44.31	8.43
2. ACE: Linguistic	77.06	14.11	73.84	14.76
3. ACE: Reading comprehension, vocabulary	27.14	10.72	24.68	9.59
4. ACE: Reading comprehension, speed	28.67	11.31	28.74	9.69
5. ACE: Reading comprehension, accuracy	70.25	14.07	69.53	13.00
6. BAT	23.98	5.83	22.94	5.38
7. Hidden figures	22.66	6.00	20.87	5.20
8. Logical reasoning	22.18	4.00	19.81	3.87
9. Word matrix	7.55	1.70	7.09	1.65
10. Things round	23.84	7.55	20.04	6.32
11. Brick uses	27.48	10.72	21.24	8.00
12. Camouflaged words	10.11	4.24	8.80	3.87
13. Associations III	16.44	4.35	14.45	4.24
14. IPAT	31.66	11.70	30.66	10.39
15. Grade-point average	2.43	.73	2.36	.65