HUMAN RELATIONS SERIES

BORN THAT WAY

BY

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TO MY COLLABORATORS IN THESE RESEARCHES

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INTRODUCTION

Management's function is to convert material in one form (raw material) by the application of labor to material in another form (finished product) for the benefit of society. In order that it may be competitive, an industry must provide itself with suitable material, suitable equipment, and a suitable working force.

Responsibility of selecting material for an organization rests with the purchasing department. This department buys many kinds of material, selecting by means of tests and investigations the kinds best suited to the particular needs of the industry. Much that is offered is necessarily refused—only the best suited is selected—and the advisability of these tests and investigations is never questioned.

Responsibility of selecting the equipment rests with the superintendent's office. Many kinds of tools for different purposes are purchased. A thorough investigation precedes every selection, and only the best suited to the requirements is installed.

Responsibility of selecting the man-power rests with the employment department. There are more kinds of men than there are kinds of machines or material, but less is known of their values and capacities. No one stands back of their performing up to expectations. It is not expected that men will always be used on the particular jobs for which they are hired but, on the contrary, it is expected that they will advance to different, more skilful, and better jobs than those for which they are originally employed. Hired for one thing, they will ultimately be used for something else. The total pay-roll of an industrial organization is usually from one half to two thirds the cost of the product; and, therefore, man-power is a more important factor than any other, or indeed all others. Are present methods of selecting employees from applicants sufficiently reliable, and once selected, are the employees allocated as well as they could be to different types of jobs?

Mr. O'Connor sets forth in this book the results of several years' experimenting with selective tests. He has applied them in different localities to different groups for different occupations. The value of his work depends on the extent to which it helps the employment manager to select and place men. It is not, and need not be, infallible, and is not a substitute for experience with an individual. But if his work is of material assistance in placing untried applicants in positions for which their natural aptitudes best fit them, it is a valuable contribution to industry. An individual is most contented and most efficient when his task requires the exercise of all his capabilities, and yet is within the range of his accomplishment. A lesser task does not hold his interest or encourage his development; a greater one leads only to discouragement.

To one who has closely followed Mr. O'Connor's research, there does not appear to be any doubt that his accepted tests do reasonably predict the line of work in which the individual may expect to succeed. His discarded tests are equally interesting, and it is to be hoped that his future studies may indicate why they failed, and perhaps develop some of them into satisfactory tests for attributes other than those on which the correlation with experience was found unsatisfactory. The real question does not seem to be whether his present tests are of real value but, rather, how soon and how far the remainder of the field, at present unknown, may be covered.

F. P. Cox.

CONTENTS

CHAPTER I

Human Engineering

With Ignorance wage eternal war,
to know thyself forever strain.
And, glancing down the range of years,
fear not thy future self to see.
—Sir Richard Burton,
The Kasidah of Haji Abdu El-Yezdi.

Science has drawn man's physical characteristics into its domain; not only measuring their extent, but formulating a portion of the laws which govern their passage from one generation to the next. Many million minute cells compose the human being. Under the discerning eye of the microscope, these may be seen, duly counted, and minutely studied. A single such cell gives birth to the child. This grows until it divides through the center into a conjoined pair, which, in turn, enlarge until they partition, making four. As development proceeds, each of the four again splits, creating a group of eight; then later sixteen; thirty-two; sixty-four; until hundreds of thousands of cells form the embryo. What determines whether the original unit cell matures as a boy or girl? Crowded within it are forty-eight tiny and mysterious particles, called chromosomes. One of these, physiologists have studied sufficiently minutely to name individually the *X* chromosome. This governs sex. Others succinctly dictate the color of the eyes, the hue of the hair; decide whether the child will be tall or short; and predetermine the gamut of physical properties which differentiate human beings; for these enchaining links, twenty-four of which derive from the father and a like number from the mother, shape the highway of the child's future voyaging. Against them, so far as physical structure is concerned, there can be no insurrection.

So invincibly is the future controlled that all children born of a light-haired, blue-eyed woman, descendant from blond ancestry—in the terms of science a *pure* blonde—united to a *pure* brunet are, without exception, dark, brown-eyed youngsters. Dark hair and brown eyes, dominant characteristics, override for a generation recessive light hair and blue eyes; but the submerged tendencies appear later in the grandchildren, one quarter of whom show blond traits. Apparent exceptions, to the rule, occur when the parents, although outwardly dark or light, are not of *pure* stock; when strains of the blond exist in the ancestry of the brunet, or a trace of the brunet in the present blond. Although, except in a few simple cases, science cannot predict the features of the first child or the second or the third, it can, with complete data of past ancestry at hand, foretell, indefinitely into the future, the percentage of each new generation which will possess a given physical trait.

What of brain processes? Are there mental characteristics? If so, can they be measured, and thus become of scientific consequence? Do they follow physical laws? The question unfolds a fascinating field of future research. Some persons master tasks, demanding careful thought, many times more quickly and easily than their associates. Some become expert engineers after only five years' intensive study, while others never achieve equal eminence. In another walk of life, occasional individuals sell with pleasure; and yet many find the work so distasteful as to become unbearable. Again, one girl, with no factory experience, learned in five days, a difficult assembly operation, which another gave up as impossible after three arduous months of continuous training.

The invisible mental endowments which enable some children to excel in school, and certain adults to outstrip their rivals in the business and professional worlds, are not as obviously apparent as blue eyes and light hair, or as the bodily height of a six-foot man or the two hundred pounds of a heavy woman. Yet aptitudes, lacking in some, exist in others. Because these predispositions of the mind, which govern life, do not instantly strike the eye and are less readily comprehended and described than obvious, physical features, the feeling constantly recurs, that to study them is to chase mere will-o'-the-wisps.

A chemist secludes himself in a laboratory. Here, surrounded by retorts and rows of prosaic bottles, he controls conditions sufficiently well to vary at will one factor at a time. Like the chemist, let the reader absent himself for a moment from the contemplation of the gigantic and intriguing problems of the universe, to take part in a simple laboratory experiment, which may make the elusive peculiarities of the human animal seem more real and vital than in the past. Tremendously picturesque as are the fascinating books which appear on the inhuman horrors of war, and the desirability of universal peace, on the eternal dilemma of labor and capital, on the passing of monarchy and the birth of democracy, to gain a clear conception of man's nature from such treatises, parallels an attempt to study chemistry from the explosion of a munition factory. A slow motion picture would reveal even such a catastrophe governed by chemical laws, ever in operation, controlling the spread of the explosive; but too many factors operate simultaneously for the human mind to grasp the entirety. To understand the force of human nature, and formulate laws for its control, the human engineer must not only turn from impressive manifestations to elementary situations, but rest content to measure first some of the border-line characteristics which, although not strictly mental, are intangible, and a step into the unknown region, once removed from physical facts.

The simplest human engineering apparatus for studying one of these half-way functions, no longer purely physical and yet hardly mental—equipment similar to the chemist's funnel and filter paper—is a board, containing, at one end, a hundred drilled holes, and, at the other, a shallow tray in which are piled three hundred, one-inch pegs. (See Figure 1, on opposite page, and Appendix B, Worksample No. 16, Apparatus, page 213.) The task of taking the pegs, three at a time, as rapidly as possible, from the tray, and placing three in each drilled hole, was presented to a large number of individuals, under the rigidly controlled conditions of what may be called a human engineering laboratory. (See Appendix B, Administration, page 213.)

Among two thousand women, whose performances were timed, one completed in six minutes; another consumed twelve. The most adept halved the time of the least skilful. This, at first glance, seems but a minor unlikeness to discover between the top and bottom of a group of two thousand, but the spread of manual dexterity, thus measured, the ratio of the fastest to the slowest woman, exceeds the corresponding ranges of many of the more obvious physical characteristics. To obtain a similar antithesis in height, a woman six feet tall should stand beside another three feet; or one seven feet near another only three and a half, a sight one never sees in normal life. The six- and twelve-minute performances typify, of course, extreme cases; but the relative standing of two thousand—more valid because of numbers—gives a similar picture. The most rapid quarter, the fastest five hundred of the two thousand women, completed the peg-board in less than seven minutes; the poorest quarter, the slowest five hundred, required longer than eight and two-tenths (see Appendix B, Scoring, page 215), a difference of seventeen per cent, double the corresponding range in their bodily heights. Furthermore, as the average man differs in height from the average woman, so also does he differ in dexterity, thus measured.

A yard-stick, graduated in this particular type of manual dexterity, and based on the exact length of time required to assemble the three hundred pins, extends up and down the left side of

Figure 4, opposite page 34. The rule is crude, in many ways inaccurate, but one must constantly use imagination to see in these first primitive measurements made in the field of intangible tendencies, the early steps toward a new science; and to realize that the facts are not sufficiently complete to form a coördinated picture—mere bits of reality beyond the present horizon—whose paramount value lies in showing the measurability, and, therefore, the scientific reality of imperceptible human propensities, and not in absolute reliability. Finger dexterity, out of the range of our immediate perception, bears every mark of as real a property as bodily stature; and one must come to regard it as of the same importance to life as height—perhaps of more because it varies more strikingly.

Having caught and charted a single dimly seen faculty, one may take another step into the unknown, and attempt to measure a more purely *mental* function, still further from the physical. Page 205 (Appendix B, Worksample No. 1) shows two parallel columns of numbers, increasing in length from two digits at the top to twelve at the bottom. These were presented to four thousand men, with instructions to check across from column to column, and record *same* or *different*. (See Appendix B, Worksample No. 1, Administration, page 206.)

The numbers:

96 96

head the two lines. Since these are identical, the directions on the instruction sheet read, *Check opposite them, in the third column marked* Same.

First column	*Second column*	*Same*	*Different*
96	96	X	

The next two figures:

64 68

differing, check in the fourth, Different *column.*

First column	*Second column*	*Same*	*Different*
64	68		X

Continue thus through the sheet.

One man completed the checking in forty seconds, while the slowest exceeded three minutes, five times as long. A similar contrast in weight would make the two persons invaluable as circus side-show acquisitions, one fivefold the weight of another. But the inequality in number checking speed is passed over in life as non-existent.

Even this wide variance in time does not represent the full extent of the true difference, because the one who finished first was accurate; while the other blundered into five mistakes. The popular expression *slow but sure* has lost much of its potency in face of the laboratory work of the past few years. Rapid workers, checking the parallel columns in less than sixty seconds, have made, as a group, fewer mistakes than slower men; those

TABLE 1

Relation of Speed to Accuracy, Worksample No. 1, Form C (Second Sheet)

TIME ON WORKSAMPLE NO. 1, SECOND SHEET	AVERAGE NUMBER OF ERRORS
Less than 1 minute	0.25
Between 1.00 and 1.25 minutes	0.78
Between 1.26 and 1.50 minutes	0.92
Between 1.51 and 1.75 minutes	0.97
Between 1.76 and 2.00 minutes	0.98
Between 2.01 and 2.50 minutes	1.17
Between 2.51 and 3.00 minutes	1.24
More than 3 minutes	1.68

Each line of this table, with the exception of the first, is based on the average of one hundred persons. Thus, one hundred persons who checked the numbers between a minute and a minute and a quarter made a total of 78 errors, or an average of 0.78 errors each. Because of the extreme rarity of those who finish in less than one minute, the first line is based on but four cases.

under two minutes, less errors in turn than ones requiring longer than two. (See Table 1.) The *slow but sure* checker is almost a myth. Exceptions, of course, persistently baffle the pursuit of a general law: occasional persons progress slowly, minutely, and correctly; while others rush through blindly and make mistakes; but even including the exceptions, swift checkers, as a group, are the most exact, and slow ones more liable to error.[1]

This extraordinary finding—the accuracy of the speedy worker—extends to other fields. Longfellow arose at three in the morning and composed the *Wreck of the Hesperus*, not grubbingly by words or phrases, but expeditiously by stanzas. Dickens, Thackeray, and Scott all wrote rapidly. Conrad, on the other hand, corrected and recorrected his manuscript, perhaps because the language was not native to him, perhaps because, after winging his way swiftly through the first steps, he saw defects which his greatness strove to remedy.

Some of the most beautiful paintings in the history of art are in fresco, a technique which demands startling dispatch, and a surety that never errs. A patch of wet plaster, applied in the morning, is transformed, before night, into the same number of square feet of soul-stirring composition, ready to hand on as an inspiration to future centuries. The section is finished and never retouched. The inimical requirements of the material and the impossibility of correcting elim-

[1] This phenomenon has been measured even more strikingly by L. J. O'Rourke, Director of Personnel Research, *Fortieth Report, United States Civil Service Commission* (1923), p. lxxxvi.

FIGURE 1. WORKSAMPLE NO. 16, FINGER DEXTERITY

Apparatus used in measuring the finger dexterity of factory workers who apply for rapid, delicate hand work such as meter or instrument assembly inated ruthlessly many youths who would have painted, could they have worked and reworked a friendly canvas. The implacable method repudiated all except the swift and sure. Perchance, for this reason, the period of fresco painting stands forth as one of the greatest.

Only years of careful research can strip of false suppositions the *slow but sure* tradition, and with it the desire for an Emersonian compensation to which we tenaciously cling. The unexpected fact remains that those who check the two columns of figures rapidly do it accurately.

Combining time and errors (see Appendix B, Scoring, page 207) gives a distribution in number checking scores far exceeding any ever found between the physical weights of normal adults. Has this scattering a practical significance, or is it merely an interesting theoretical finding? Laboratory research continually discloses weird phenomena, too often of no value. Is the striking divergence of abilities to check two columns of numbers but another non-essential fact, or has it value to the world?

Before attempting an answer, consider still a third task, perhaps more complicated than the pins or number checking, solving a Chinese puzzle, fitting together nine irregular pieces of wood to form a rectangular solid. Two college graduates—

room-mates the last three years of their course—entered the human engineering laboratory and seated themselves at separate tables. Each received the large block of wood—pictured on the opposite page and was told, *This is made up of nine blocks, like this.* One of the top corner blocks was then taken in the hand, and shown to the examinee. *I will mix them up, and get you to put them together again.* The block was replaced with the words, *Notice carefully how it is made. It is cut through into three piles, with three blocks in each pile.* While saying this, the blocks were separated into three vertical piles, three blocks in each. The hand was moved down as if cutting the formation twice through. The three piles were pushed together again, making the block once more as originally assembled. *It is also cut through into three layers with three blocks in each layer.* While saying this, the top two layers of three each were removed, and placed on the table beside the bottom layer, a few inches from it. Then the top layer of three was lifted from the middle layer, and placed so that the three were arranged before the examinee in this order, bottom, middle, and top. The three blocks in the lower layer were separated, left for a moment, and then pushed together again. In the same way the three blocks in the middle layer were separated for a moment

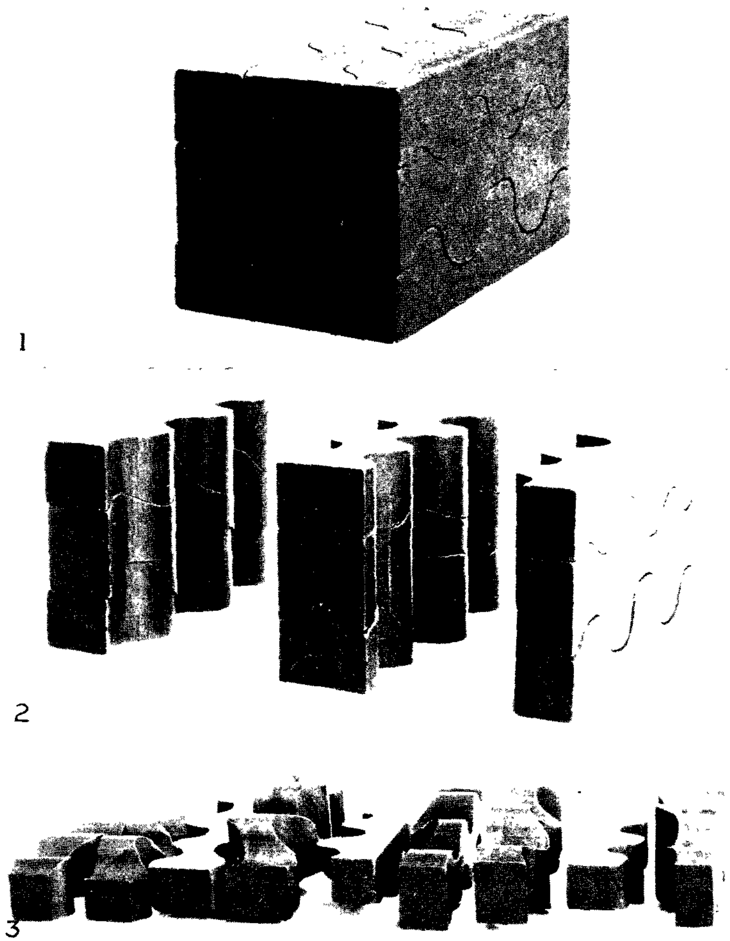


FIGURE 2. WORKSAMPLE NO. 5. MECHANICAL APTITUDE

Three views of the apparatus used in measuring the aptitude of boys who wish to undertake engineering, designing drafting, or the higher types of mechanical work such as tool- or die-making.

and then the three in the top. They were reassembled, with the remark, *Remember that it is three blocks high and three blocks wide. Now I will mix them up.* (See Appendix B, Worksample No. 5, Administration, page 209.)

The parts having been shuffled, the youths attempted to reassemble the pieces to form the original solid. One of the pair finished without apparent haste, almost nonchalantly, in thirty seconds. The other struggled half an hour to reach an identical goal, sixty times as long.

As chance plays a considerable part in the selection of the correct block,[1] the men repeated the solution. He who had succeeded in half a minute, equalled his execution; the other, who originally consumed half an hour, improved, needing but twenty minutes, and on a third attempt, only twelve,[2] still twenty-four times as long as his com-

[1] The correlation of the first and second trials is low (0.36) as is also that between the first and third (0.38). The average of three trials is, however, reliable for it correlates 0.76 with another mechanical test, Worksample No. 75, Formboard 4b, designed by Dr. Grace H. Kent, and administered without introductory boards.

[2] The average first time divided by the average second time equals 1.4; while the initial trial divided by the average third gives 1.7. These factors of improvement are used in the formal scoring of the test to render each new trial comparable with the first. (See Appendix B, Scoring, page 212.)

panion. The ability of the first to reproduce his excellent feat thrice, unchanged, and the inability of the second even to approach this standard, demonstrated that luck, which might have caused the discrepancy, acted not more than a minor rôle. The block exposed a substantial inequality.

On the surface, both were youths whom any employer would consider himself fortunate in obtaining, but beneath, they exhibited an astonishing uniqueness, which education failed to eradicate; for, after the customary primary and high school courses, they had, for four years, attended the same engineering college. Something in either the bringing-up or ancestry of the one enabled him to recognize and unravel the essential elements of the jig-sawed pieces sixty times more rapidly than his room-mate. This rearouses the still unanswered question, Are such dissimilarities the accumulated result of home environment, early training, and formal education? or are they born as integral parts of individuals, as blue eyes and brown hair, and handed from father to son in accordance with the Mendelian laws? Have our great institutions of scientific learning the power within their walls of supplying every one who enters with the ability of solving at a glance so simple an analytical problem, and if so why did the youths differ? Possibly one voraciously grasped every class-room opportunity, while the other shamelessly shirked book work. Possibly one chanced upon gifted instructors, born to impart the spark of knowledge. The exact effects of school drill persistently elude unbiased judgment.

In order to disclose the effect of repetition in reducing the time, the two repeated the assembly some twenty times. The half-minute performer did not improve materially with practice; for the manual manipulation of the parts, with perfect mental understanding, consumes thirty seconds. The half-hour straggler gradually lowered his time until he reproduced the accomplishment of the other so well that a new-comer, entering the laboratory after the twentieth lesson, could not have distinguished the slow analyst from the fast. Education, it seemed, had overcome for the laggard his former inferiority. Training gave the mechanically dull as brilliant a surface as the genius.

The two then undertook to rebuild another block, identical with the previous, but half its size, six inches in length instead of ten, two inches high and wide, in place of six. The one who had untangled in half a minute the little knotty problems presented by the original set, solved the new with the same easy complacence; while he who had labored half an hour, but learned to perform the task as rapidly as the other, repudiated his training by losing twenty minutes in disentangling the second puzzle, despite its similarity of principle. Education, through constant repetition of the same task, taught the assembly of a particular set of wiggly blocks; but failed utterly to instil an analytical concept of the problem. Here is the first premonition—one that will grow as work proceeds—that, after the fourteenth or sixteenth year, when the child applies to the vocational school for specific training or to the world for work, his capacities are fixed; and, if they originated from early environment, are now so ingrained in his nature that he might equally well have been born that way.

After this revealing experience with two extreme men, who serve to emphasize the marked inequalities found in the mental make-up of persons outwardly alike, four thousand others were timed in assembling the squiggly blocks, amid the unchanging conditions of a modern engineering laboratory. The fastest quarter, the most rapid thousand, complete in two and three-quarter minutes or less; the slowest thousand score more than six. (See Appendix B, Norms, page 213.) As no human deed or thought or action can be rightly judged in itself either fast or slow or good or bad, the exhibition of the half-minute boy did not seem remark-able until contrasted with that of his companion. When compared with four thousand, he assumes his true status, not only outstripping his roommate, but attaining the acme of the group.

Of the four thousand people tested, many are mature holders of responsible positions. On segregating these by vocations one may discover those in which the rapid block assemblers prosper, and also the ones in which the slow men rise, despite their slowness; and so guide the boy with a ready gift for analyzing mechanical puzzles. Of those who finish within three minutes, many are successful in designing and construction engineering, designing drafting, scientific research, tool- and die-making, all-round machining, machine setting-up and repairing, and structural iron and sheet-metal work. Only an occasional representative of these professions exceeds six minutes.

The height of normal unselected men extends from six feet, three or four inches, downward to four feet, some inches. The height of soldiers, on the other hand, stops sharply at five feet, four inches for its lowest limit. Men who come below this figure are not admitted to the army. A study of the heights of policemen, and another of firemen, would disclose, at a glance, the limits below which men are excluded from these departments. No such obvious requirements are set up for admittance to the engineering profession; and yet, a comparison of the wiggly block distribution for successful engineers, Figure 6, with the curve for mankind, shows that rigid rules are operating. Practically all men, who require more than four minutes to assemble the wiggly block have been excluded from engineering. In the general curve, Figure 3 on the opposite page, one half of humanity exceeds this time; while only eighteen per cent of the engineers fall below. The same is true of mechanics and designing draftsmen. These three occupations have unknowingly set a standard of excellence as rigid as the fixed code of the United States army.

If mature engineers and mechanics have acquired, through experience in their work, this grasp of mechanical relationships, the college youth, who expended half an hour in deciphering the block, might, with safety, embrace engineering, and, in time, learn to solve such situations; but he had already attended a technical school of the highest standing, and for four years devoted himself, unsuccessfully, to the development of engineering abilities. The chance of progressing further in a reasonable period is slight. At best he would enter the profession with a decided handicap. This incident suggests that the defective analyst has little chance of overtaking his superior

EXPLANATION OF FIGURES 3, 4, 5, AND 6

EXPLANATION OF FIGURES 3, 4, 5, AND 6

FIGURE 3. DISTRIBUTION CURVE FOR ADULT MEN IN THE WIGGLY BLOCK, WORKSAMPLE NO. 5, MECHANICAL APTITUDE

Each button represents an adult man who has been measured in the wiggly block assembly. The figures in the right-hand margin indicate, in minutes and decimals, the times consumed. Thus, nine men finished the assembly in less than a minute; twelve others completed in between a minute and a minute and a quarter; and seventy-nine others took longer than 15 minutes or found the task impossible.

FIGURE 4. DISTRIBUTION CURVE FOR WOMEN IN THE THREE-PIN TEST, WORKSAMPLE NO. 16, FINGER DEXTERITY

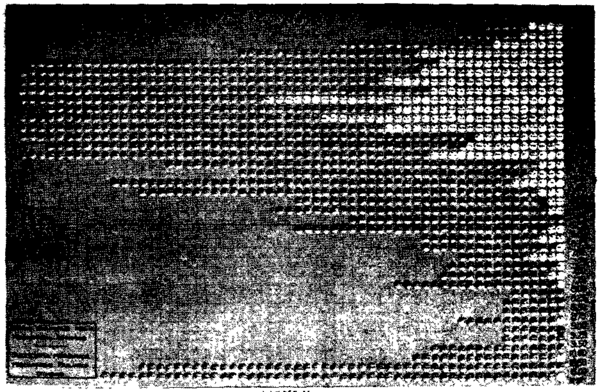
Each button represents an adult woman measured with the three-pin worksample. The figures in the left-hand margin show, in minutes and decimals, the times taken. Thus, twenty women performed the test in less than 6.0 minutes; sixteen others between 6.0 and 6.1 minutes; fifteen between 6.1 and 6.2 minutes; and thirty-two exceeded 10.5 minutes.

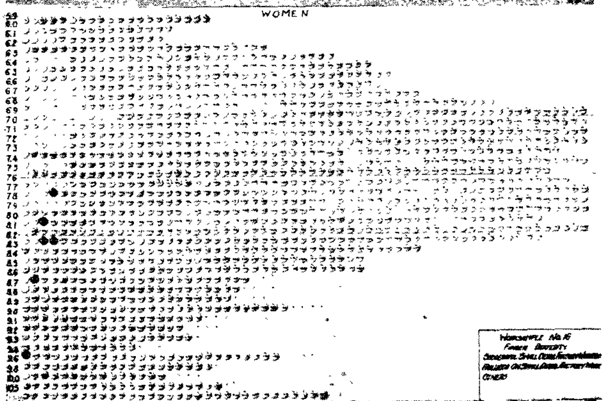
The black buttons indicate women engaged for rapid, delicate factory work and later discharged as unsatisfactory. The white buttons show others engaged under the same conditions but not discharged. The neutral buttons show still others who have not been tried on this particular type of work, and who are, therefore, not known successes or failures.

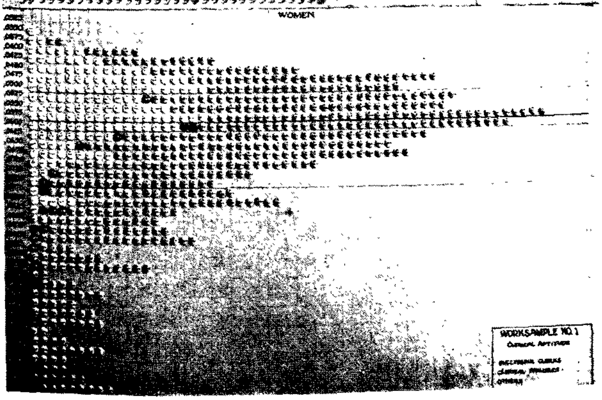
FIGURE 5. DISTRIBUTION CURVE FOR ADULT WOMEN IN THE NUMBER CHECKING TEST, WORKSAMPLE NO. 1, CLERICAL APTITUDE

Each button represents an adult woman measured with the number checking worksample. The figures in the left-hand margin show the scores obtained. The smallest numbers are the best scores. Thus, one woman, better in the number checking than all others, obtained a score between .0350 and .0375; four others, not quite so fast or accurate, scored between .0375 and .0400; and twelve others between .0400 and .0425; nine others, poorer than the group, exceeded .1600.

The black buttons indicate women, engaged for clerical work, but later discharged as unsatisfactory. If a heavy line be drawn across the chart at a score of .0600, 95 per cent of the black buttons fall below it. Thus, if every woman who applies for clerical work be measured with this worksample and those who come below .0600 refused clerical work, 95 per cent of the clerical failures might be eliminated.







FIGURES 3, 4 AND 5

FIGURE 5. DISTRIBUTION CURVE FOR ADULT WOMEN IN THE NUMBER CHECKING TEST, WORKSAMPLE NO. 1, CLERICAL APTITUDE—*Continued.*

The white buttons show other women, engaged under the same conditions, who have not been discharged; 70 per cent of these come above the same line drawn at a score of .0600. Thus, with this as a criterion, 70 per cent of the successful women might be engaged and 95 per cent of the failures eliminated.

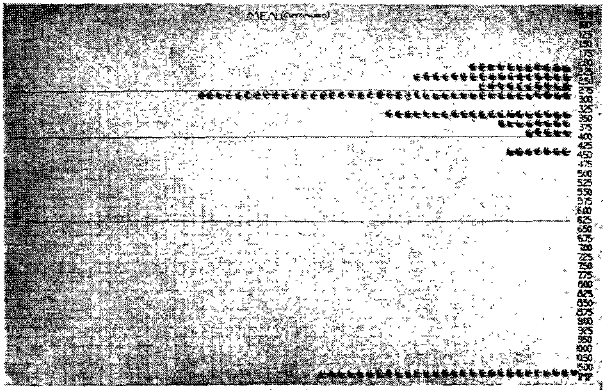
This seems an injustice to women who score below .0600 but who might make good, represented by the white buttons below .0600 line; but, if another step be taken, if an estimate of the grade of work of these be obtained and compared with the grade of work done by those who score above .0600, those above are, on the whole, more satisfactory than those below.

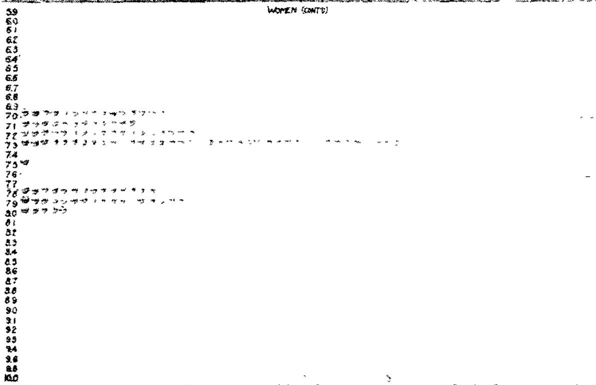
The gray buttons represent still others who have not been tried on clerical work and who are, therefore, not known successes or failures.

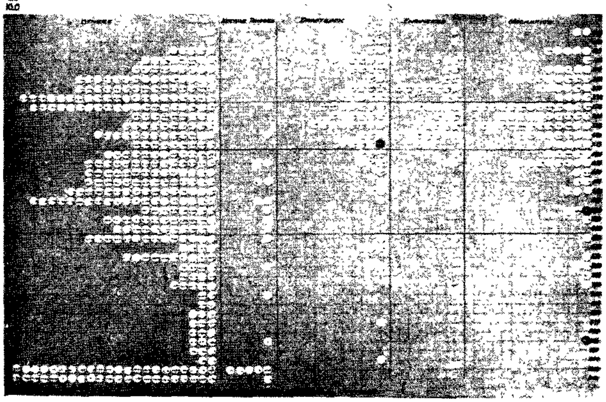
FIGURE 6. DISTRIBUTION CURVE FOR SELECTED GROUPS OF ADULT MALE WORKERS IN THE WIGGLY BLOCK, WORKSAMPLE NO. 5, MECHANICAL APTITUDE

The three horizontal lines across the chart divide an unselected group of workers into quarters. Thus, 25 per cent of an unselected group score above the upper line, and 25 per cent below the lower line. Reading across the chart from right to left the distribution curves are those of: first, mechanics; second, engineers; third, draftsmen; fourth, machine tenders; fifth, all others not included in the previous groups. It is seen that 82 per cent of the engineers are above the median (the center line), 75 per cent of the draftsmen; and 71 per cent of the mechanics.

The most interesting feature of the chart is the distribution of machine tenders. Not one scores in the upper quarter, and the majority are below average. The ability measured by the wiggly block is not needed in machine tending, but the next step in advance for a machine tender is to a high grade of mechanical work. All those machine tenders who originally graded A in the block have been advanced as mechanics; so that only those are left as machine tenders who originally lacked the aptitude measured by this test. A boy who is poor in this test should not be placed on machine tending because the logical road of advancement is to mechanical work, and he lacks the ability required.







FIGURES 3 AND 4 CONTINUED AND FIGURE 6

in the field; and that engineers solve the puzzle rapidly because the profession has excluded those who originally exceeded six minutes in the block solution; not as does the army by a careful examination of every applicant, and rejection of the unsuitable; but by admitting all, and after two, or five, or ten years, heartlessly discarding, on the scrap heap of humanity, those who originally came below four minutes on the block, and yet have given their best years to a profession for which they were unfit.

The other, the half-minute boy, has one qualification in common with successful engineers, designing draftsmen, and mechanics, and, in order to find daily opportunity of employing his ability to the full, should tread in the steps of such men. The half-hour boy lacks something which they exhibit, and would do well to avoid their occupations.

Manual dexterity, number checking, and the solution of a problem requiring mechanical analysis, show individual differences as striking as do physical characteristics. This holds for the extreme cases, and for the total distribution, represented by the performance of the fastest quarter, as compared with the poorest. Furthermore, these intangible unparallelisms are of vital significance to success and happiness.

In view of the fact that individuals vary radically, one from another, and that these differentials cannot be seen, it becomes of the greatest importance to measure accurately the abilities of every child. Guessing does not suffice. Human nature must be weighed and assayed with even greater care than that used in handling gold at the mint. Arthur Gosslett Smith in *The Desert,* tells of a venerable money changer of El Merb, near Biskra, in the Sahara, who could plunge his horn spoon into a bag of gold-dust, and judge an ounce nearly every time; but even he had learned to check himself on two metal discs, suspended by silk threads from the ends of a fern stem, balanced upon the edge of a knife. There are parents, teachers, and employers in industry, who, with a skill equal to that of old Hassan, the money changer of El Merb, select instinctively, the born accountant, the gifted engineer, but the skill of these few endowed mortals cannot guide every youngster to his own field. More absolute measures are needed, aptitude yard-sticks, calibrated mental rules.

CHAPTER II

Personality

One further halting step may be taken into the mystic region within which the student of human eccentricities has been groping his way from the visible size of man's physical frame, first, to one of his invisible, physical attributes, dexterity; and then, through the more or less obvious checking of numbers, to reasoning and the tenuous subtlety of the wiggly blocks.

James Huneker, most fascinating of modern critics, who, through the strings of his own temperament, transformed every art which he touched into a vibrating, inspiring, soul-stirring chord, called Henrick Ibsen the best hated artist of the nineteenth century, a mystery to his friends and foes. Richard Wagner did everything possible to provoke antagonism. Ridicule, calumny, vituperation pursued Edouard Manet for many years. But neither surpassed Ibsen in massiveness of martyrdom, and one must go back to Byron and Shelley, both more subjective, more individual, for examples of such unanimous condemnation as Ibsen inspired. What causes these violent storms, and makes such different men akin?

The special ability which enabled Ibsen to conceive *The Wild Duck*, or *Hedda Gabler*, or *The Master Builder*, would have been useless to Manet, standing, brush in hand, before his easel. The thundering chords of Wagner, had they reverberated in Shelley's mind, would have destroyed his sweetness. The link between these men is not similarity in special abilities, such as connected the Venetian painters, but a kinship in personality. Each viewed life at variance with the accepted standard of the time; and, because he *differed*, brought upon his head an incessant rain of criticism.

Even such *personality* contrasts can be measured by a device which indicates crudely the division between those who associate easily with their fellow-beings, and others marked as *different*, cyclone centers about which rage the winds of public opinion.

Read aloud a single word: TABLE. (See Appendix B, Worksample No. 35, page 217.) Request the hearer to name instantly the first related or connected word which comes to his tongue. An immediate response betrays the unconscious attitude of the answerer toward life. A research physicist who offered himself as a victim for experimentation, responded *dog*. Although the connection seemed remote and inappropriate, he explained that, often in the evening at home, when he sat down to read, his dog slept under the table beside him. The reply, when amplified, was logical; the physicist thought of an individual experience, his own table, his own dog, and room, and home. A highly skilled die-maker, an artist in his field, replied *old*, because the previous Sunday he had mended an old table. A draftsman, responding *antique*, had in mind a particular heirloom. Only one among a thousand answered *dog;* only one, *old;* only one, *antique*. Of the same thousand people, two hundred and sixty-seven answered *chair* to TABLE. None knew why. TABLE-*chair* relates no incident peculiar to the lives of these men. Their first thought was objective, not personal. In the following partial list, the figures in parentheses designate the number of individuals, among one thousand tested, who made each reply (see Appendix C, page 225):

Chair	(267)	Chemical	(1)
Wood	(76)	Dissection	(1)
Furniture	(75)	Ferns	(1)
Eat	(63)	Ink	(1)
Cloth	(57)	Kitchen	(1)
Dinner	(26)	Lamp	(1)
Hard	(9)	Number	(1)
Book	(7)	Operating	(1)
Play	(4)	Polished	(1)
Breakfast	(2)	School	(1)
Broad	(2)	Spiritualism	(1)
Old	(1)	Typewriter	(1)
Antique	(1)	Whist	(1)
Dog	(1)		

What does a word tell of the personality of the man? He who responds *chair*, concurs with the majority; his first thought identifies him with a controlling percentage of humanity; he is in perfect accord with two hundred and sixty-seven others from every thousand, sympathizes with their mode of expression, foresees their reactions, and feels himself akin with the world; the result is far-reaching. When he speaks, others nod in approval—he has expressed their own thought. He speaks again with more confidence and self-assurance; gradually usurps command; ultimately often dominates.

The score in the test, the number of others from every thousand who give the same reply, is a man's group contact. *Chair* replied to TABLE counts two hundred and sixty-seven, because so many in every thousand make the answer. TABLE-*wood* scores seventy-six points, for this thought occurs to seventy-six others. The indication goes deeper. The unanimity of so large a number of people suggests that the relation, TABLE-*chair*, epitomizes a general concept. Any table may associate with chair; every table is furniture—the third most usual word; most are wood—second in popularity. A word on which several hundred persons concur bears an objective relation to the original stimulus. So many answerers would not be likely to agree in lighting upon an identical personal retort.

TABLE, considered impersonally, creates comparatively few suggestions. TABLE, meaning a specific, individual, or well-known object in one's own home, arouses instantly a thousand recollections. TABLE, in the abstract, is not *antique, old,* or *polished;* these thoughts apply to individual examples. What then of the man who makes such replies? His answers epitomize his life; he differs from the multitude; he acts a monologue in the world drama. He fails to comprehend the impulses of the majority, or the tie which binds it together, apparently against him.

Modern science calls him the *introvert* and his antithesis, the *extravert.* No mortal is wholly the one or the other. The words express directions, not positions. On the whole, the extravert is objective, views the world impersonally; the introvert interprets existence subjectively, follows his own thoughts, evolves his own ideas, applies chance remarks to himself, and lives largely alone.

To enhance the isolation of the introvert and increase his embarrassment, his reactions are personal, and discover, to the world's gaze, his bare soul. In answering to TABLE, only one in a thousand gave *chemical*, only one, *dissection, ferns, ink, kitchen, lamp, number, operating, polished, school,* *spiritualism*, *typewriter*, *whist*. Each word tells something of the man, and a little imagination reconstructs scenes from his life. Probably a doctor or nurse answered *operating;* a medical student, *dissection;* a stenographer, *typewriter;* a card player, *whist*. One word gives little information, but a perusal of one hundred personal answers discloses the life of the man.

Table 2 lists the reactions of an extreme introvert, while the figures in parentheses tell the number of persons in a thousand who give a similar response. The replies, *Malden*, given to both the seventy-ninth and eightieth words, CITY and SQUARE, betray the man's residence; and, joining with *Russell* to STREET, supply his complete home address. Thus, unconsciously, in his first thought, the man revealed a portion of his personal life. In addition, he answered *G. E.* to WORKING, thereby naming his employer. To both PRIEST and RELIGION, he reacted *Catholic*, stating correctly his own faith. Two answers—GIRL-*sweetheart* and OCEAN-*beaches*—indicate the man's youthfulness; and a third—BABY-*sisters*—coupled with these, shows that, in all probability, he is unmarried. The fifteenth—SHORT-*self*—states the man's height and his thought of himself. He is, by this one response, introvert to some extent.

Of a slightly different type are the replies indi-

TABLE 2

Reactions of an Extreme Introvert

1.	TABLE	*legs*	(10)
2.	DARK	*light*	(427)
3.	MUSIC	*singer*	(1)
4.	SICKNESS	*health*	(142)
5.	MAN	*woman*	(394)
6.	DEEP	*river*	(13)
7.	SOFT	*hard*	(365)
8.	EATING	*nice*	(3)
9.	MOUNTAIN	*Kearsarge*	(0)
10.	HOUSE	*home*	(103)
11.	BLACK	*white*	(339)
12.	MUTTON	*sheep*	(204)
13.	COMFORT	*easy*	(61)
14.	HAND	*fingers*	(83)
15.	SHORT	*self*	(0)
16.	FRUIT	*apple*	(157)
17.	BUTTERFLY	*country*	(2)
18.	SMOOTH	*nice*	(4)
19.	COMMAND	*army*	(16)
20.	CHAIR	*table*	(191)
21.	SWEET	*candy*	(82)
22.	WHISTLE	*blowing*	(6)
23.	WOMAN	*girl*	(59)
24.	COLD	*winter*	(120)
25.	SLOW	*person*	(8)
26.	WISH	*thought*	(47)
27.	RIVER	*deep*	(35)
28.	WHITE	*black*	(305)
29.	BEAUTIFUL	*woman*	(29)
30.	WINDOW	*frame*	(5)
31.	ROUGH	*woods*	(0)
32.	CITIZEN	*father*	(0)

TABLE 2—*Continued*

33. FOOT	*twelve inches*	(0)
34. SPIDER	*legs*	(27)
35. NEEDLE	*sewing*	(107)
36. RED	*flag*	(16)
37. SLEEP	*bed*	(75)
38. ANGER	*mad*	(121)
39. CARPET	*nice*	(2)
40. GIRL	*sweetheart*	(2)
41. HIGH	*mountain*	(157)
42. WORKING	*G. E.*	(0)
43. SOUR	*apple*	(27)
44. EARTH	*world*	(46)
45. TROUBLE	*sorrow*	(202)
46. SOLDIER	*army*	(137)
47. CABBAGE	*garden*	(43)
48. HARD	*soft*	(367)
49. EAGLE	*American*	(12)
50. STOMACH	*pain*	(28)
51. STEM	*watch*	(7)
52. LAMP	*light*	(650)
53. DREAM	*sleeping*	(39)
54. YELLOW	*green*	(41)
55. BREAD	*butter*	(151)
56. JUSTICE	*law*	(74)
57. BOY	*childhood*	(0)
58. LIGHT	*dark*	(231)
59. HEALTH	*sickness*	(153)
60. BIBLE	*scripture*	(17)
61. MEMORY	*brain*	(46)
62. SHEEP	*hills*	(0)
63. BATH	*water*	(339)
64. COTTAGE	*bungalow*	(13)
65. SWIFT	*river*	(18)
66. BLUE	*American flag*	(0)

TABLE 2—*Concluded*

67.	HUNGRY	*money*	(0)
68.	PRIEST	*Catholic*	(36)
69.	OCEAN	*beaches*	(0)
70.	HEAD	*eyes*	(10)
71.	STOVE	*fire*	(217)
72.	LONG	*rule*	(2)
73.	RELIGION	*Catholic*	(56)
74.	WHISKY	*prohibition*	(2)
75.	CHILD	*baby*	(193)
76.	BITTER	*hate*	(0)
77.	HAMMER	*tool-box*	(0)
78.	THIRSTY	*water*	(341)
79.	CITY	*Malden*	(0)
80.	SQUARE	*Malden*	(0)
81.	BUTTER	*bread*	(206)
82.	DOCTOR	*sickness*	(104)
83.	LOUD	*speaker*	(0)
84.	THIEF	*burglar*	(118)
85.	LION	*cages*	(0)
86.	JOY	*happiness*	(215)
87.	BED	*sleep*	(345)
88.	HEAVY	*iron*	(70)
89.	TOBACCO	*cigar*	(19)
90.	BABY	*sisters*	(0)
91.	MOON	*night*	(66)
92.	SCISSORS	*cutting*	(114)
93.	QUIET	*home*	(6)
94.	GREEN	*fields*	(10)
95.	SALT	*pepper*	(142)
96.	STREET	*Russell*	(0)
97.	KING	*queen*	(354)
98.	CHEESE	*butter*	(136)
99.	BLOSSOM	*spring*	(23)
100.	AFRAID	*darkness*	(16)

cating his likes and dislikes, such as—EATING-*nice;* SMOOTH-*nice;* CARPET-*nice;* BITTER-*hate.* Other, more far-fetched inferences may be drawn as to the man's occupation and past experiences: that he uses a tool-box, a foot rule, and a long measure and is, therefore, a carpenter, plumber, or electrician, follows from FOOT-*twelve inches;* LONG-*rule;* HAMMER-*tool-box.* His trade, in reality, is that of an electrician. He owns an automobile, as suggested by the reaction ROUGH-*roads.* The father, born in Scotland, had recently become a citizen of the United States:—CITIZEN-*father.* Further light is thrown on his personality by BUTTERFLY-*country;* SHEEP-*hills;* QUIET-*home;* GREEN-*fields;* AFRAID-*darkness.* That absurd inferences should not creep into this analysis of the man, these deductions were made by one who had never seen him and knew nothing of his home life or personality. They check exactly with facts; are the intimate impress of that indwelling soul which Walter Pater denominates the peculiar fascination of Italian art in the fifteenth century.

Compare these which betray so much of the inner man, with typical extravert replies to the same words (see Table 3). They furnish not one suggestion of the extravert's personality. Realizing that his life is open to the ridicule of the multitude, the introvert grows aloof, reticent, and self-contained; or, occasionally, instead of retiring quietly, blazonly trumpets forth his opposition. The world either imprisons him as a disturber; or,

TABLE 3

Typical Extravert Replies

8. EATING	*food*	(170)
15. SHORT	*long*	(279)
17. BUTTERFLY	*insect*	(261)
18. SMOOTH	*rough*	(277)
31. ROUGH	*smooth*	(346)
32. CITIZEN	*man*	(278)
33. FOOT	*hand*	(185)
39. CARPET	*floor*	(256)
40. GIRL	*boy*	(350)
42. WORKING	*labor*	(147)
68. PRIEST	*minister*	(178)
69. OCEAN	*water*	(427)
72. LONG	*short*	(413)
76. BITTER	*sweet*	(305)
77. HAMMER	*nail*	(185)
79. CITY	*town*	(258)
80. SQUARE	*round*	(250)
90. BABY	*child*	(239)
93. QUIET	*still*	(136)
94. GREEN	*grass*	(284)
96. STREET	*road*	(91)

as in the case of Byron and Shelley, turns to accept his philosophy, his beauty, his ideals, as its standard. Life is difficult for the introvert. An extravert seldom martyrs himself for any cause.

CHAPTER III

Limitations in Adult Education

Watch the beautifully coördinated strides of a cat as he glides majestically along the fence top, and let the reader endeavor to progress likewise on all fours, even though only across the level floor, advancing the right hand and left foot simultaneously, then the left hand and right foot. Locomotion is slow and awkward. Has the cat a greater brain than the reader, which enables him to control every muscle with such perfect precision? Can he *think* the complex pattern more clearly? Or has he learned the nice handling of his limbs through imitation and necessity? Or, a third possibility, if neither conscious *thought* nor *acquired training*, may this feline management of perfectly synchronized muscles be inherited from a line of ancestors? Muscular control through mental capacity, coördination resulting from training, or an inherited potentiality, are three theses.

Petition a skilled surgeon to place the animal under heavy anæsthesia and extract its forebrain, its cerebrum. Now unconscious, deprived of the brain which voluntarily initiates endeavors, it no longer directs actions. Despite the deprivation, the legs, although unable to support the weight of the body, move in a walking rhythm still more perfect than that of the human being attempting to crawl. The left fore and right hind feet advance concurrently without the intercession of the cerebrum, coördinated by means of reflex arcs—the progression reflex—operated from centers in the spinal cord. Touch the decerebrate cat's ear as if a fly had alighted, and the ear twitches nervously—the pinnar reflex—ostensibly freeing itself of the irritation, but, because of the absence of the cerebrum, necessarily the automatic result of stimulating a hair. The fore limbs of a cat bend mechanically when the head lowers, to peer under the sofa for a mouse. Occasionally, on whistling to the cat whose cerebrum has been removed, the tail wags—again, a reflex motion.

As a lingering doubt still disturbs the minds of many, and a feeling persists that, granted the absence of the cerebrum, the animal impels its legs, twitches its ear, and wags its tail consciously, the same surgeon severs the entire head, including both cerebrum and cerebellum. Keeping the body alive by artificial breathing, support it in a standing position. On advancing one leg as before, the others move in unison. The nerve impulse, which controls progression, need not enter the head. Conscious brain control is an unnecessary accompaniment to many customary actions.

The surgeon now proceeds a step further and cuts the spinal cord in the middle of the back, between the fore and hind limbs. Touch the right hind leg as if the cat had stepped on a sharp stone, and it lifts, drawing away from the annoyance; the flexor muscles contract while the extensors relax. Concomitantly the left leg stiffens to carry the weight of the body; the stimulation synchronously inhibits the extensor muscles of one side and contracts those of the other. The behavior exhibits every manifestation of issuing from conscious reasoning, withdrawing the leg from the pain, and yet arises from a contrivance—the crossed extension reflex—as divorced from the brain proper as the push of a piston at the explosion in the cylinder.

Severing thus the spinal cord eliminates from the picture the forward half of the body; but, as the philosophical discussions of the past locate the seat of consciousness in every conceivable part of the organism, the surgeon takes one further step toward the elementary. A single isolated nerve and the attendant muscle which it incites—the nerve-muscle preparation—can be taken from the body and kept alive several hours in a moist chamber. On exciting such a nerve, either mechanically, by a gentle tap, or electrically, by an induction shock, an impulse passes along the fibres, into the muscle, and causes it to act. This beautifully operating bit of mechanism, unconnected with a living organism, functions apart from the brain, and involves no *thinking*.

Human beings pride themselves on ability to make conscious decisions, but most of their familiar actions are operated by these same self-acting reflexes. Why do some golfers go around an eighteen hole course with fewer than seventy strokes, and others make—and even occasionally score—twice as many? The dicta of the professional are extremely simple. *Keep the eye on the ball*—any child can do that! *Do not raise the head. Grip slightly harder with the left hand than with the right. Follow through.* Clear directions all; and yet watch a beginner! The club makes but half its swing when the novice looks up, hoping to catch a glimpse of the white speck sailing toward the green: and finds it still on the tee untouched. *Keep the eye on the ball! Do not look up!* reiterates the professional. The pupil does as told; but the club stops short, this time with no *follow-through*. *Now combine the two.* Impossible! No beginner can apprehend two contemporary thoughts. Nor can the professional. The *follow-through* is not *thought;* but a reflex motion regulated by centers in the spinal cord. The golfer, who would keep his eye on the ball and follow through coincidentally, must habituate a reflex arc to care for one of the two, so that he may concentrate on the other.

Even walking is not *thought.* Attempt to control, consciously, the play of every muscle in approaching the first tee. An impossible task. Man walks successfully because reflexes, which never enter the brain, operate more than nine tenths of the muscular machinery. Bend one knee by shortening the flexor muscles, and not only do the extensors automatically relax in order to free the flexors, but the other leg involuntarily stiffens to receive the unbalanced weight of the body.

The intelligence of a great philosopher, or logician, or historian, far above average, often sinks into insignificance when the man attempts to use his hands. He needs not *thought*, but, again in scientific terms, reflexes, to operate magically detached from his conflict with the gusty gale of fathomless inquiries. Forget then, for the moment, the word *intelligence*, whose mention starts an avalanche of half completed controversies, forget *thought* and *reasoning*, and regard the simple experiment of the previous chapter, the placing of three pins at a time in a drilled hole, as a combination of reflexes, devoid of *thought*, independent of either high mental equipment or low, or any nicely specified intermediate amount.

Are these automatic reflexes acquired by practice? A small child portrays, to some degree, a picture of life without them. Yet he, in time, learns, acquiring ultimately a full accoutrement. Is this true learning or the maturing with years of an inherited potentiality? George A. Dorsey[1] tells of a babe, born without a brain, who grasped, by reflex action, anything which touched the palm of its hand. The difficulty of picturing this grasp reflex of a brainless child, developing without a brain to inaugurate its initial stages, suggests its coming by inheritance, and its development as a concomitant of physical growth and not a true learning.

The condensation of the fixed adult from his nebulous beginning continues an enigma to the physiologist. Can any one acquire the unerring swing of a true golfer? Does the school system spread over the United States, the most extensive ever attempted by any country, bring forward the laggards, reduce the unevenness of mankind, start men on a more comparable footing? Life so confounds the issue as to render it inextricable from other factors whose intricate complications defy unravelling until further light illumines some underlying laws of human nature. The much discussed

[1] G. A. Dorsey, *Why We Behave Like Human Beings* (New York: Harper & Brothers, 1925). p. 286.

golfer is little understood and too involved a subject for the twentieth century biologist, who advances as rapidly as a bright pupil in a primary grade; but, in comparison with his future possibilities, has not yet graduated from elementary work. Child development is one of the most mysterious of human processes and its study should follow and not precede an interpretation of the adult.

To investigate the problem of learning, the student must return to the laboratory and the human engineer's apparatus—the three peg board—and the simple reflexes involved. Is this particular type of finger dexterity the outgrowth of education? of adult experience? of high school manual training? of kindergarten pasting and cutting? or is it in part bestowed upon an individual by inheritance, and subject to limitations not wholly obliterated by external environment? Although the world considers physical height a nearly unalterable fact, augmented slightly by exercise, but never materially increased, it thinks of finger dexterity as the result of past experience. Can it be captured by either unremitting zeal or early training?

One of the slowest girls to finish the pins, requiring over fifteen minutes her first day in the laboratory, showed a gain on second trial, needing but twelve. In a series of thirty practice periods, spread over a month, she improved steadily until she subtracted nearly a third from her original time. Similar improvement rests within reach of every person sufficiently patient to repeat the assembly.

By the same token all skills are susceptible to almost limitless development through reiteration. Few mortals have ever attained the ultimate within their power. The performance of a girl who picked up one hundred and thirty pins a minute, advanced by ten trials to one hundred and sixty. F. Lyman Wells found that an individual making two hundred and ninety additions during the first five minutes, reached, at the thirtieth trial five hundred and forty, an enormous advance. In an experiment recorded by W. F. Dearborn, a subject, who, during a twenty minute test, substituted one hundred and fifty shorthand symbols for common English words and phrases, improved, in the sixteenth similar practice period, forming one thousand such substitutions; and so the list might continue. The laboratory, with its controlled conditions, corroborates the popular feeling that dexterity, and many more obscure mental functions, may be cultivated. Amid the criticisms levelled upon education because of its abject failure to instil thinking in the youth, the school may justly claim one accomplishment; it can, through persistent rehearsing, increase facility in any line. Every skill is amenable to that discipline whose tremendous possibilities are occasionally exaggerated, but more often underestimated.

In cases where there has been past contact with peg-board assembly, the differences found between persons may result either in whole or in part from such preliminary training. Yet children are not born alike; and before entering the human engineering laboratory, only the rare exception has confronted the peculiar problem of picking up such small brass pins. Although repetition of this particular act improves its performance, a negligible few have had adequate opportunity to habituate themselves to such specialized reactions; and protracted exercise in other handicrafts involving dexterity exerts no evident effect upon the three pin time.

Twenty persons assembled the pins once, as fast as possible, with scores varying from six to twelve minutes. Then, once a day for two weeks, half of these subjects assembled one hundred of the same pins, one by one, with tweezers similar to those employed by instrument workers and watch repairers (see Figure 7 and Appendix B, Worksample No. 17, page 215), a task which apparently requires considerably more dexterity than the finger worksample, and which should

FIGURE 7. WORKSAMPLE NO. 17, TWEEZER DEXTERITY

Apparatus used in measuring the tweezer dexterity of factory workers who apply for positions requiring the use of tweezers, such as miniature instrument assembly or glass blowing.

train the muscles of the hand in delicacy of touch and rapid manipulation. The balance of the group remained idle. The workers with tweezers improved remarkably during the ten days, so that their times at the end were a third less than at the beginning. They had learned to use these refractory tools far more skilfully than before entrance into the laboratory. Yet, on reperforming the task with fingers, after this tweezer training period, they gained no more over their initial endeavors than those without intervening tweezer drill. The acquired efficiency failed to carry over from the tweezers to the fingers. (See Table 4.) The same is true of other performances.

The rapidity of the easy pin assembler does not eventuate from drill in manual operations other than the peg-board itself. Even long previous participation in highly skilled handicrafts fails to aid. Among two thousand inexperienced applicants for factory positions, eight finished the pins as rapidly as the fastest skilled woman, who had spent five years in a factory position, requiring extreme finger dexterity, and whose training unquestionably far exceeded any which the applicants may have previously gained from sewing or other household occupations. Over a hundred inexperienced women surpassed the average of the skilled group. If training in handling small parts

TABLE 4

Comparison of Group Using Tweezers With Group Not Using Tweezers

	GROUP WHO PRACTISED WITH TWEEZERS	GROUP WHO DID NOT PRACTISE WITH TWEEZERS
Average Time on 16, First Trial	8.04	8.28
Average Time on 17, First Trial	5.59	
Average Time on 17, Second Trial	4.64	
Average Time on 17, Third Trial	4.78	
Average Time on 17, Fourth Trial	4.38	
Average Time on 17, Fifth Trial	4.61	
Average Time on 17, Sixth Trial	4.43	
Average Time on 17, Seventh Trial	4.23	
Average Time on 17, Eighth Trial	4.12	
Average Time on 17, Ninth Trial	4.14	
Average Time on 17, Tenth Trial	3.94	
Average Time on 16, Second Trial	7.57	7.49
Ratio: $\frac{\text{First Trial}}{\text{Second Trial}}$	1.06	1.10

In the actual experiment those without intervening drill with tweezers improved slightly more than the others. This seems to be a purely chance result. Twenty-four hours elapsed between each of the trials so that fatigue should not have entered. In this experiment, the total time for Worksample No. 16 (one hundred holes) was measured, and not the time for each half as is now required. See p. 215.

contributes to the initial pin performance, even to a minor degree, the speediest experts on fine instrument assembly should easily outdistance all amateur rivals. Although a novice rarely achieves such high speeds, the fact that even one, occasionally, without experience, equals the best skilled operator, proves that the wide variation among adults in their initial performances of the three pin task, the ability of some to finish in six minutes and the inability of others to complete in twice this time, does not result wholly from the past training of some and the unfamiliarity of others. Schooling certainly modifies the innate capacity with which every mortal is gifted; and yet something very close to what one must call a natural aptitude plays at least a part, and apparently a predominant part, in determining the speed of the first three pin trial.

One hesitates to believe any performance so slightly affected by experience. This is, however, only a single case. Most achievements of life depend inseparably upon training. Even many manual operations are not of this inherent type. One can as yet draw no sweeping conclusions about the relative importance of heredity and environment; but must study, individually, every human action and determine to what extent it is amenable to education, and to what degree possessed by untutored persons.

Research discloses many reflexes where environment, in the form of experience, far overshadows initial capacity. A woman, who had used a screw-driver, for four years, in connection with miniature instrument assembly, turned the handle of a laboratory apparatus, simulating a screw-driver and pictured opposite, fifty-nine times in half a minute. The fastest uninitiated applicant scored but twenty-seven. The habituated person produced double the output of the unversed. The reflex, if it can be called such, results from experience with a screw-driver, and among novitiates never approximates the average skilled result. The extent to which the fastest trained examinee outdistances the most rapid novice supplies one means of discovering the degree to which training influences the performance. In the three pin task the quickest experienced person does not surpass the speediest inexperienced. Training is ineffective. With the screw-driver the fastest experienced girl makes twice the turns of the most rapid inexperienced. Training here doubles efficiency.

Furthermore, with the screw-driver, the variations from one novice to another are slight compared with those between skilled persons and a little training soon obscures the originally low dispersion which existed. This is one of the diag-

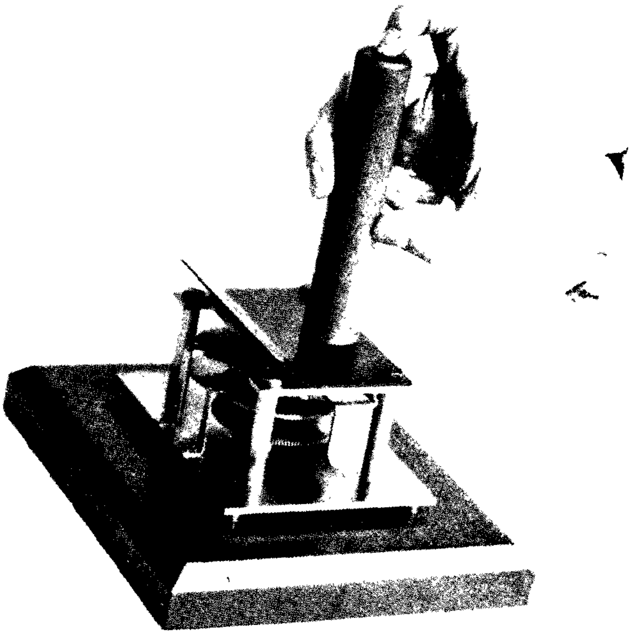


FIGURE 8. WORKSAMPLE NO. 57, SCREW-DRIVER SKILL

This apparatus measures skill rather than ability and should not therefore be used in predictory success or failure.

nostic points which separates an acquired from an innate function. When both are measured in amount of work completed in a given time, trained persons vary more among themselves in the former, the acquired function, than do untrained; in the latter, less.

With the three pins practice exerts its influence, but the initial differences endure. Two girls, one consuming twelve minutes and the other but half as long in assembling the pins, repeated the task. The former reduced her time to eleven minutes; while the latter needed but five and one-half. Both improved, but the faster girl still finished in half the time of the slower. Practice helped both; and yet the relationship of two to one maintained. The pair continued through ten trials to thirty. The times lessened radically over the first attainments; the twelve-minute girl ultimately taking but eight, the six-minute girl only four; and yet, at the end of the thirtieth day, the slower beginner still absorbed double as long as the faster. Education achieved important results in cultivating greater efficiency, but when administered in equal amounts did not overcome the initial differences in the three pin assembly time or alter the incipient standing.

Thus far laboratory experiments have been the sole subject of discussion. Skilful tennis, piano-playing, and golf, all difficult performances, are known to be dependent upon practice. Yet, in the complicated skills, where technique hinges upon the same peculiar adroitness disclosed by speed with the pins, the effect of training is minor compared with the initial test score. The energy required and time consumed by the ungifted, in gaining proficiency through monotonous repetition, far overbalances the sacrifice.

Among sixty-six girls, selected by a factory employment manager, through the customary interview, and hired for small assembly work, fifteen lacked aptness with the pins, exceeding 7.60 minutes.[1] The livelihood of these girls depended upon their ready manipulation of small instrument parts; and they dedicated eight and a half hours a day to rousing into play their dormant muscles and sinews; and yet, within a year, six of the fifteen were dismissed by the foremen in charge as unsatisfactory. Ultimately they might have learned; but, in comparison with fifty-one others possessed of latent speed, indicated and measured by fast pin time, not one of whom was discharged, the slow girls, playing parts foreign to themselves, showed so poorly that supervision soon realized its inability to afford the excess cost.

[1] Time for first half and therefore *score* in test equalled 3.98. See p. 215 for scoring.

Of the fifteen, slow in the pin test, in addition to the six asked to leave in the first year, five became discouraged with the vague weariness which accompanies fruitless exertions amid inclement surroundings and voluntarily severed their connection with the company. Eleven of the fifteen destitute of the dexterity shown by the three pin test, failed to win it. This new mode of action could not be engrafted upon an uncongenial native stock.

One of the remaining four, who escaped dismissal and discouragement, wrestled for nine months, satisfied with mediocre accomplishment. The day she was engaged another girl, fast with the pins, was given similar work. The rapid girl took serene possession of her assigned allotment the first week in the factory; the other, with a slow score in the pin assembly, consumed two months and a half gleaning equal facility at the same operation. At the expiration of nine months, the fast pin assembler made half again as many finished parts a day as the other. The interest and persistence of the slow girl has not enabled her to learn muscular deftness.

Not only does the inapt girl lose the position which depends upon her acquiring dexterity, or succumb to jaded discouragement, or continue as a slow, mediocre plodder, but she may even approach a nervous breakdown because of the too great dependence of her welfare upon achieving an intangible aptness. She sees life's conflicts approaching and overwhelming her feeble efforts more rapidly than she can pick up a characteristic which others unconsciously possess.

A factory operator, slow with the pin-board, located on small rapid fabricating, completed a production of nine hundred meter parts a day. The management, after careful study, considered twelve hundred a just requirement. The girl, honestly expending her whole energy, feeling that her employer had singled her out as a special victim, trudged home exhausted at night, complained bitterly during the day of factory conditions, and the injustice of expecting impossibilities; and, for several months, created an unbearable atmosphere throughout her section of the shop. She distrusted visitors who stopped for a moment to observe her product, imagining them sent to spy on her actions, and record the time she rested or wasted.

Such a laborer, ill-adapted to her task, but driven to it, daily, by the needs of her home, develops not only physical signs of over-fatigue, but symptoms associated with mental disorders. The apprehensions of this girl differ little from those of some mentally diseased, hospital inmates, who display, as one of the first auguries of the impending breakdown, a suspicion that unknown persons are following them through the streets, spying on their actions, and who feel that the world has selected them as its particular victims.

A new girl, gifted with the cunning finger of a born craftsman, as shown by her assembly of the pins, was given the same work. The second week she averaged twelve hundred pieces, and now turns out well over fifteen hundred. The unhappy original holder of the place, transferred to another operation, seemingly more involved, but for which her execution of a sample indicated her suitability, almost immediately succeeded, with a significant alteration in personality and change in attitude toward her employer and the world. She now enjoys her occupation, is happy, satisfied with conditions, and returns home at night rested. She even studies music evenings. Proud of the fact that she performs her new work well and easily, she welcomes visitors.

A lackadaisical, slovenly craftsman, turning from an unsuitable task to one fitting his abilities, by some mysterious metempsychosis, acquires desirable general characteristics. Many souls give out their sweetest perfume only in the loosening winds of a congenial environment. Perfect adaptation does not assure the coveted goal; one cannot loll complacently in an easy chair; but a surprisingly large percentage of those whom scientific measures demonstrate are properly located push contemptuously aside, without apparent energy or concentration, the turbulent crowd of petty rebuffs which assail every one and sway the misplaced.

Not enough cases have as yet been examined to know the full danger of forcing oneself to overcome a disability, certainly there is little harm where the task is undertaken for pleasure and the development of a fuller individuality. But as of a thousand seeds, scattered by the wind, one matures, so the instance of this factory girl, if confirmed by others, may show that, where life depends upon the issue, blind, hopeless struggle against seemingly insurmountable barriers contributes to the filling of our psychopathic institutions.

Two factors unite in destroying normal mentality; first, inheritance, for a predisposition received from ancestors contributes materially to the mental ailments which appear. On careful search such a tendency crops up in the most unsuspected quarters, and one wonders if any family is wholly immune. Fortunately an inherited trait alone does not suffice to cause trouble, and an impaired mental equipment may steer the body through life oblivious of weakness. To predetermine the break, the predisposed mind must receive an unwonted jar or be fomented by undue tension, such as caused by the present vague and uncertain pairing of problems and men. Although psychiatrists are rapidly advancing in the treatment of mental disorders, once the disease breaks out, the case demands individual handling and consumes many hours. In one hundredth the time necessary to cure, the mental hazards which the modern world invariably arouses can be mitigated; for, partly unwittingly, and partly with the secure feeling that gigantic effort invariably develops strength, civilization continually orders plainsmen, ignorant of mountain structure, to climb a Matterhorn. Wanton destruction of many to assure a few men problems sufficiently formidable to develop their capacities is not a reasonable solution. Were the victims of misplacement always the dross and dust of society, their elimination through improper guidance might justify the present procedure; but every psychopathic institution sees youths of promise wrecked by circumstances.

Between life's tragedies and picking up brass pins yawns a seemingly impassible chasm. Yet as the Lycosa, the black-bellied tarantula, spins a dozen gossamer threads and leaves them dangling in the breeze until one catches to bridge a gap, so the scientist makes many assays until one shows a thread of truth on which to cross the next chasm of the unknown. Extraordinary facility in filling the three pin board ensues from persistent repetition; but the initial speed is contingent upon the degree of aptitude possessed at fifteen or sixteen, and not upon subsequent environment. The wide discrepancies between the times in which the pins are first assembled do not result from differences in adult training.

As a Roman nose, and high cheek bones, and a Hapsburg lip, persist through the maturing of the features and appear equally discernible under the fresh skin of youth or the dried wrinkles of age, so this aptitude exists in the boy and the mature man, an integral part of the complex collection of traits called an individual. Although attainable in part by conscious practice, it is not mastered in the time and with the energy an individual can afford to expend; and one who lacks it, but enters an occupation demanding it, endangers his position, his income, and even his mental balance.

CHAPTER IV

Early Training

The charm of youth resides in a confidence which sees no obstacle as unconquerable. The weakening of this buoyant optimism, and the recognition of an occasional restriction, forebodes the approach of age. Science must never lessen a courage it cannot replace; but, by gently dispersing the clouds of misapprehension which conceal the enchantment of reality, may forestall the sudden realization of an inability after some humiliating failure.

The effect, on the initial pin-board speed, of prior adult experiences, even of long years of conscientious application to factory work demanding extreme dexterity, is too microscopic to reveal itself under the scientist's present technique. Although almost any desired facility in assembling the three hundred pins follows persistent repetition, the skill thus acquired is extraordinarily narrow in scope, and in no way approaches general deftness. Dissimilarities of previous post-adolescent training cause certainly less than ten per cent of the pin-board discrepancies between normal persons.

The number checking, already described, when submitted to the same analysis, leads to a similar conclusion. Education plays no measurable part in causing the distinctions found. Number checking simulates closely the type of subject matter rigorously taught in both high school and college, and might conceivably show the consequence of such instruction. Furthermore, in the history of the human race, number sense is a more recent acquisition than finger dexterity which has demanded man's attention from the beginning of his existence and upon which depended much of his early success over other animals. Finger dexterity and number checking should differ in their susceptibility to environment, and yet so far as laboratory results, do not.

A highly skilled senior accountant, a large portion of whose time for ten years had necessitated swift and certain handling of accounts, and often comparison from column to column, the fastest member of that profession who has checked the numbers, failed to finish faster or more accurately than eight employment office applicants with, as nearly as could be discovered, no more experience than is supplied by the average elementary school. A youngster of fifteen scored equally high; and not one of several men who had begun their accounting at fifteen or sixteen, and worked continuously since, did as well. The glaring inequality of preparation between these individuals did not lead to a disparity in performance. Foregoing intimacy with figures avails as little in substantially bettering this worksample score as did factory experience in the three pin task.

Still further to corroborate this finding, under the rigidly controlled conditions of a modern laboratory, a second worksample was devised, a counterpart of the numbers in words. The numbers begin

69 69

two similar two figure numbers. The words start

to to

two similar two letter words. The numbers continue

85 88

two figures each, differing in the last. The words continue

am an

two letters each, unlike again at the end. Further down the sheet the two four letter words

slit silt

replace the two four figure numbers

1382 1832

If the ceaseless juggling of numbers, which forms so large a portion of the accountant's daily life, aids him to score well with them, he should, for this reason, grade higher than the business stenographer who has no more experience with numerals than the average individual. By the same token, the stenographer, incessantly hearing, taking, typing words, should compare them better than the accountant in no more intimate touch with them than the everyday newspaper reader. Yet, unbelievable as it seems, typists and stenographers finish the digits with the same facility as trained accountants;[1] and the latter do the words as easily as expert stenographers. The training of the accountant in numbers and of the stenographer in words is nugatory in the two checking tasks. It appears inconceivable that five or ten or fifteen years unbroken manipulation of the cardinals has no measurable reaction on number checking speed or accuracy, and yet such is the case. The wide diversity is not caused by different amounts of adult training; but discloses something within individuals at fifteen or sixteen unaffected by subsequent use.

One further fact adds perhaps the most convincing bit of evidence in proof of the impotence of

[1] Median score for number workers............. 0.0555
Median score for word workers............... 0.0556

adult experience in altering the speed and accuracy with which the numbers are initially checked.

TABLE 5

Age Norms for Worksample No. 1, Clerical Aptitude—Male

AGE LAST BIRTHDAY	A	B	C	D		NUMBER OF CASES
		75 per-centile	50 per-centile	25 per-centile		
[14]	0	0.0617	0.0677	0.0817	up	33
[15]	0	0.0629	0.0750	0.0810	up	24
16	0	0.0679	0.0812	0.0991	up	207
17	0	0.0609	0.0711	0.0881	up	268
18	0	0.0599	0.0694	0.0870	up	332
19	0	0.0604	0.0725	0.0865	up	278
20	0	0.0562	0.0679	0.0828	up	170
[21]	0	0.0565	0.0677	0.0822	up	79
[22]	0	0.0580	0.0652	0 0810	up	28
[23]	0	0.0508	0.0580	0.0690	up	24
Adult	0	0.0590	0.0706	0.0886	up	2045

Four hundred unselected cases usually form a sufficient sampling of humanity to give norms which are reproduced with fair accuracy by another four hundred similarly unselected. Norms based on fewer than one hundred persons—bracketed in the table—are of low reliability.

The figures of the table suggest that full maturity may not be reached until twenty-three or four, and that thereafter there may be a slight falling off in performance. Not sufficient data exists as yet.

The average age of the adults used is probably about thirty.

Four hundred persons suffice in number to form a fairly representative sampling of any group.

Four hundred unselected boys, seventeen years of age, obtained an average (median) score of 0.0711 in the number checking. (See Table 5.) An analogous group of twenty-eight-year-olds, who had not previously taken the test, made the same average mark. The last year or two of high school and the four years of college which in many cases had intervened, failed to contribute to the number checking sufficiently to raise the score the one part in ten which could have been gauged and detected. Still a third group, consisting of adult men thirty-five to forty years of age, some with ten to fifteen years of clerical experience, not only averaged no higher, but failed, as a group, to contain one individual member who surpassed the top seventeen-year-old youngster. The host of experiences which crowd every life between seventeen and forty do not palpably alter the speed and accuracy with which man checks the number worksample the first time he tries it.

The fundamental unlikeness between fast and slow checkers appears strikingly in some actual situations of life. Of sixty factory girls, new to clerical work, many of whom were under twenty, who enrolled in an evening course in comptometer or adding machine work, forty-three (see Table 6) volunteered to try the number checking worksample prior to the start of the class, and to allow the rec-

TABLE 6

Correlation of Worksample No. 1 With Comptometer or Adding Machine Work

GRADE IN WORKSAMPLE NO. 1 BEFORE BEGINNING OF COURSE	GRADE OF WORK DONE IN COURSE—ESTIMATED BY INSTRUCTOR
A	Excellent
A	Excellent
A	Excellent
A	Excellent
A	Excellent
A	Excellent
A	Good
A	Good
A	Good
A	Fair
B+	Excellent
B+	Excellent
B+	Good
B	Excellent
B	Excellent
B	Excellent
B	Good
B	Good
B	Good
B	Good
B	Good
B	Fair
B	Poor
C+	Good
C	Excellent
C	Good
C	Good

TABLE 6—*Continued*

GRADE IN WORKSAMPLE NO. 1 BEFORE BEGINNING OF COURSE	GRADE OF WORK DONE IN COURSE—ESTIMATED BY INSTRUCTOR	
C	Good	
C	Fair	Dropped
C	Fair	
C	Fair	
C	Fair	
C	Poor	
C	Poor	
D	Fair	
D	Fair	Dropped
D	Fair	Dropped
D	Poor	Dropped
D	Poor	Dropped
D	Poor	Dropped
D	Poor	Dropped
D	Poor	Dropped
D	Poor	Dropped

ords to stay secret, so that a poor standing would not lead to their own disheartenment or influence the supervisor's attitude. Nine failed in the test, registering D, the mark assigned to the bottom quarter of all who have tried the task. Within the three months covered by the school period, eight of these became so discouraged that they dropped the work, despite the fact that they were urged to finish; and the remaining one did poorly.

Thirteen, equally unacquainted with clerical routine at the outset, obtained A in the number checking, scaling among the top quarter in speed and accuracy. At the end of three months, with one exception, they were graded by the instructor either *excellent* or *good*, the anomaly proving but *fair*. Thus the test at the beginning of the course predicted the competence of the A girls; and actual following showed the ineptitude of the poor beginners in attempting to overcome their handicap, and procure a faculty which they lacked. The continuation of the teaching could have added nothing to the certainty of the results, for eight of the nine students who lacked capability severed their connection with the class before its close.

Yet one persists a little unconvinced and cannot help feeling that proper instruction, covering an ample interval, should enable the acquisition of enough velocity and precision to operate an adding machine satisfactorily. The curriculum for this division, adapted to A girls, was too fast for those with D in the number checking. A second course in comptometer operation, tenfold the length of that just described was, therefore, mapped out, and given to a new group of recruits. Even at the end of this over-abundant opportunity, not one who obtained D in number checking, that notification of clerical failure, became an *excellent* operator; while all who quit without completing the programme had previously ranked C or D. One must finally acknowledge that, even though it may not be wholly impossible to teach number sense, and with it adding machine operation, to the dilatory number checkers, the effort is an unpardonable waste of both the student and the instructor. By definition, one half of humanity scores C or D; and among this fifty per cent are practically none who can become proficient in clerical occupations within the period for which a business organization, whose life is measured in dollars and cents, can afford to pay.

What, however, are the possibilities of learning number sense over a period of years? What is the prognostic value of number checking in predicting ultimate accomplishment, not in the artificial atmosphere of a class-room, but in life where livelihood depends upon progress? Realizing the importance of answering precisely this query, F. P. Cox, manager of the West Lynn Works of the General Electric Company, formed a department within his organization to measure, scientifically, the characteristics of new workers, and of those already on his pay-roll who care to volunteer for the experiment; and then to follow, individually, the subjects of these researches, and observe the relation between the measured endowments, and success or failure in various occupations.

In the West Lynn factory an applicant for work enters the employment office and is briefly interviewed. If an opening exists in the organization for one with his experience, he goes to the human engineering laboratory which adjoins, and performs the number checking and any other measures which apply to his position.

The most troublesome obstacle encountered has been nervousness, that strange misgiving which penetrates even the sturdiest frame on approaching a test, and yet which must be reduced to a minimum before venturing to evaluate an innate ability. As the surroundings exert a profound influence, felt instantly on entering, the laboratory is a large, attractive room, looking little like an employment office or factory. Bookcases line the walls and, in the late afternoon, floor lamps supply a soft illumination. The scientist, in charge, measures applicants individually—never in groups—that he may study each as a distinct problem, and determine to what extent he overcomes the natural hesitancy always present.

To lessen still further the first timidity and aid the individual in adjusting himself to the situation the analysis is introduced by a full explanation, requiring from ten to fifteen minutes, and occasionally lengthened to half an hour, of the purpose in forming the laboratory and of the aims in measuring human beings.

We have made a set of what we call worksamples —the experimenter scrupulously avoids the word *test—so that we can try a new person on an actual sample of the type of work he plans to do. One sample, for instance, represents clerical work; another, inspection; and another, mechanical work.*

We have attempted to make samples which measure, as nearly as possible, natural abilities and not training, because we wish, ultimately, to use them only with boys who come to us directly from school. Many now apply for work with no idea of what they would like to do or for what they are fitted. We shall never be able to tell a boy unquestionably that he will succeed in this or fail in that, but we can indicate to some extent inclinations toward mechanics or clerking or executive work.

For four or five years, we have been asking every one to try the samples, regardless of whether he is a boy just out of school or a trained mechanic with years of experience. If men, who perform a mechanical sample well, later succeed at mechanical work; and men, who fail on a sample, fail at the work, the sample is fair to try with boys; if, on the other hand, men who do the sample poorly, succeed later in the type of work represented, the sample is unfair and must be scrapped and another found.

This outlined explanation is amplified to fit the interests of the applicant.

Unless the worksample purposes to measure ability to grasp instructions, the directions must be sufficiently clear for the individual, who experiences extreme difficulty in following language, to comprehend without effort. Some experimenters use a routine formula. This is usually inadequate, because, if clear and concise, it leaves some in a state of uncertainty, or at least demands an effort unconnected with the problem; and, if long and elaborate, tires the man who understands readily and soon exhausts his patience. The directions must be varied to suit the individual; but adapted so skilfully that no essential detail is altered, and each individual undertakes the task with the same amount of knowledge.

All spectators are excluded. Thoughtless visitors often ask to see the worksamples in operation, forgetting the importance of that particular moment to the examinee; for the slightest distraction of his attention, created by an outsider entering the room or standing quietly to one side, may cause failure and bar the man from suitable work. The attitude of the examiner plays an important rôle. He must show a keen interest in the applicant, without, however, standing over him in either a domineering or embarrassing attitude.

In order still further to reduce nervousness, the department never requires or even asks an employee, already on the pay-roll, to undergo a test; and as over twenty-five hundred out of three thousand workers have volunteered, avoids subjecting the few who dislike tests to the ordeal of taking them.

Under these conditions a group of sixty-three college graduates, desirous of entering accounting were carefully tested. They had been chosen with scrupulous care to the minutest details, except that they did not perform the number checking until after selection, at which time slightly over half graded A and so possessed accounting aptitude as indicated by this measure, while half lacked it to some extent. They were then hired, by a manufacturing company, and assigned regular accounting duties. As they had evinced capacity for adapting themselves to a variety of subjects, through a long school career, they should be able to acquire number sense if such acquisition is possible. Yet, a year later, the standing of some began to show inability to gain. Although pleasing in personality and brilliant in school, the poorest men in the checking sample found themselves unfitted for accounting, and unable to acquire the speed in handling numbers which the work required. One, who when measured scientifically exhibited a complete lack of number sense, by failing to pass the number checking and falling to the poorest division, D, but who, before he entered accounting, was judged excellent in all other respects, failed at the work so badly that, after three months' trial period, his superior, ignorant of his measured ability, called his work mediocre in quality; and, soon after, the boy grew dissatisfied and resigned. Another, of equally pleasing personality, judged excellent by his superior before entering the accounting department, but similarly D in number checking, was rated *good* at the end of three months, but dropped in a year as unsatisfactory. Two men, grading C in number checking, were estimated, on a basis of three months with the company, as excellent in quality of work; but this semblance of success vanished within a year, when the youths' inability to acquire number facility drew more clearly into view, and the same department head who gave *excellent* as a three months' opinion, still ignorant of the test grades, changed his ratings to *fair*.

At the end of a year with the company, forty of the original sixty-three college men were considered *excellent* in carrying out their accounting department duties. Of this forty, seventy per cent had originally possessed aptitude, as shown by an A in the checking, and none had so completely lacked it as to have graded D, for the first year left by the wayside half of the D's, and branded the balance as unsuited for accounting. Slow and inaccurate checkers, indigent of number sense, lack something which, after fifteen or sixteen years of age, cannot be gained through the usual experiences of adult life which should most obviously develop it.

Yet these abilities—finger dexterity and number sense—impossible to secure following adolescence, may perchance still be purchased by training. Physiological human structure is more rigidly fixed after fifteen or sixteen than in childhood, and an ability, unalterable by high school or college, may be an early acquisition. Experiments are now in progress with young children; but the necessary measures are difficult to make satisfactorily, and although carried back within the first year, will not prove conclusive. It will ever be possible to claim that the facility in question was attained in the first few months or even prior to birth. There has been a constant tendency of late to push back the formative years earlier in a child's life. For some time to come, the proof as to whether an aptitude springs from early training or is largely inherited, must rest on reasoning from circumstantial evidence, and not upon direct experimentation.

Effective early training may be either one or both of two types: possibly specific drill in, for instance, figures which leads to a later excellence in number checking; or perchance a general education attuning the entire mental equipment.

The extreme type of restricted youthful training would be actual previous execution of the number checking, and this possible supposition must be examined in detail. Although each repetition of the checking shows a gain over the preceding, the rate of this advance grows less with continued redoing. Thus, the average second trial betters the first by twelve per cent, while the third endeavor exhibits only a six per cent gain over the second. An imaginary aggregate of individuals who might conceivably check the figures once, and then, entering the laboratory, do them twice more should improve less upon repetition than another group who compare the numbers twice in the laboratory, without preliminary experience. Theoretically, the amount of a man's improvement betrays his past life. Actually, in the individual case, the figure is too erratic to be indicative; with a group it has validity.

If foregoing experience contributes to a high score in number checking, then the A grade group should improve less on repetition than the D. And conversely, if lack of practice leads to a low score, the D group must necessarily gain relatively more on repetition than the A. In actual practice the percentage of gain for both fast and slow beginners is sufficiently alike (see Table 7) to show that those who do well in the number checking have not, in the past, performed a similar task, and their excellence cannot result from special training.

The solution of the wiggly blocks, already described in Chapter I, shows the same improvement with repetition as the three pin test and number checking; but again, as with the others, the initial time of assembly is not influenced by such adult

TABLE 7

Worksample No. 1 (taken after Worksample No. 43)

Improvement factor $\frac{\text{S—First trial}}{\text{S—Second trial}}$

Grade (first trial) A	1.047
B	1.058
C	1.059
D	1.059

experience as comes with engineering, which seemingly might aid.

Howbeit an unconsidered possibility of training still exists. In early years the organism may not only be more flexible but also less rigidly differentiated than in maturity. Although adult environment produces no appreciable influence, and although there exists no measurable evidence of the effect of narrowly specialized early schooling, a congenial environment, from the beginning, may result in the tuning up of all mental processes, and consequently in generally high test scores. Such a course of education should enable its recipient to do all tasks better than the untrained, and, consequently, cause a relationship between the numbers and the blocks. This would reveal itself to the scientist in the form of what he chooses to call a correlation; that is, individuals who do well in the block assembly should, to the extent to which general training is effective in the two cases, do equally well in the numbers; and, if excellence in these tasks depends wholly upon general training, every individual should do equally well in the two.

No such perfect relationship exists. The mental reservoir drawn upon for a rapid solution of the wiggly blocks is not filled from the same source as that which makes possible accurate checking of figures. Some persons who solve the block rapidly and easily, check numbers slowly and laboriously; an extraordinarily quick—fifty-second—block assembler, a mechanical genius, lagged among the slowest in number checking; while one of the fastest checkers found the block impossible in twenty minutes. In this particular case, the cause of excellence in number checking differed from that which gave power to analyze concrete structure.

The vague, indefinite something which led to fast block assembly was not general.

The further discovery that only one person in four does both the number checking and the block assembly above average shows that the two tasks involve thought processes so wholly differentiated from one another that the two are never amenable to the same training. A nickel and a penny, tossed into the air together, land, because disconnected, one quarter of the time both heads up, one quarter of the time both tails up; a third quarter the penny heads and the nickel tails; and a fourth quarter the penny tails and the nickel heads. Chance prescribes the fourfold relationship of two disconnected phenomena. Laboratory measures of several thousand persons give exactly this symmetrical distribution of block and number scores. Aptitude for the one and the other are so completely independent that only twenty-five per cent of those tested do both well; only twenty-five per cent both poorly; twenty-five per cent checking well and the blocks poorly; and the remaining quarter number checking poorly and the blocks well. No overlapping, no common element, joins the two (see Table 8). Capacity to check numbers is independent of ability to assemble the blocks; the two are separate brain functions, never reached by the same training. Neither adult expe-

TABLE 8

Correlation Between Worksample No. 1, Clerical Aptitude, and Worksample No. 5, Mechanical Aptitude—596 Cases (r = 0.20)

Worksample No. 5	0.1400	0.1350	0.1300	0.1250	0.1200	0.1150	0.1100	0.1050	0.1000	0.0975	0.0950	0.0925	0.0900	0.0880	0.0860	0.0840	0.0820	0.0800	0.0780	0.0770	0.0760	0.0750	0.0740	0.0730	0.0720	0.0710	0.0700	0.0690	0.0680	0.0670	0.0660	0.0650	0.0640	0.0630	0.0620	0.0610	0.0600	0.0590	0.0580	0.0570	0.0560	0.0550	0.0540	0.0530	0.0520	0.0510	0.0500	0.0490	0.0480	0.0470	0.0460	0.0450	0.0440	0.0430	0.0420	0.0410	0.0400	0.0350	0.0325	0.0300
0.75																																																												
1.00							1								1																										2																			
1.25																											1		1						1	1				1	1																			
1.50											1							1		2				1								2											1			1	2													
1.75	1								1					1		2						1	1					1			1					1	1	1													1	1								
2.00	1							1	1					1										2								1	2	1		1	1		3								1		1				1							
2.25				1				1	1	1			1		1		2							1			1	1		2					1			1	1	3		2	1								1									
2.50			1				1			2			1		2	1		2		2	1			1	1			1	2				1	1		2		1				1		1		1							1	1						
2.75	1			1	1	1	2	1	1		1	2					2	3		1					2	1	1	2	1	2	1	2	1	2		2	2	1	1		2									1										
3.00	3					1		1	1	1	2	2		1	1			1	1	3	2			1		1	1	2	1	1				3			1	3	2	2	1		1	1	1	1			1								1			
3.25					1	1	1		1				2		1	3	1	1				1	1				2			1	1				1		1			1			1	1	1	1	1	1												
3.50				1					3		1	2	1				2	2		3			1	2		2		1	1		1				1		1	1	1	1		1				1														
3.75	1					1	1		1	2	1		3		2		1	1	1			1			1	1		2		1		1				1	1	1	1	1	1																			
4.00	1		1	1	1		1		1	2			2		1	1								1				1									1			1	2		1									1	1							
4.25	1								1		1			2			2	1							1		1	2		2	1	1	1		1	1	1	1	1							1						1								
4.50	1						2	2		2		1		1	1		1	2			1	1			1				2		1	3	1					1				1					1						1							
4.75			1			1		1	1		1			1	2	1	1	1					1						1	1		2	1						2	1				1											1					
5.00					2	1		1							2	1		1	2	1	1					2		1							1			1					1																	
5.25								1	2				1	1			1			1		2		1	1			1					1		1			1												1										
5.50	3				1	1				1	1	2		1	1	2	1	1								1						1							1				1		1															
5.75	1				1	1			1		1		1		1											1			1	1			1																		1									
6.00	2			2									1						1	1			3		1																			1			1	1												
6.25			1	1	1				1								2			1		1			1													1			1																			
6.50						2		2	1		1							1	1												1	1				1	1																							
6.75	1									1						1												1																								1								
7.00		1					1				1	1					1				1												1																											
7.25												1						1	1					1		1																1		1																
7.50	1			1	1												1			1			1	1								1																												
7.75	1							1		1			1				1	1													1																													
8.00									1							1			1													1	1			1						1	1	1																
8.25																					1	1																			1																			
8.50			1																			1		1																																				
8.75			1				1																										1																											
9.00								1																			1																1																	
9.25	1				1		1					1							1	1																	1												1											
9.50	1	1																1																																										
10.00	1								1						1	1																								1			1					2												
10.50	1						2				1											1	1																	1				1																
Imp.	3	1		2	2	2	2	2		1		2	2	1	2	1	1	1	1	1	1	2	2	1	1		1		1	1			1		2									1											1					

Worksample No. 1

In the ordinary run of employment office testing, a certain amount of selection always takes place. In two groups of one hundred persons each, as nearly unselected as possible, the correlations between Worksamples No. 1 and No. 5 were $r = 0.04$ and 0.07. The size of this correlation ($r = 0.20$) is caused, at least in part, by the selection of the examiners.

rience, nor early special training, nor early general education causes the differences measured by these simple tasks. What then is their source?

The chromosomes, the forty-eight tiny particles within the germ cell, are the mechanism by which physical characteristics are believed to pass from generation to generation. It is a long way from the germ cell to the number checking and the block assembly, and yet considerable evidence—swelling as the research work in this field increases—leads to the belief that, with full knowledge and understanding of the germ cell and the forty-eight tiny particles which it encloses, one might predict, with considerable accuracy, the initial speed with which the mature individual would check the numbers and assemble the nine wiggly blocks.

The development of the child from birth to maturity is similar to the crystallization of an amorphous substance into an immutable pattern. Although the chemist cannot alter structural type he can facilitate condensation by inserting a nucleus, and enormously increase the size and perfection of the resulting crystals by controlling temperature and speed. In much the same way education, by recognizing the type of individual with whom it has to deal, can aid the crystallization of the youth into his mature self.

Amid this convocation of evidence continually revealing a new limitation in the effectiveness of education, one must not for a moment lose sight of the value of training. Schools, like the world, swing from one rabid extreme to another. They insist upon hours of exhausting, soul-shrivelling drill; or, whirling with a dizzy swoop to the other pole, offer the child opportunity to develop his natural gifts untrammelled and untrained. They should remember not only that all performances improve with practice, but that many are enormously influenced by education. The three which have been discussed, the pins, the numbers, and the blocks, have been chosen from many hundreds because they measure three elusive and intangible gifts which seem to vanish into thin air on too intimate approach, and wilt to apparent nothingness when grasped, and yet suffice to lay the foundation of success or failure, happiness or misery, even charm or its lack, and constitute the wrappings of that strange something which makes an individual, and is sometimes called the soul.

CHAPTER V

The Future of Man

The individual embarks upon life with a mental and physical equipment rigidly circumscribed in at least three directions. These limitations by the combined capacities of his ancestors probably foreshadow others beyond which he cannot transgress. What then of the future of mankind and its eager search for ideals? Can humanity never surpass itself? never strive hopefully for higher aims than those within its immediate reach? There seems at first but one answer: no beautiful vista of ever increasing attainment opens before the species.

Yet, to return once more to a concrete instance, despite the inefficacy of all types of training in improving the initial performance of the number checking, since paleolithic times a certain readiness with figures has been gained by mankind. The Arabic system, which man converts to his service with an ever increasing efficiency, is an arbitrary combination of artificial symbols, the handling of which is of necessity an acquired function. Humanity invented Arabic digits as an outgrowth of civilization; and then learned to use them. How has this facility with numbers come to pass, in view of the ineffectiveness of training in number checking suggested in the previous chapters?

Three processes may have operated: the first of these, the much discussed natural selection. The iron hand of civilization may have raised the level of number speed by the mechanism of evolution, grasping, as its favored pawns, human specimens singularly gifted with this tendency. Although biology has brought to light no certain means of modifying the chromosomes, descending inviolate from generation to generation, it can select parents who possess the specific forty-eight most desirable for the future of the human race. The stringent conditions of the past may unknowingly have done exactly this, by crushing youngsters who, too markedly, impugned the environment, and so, in the course of ages, obliterated the chromosomes which prescribed inimical characteristics, and unhinged and set wide open the doors of opportunity for the remainder.

A characteristic, to be augmented by selection, must be innate, must depend upon the chromosomes. It seemed inevitable that the accountant, whose working life is built of number checking, would handle the numbers more accurately and rapidly than the stenographer. But not only does his past training fail to give him greater speed or precision than word trained persons; but a comparison of the number checking and the word checking tests, shows that men, practically without exception, who succeed with the numbers, perform equally well with the words.[1] Gifted figure checkers are also able with letters; word minded individuals, as indicated by these tasks, are equally number minded. Although subjectively the two tests seem quite dissimilar, and to be performed by separate mental processes, they are, in reality, closely identical. Were they not, occasional persons would do one well and not the other. The number checking, then, although so obviously embracing numbers, when more critically examined, measures something more inclusive than number sense in its narrow meaning, an ability to handle symbols regardless of whether these are numbers, letters, or words, an inclusive faculty which may be called *symbol sense.*

However improbable the existence of a number checking chromosome, primordial man possessed a love of symbols, shown in his early drawings and his attempts to represent, by all manner of devices, the interests of life. The early artist and the modern clerk may perchance have in common a sense for symbols. (Compare Tables 9 and 10.)

Despite the many objections voiced against

[1] $r = 0.67$.

TABLE 9

Correlation Between First and Second Sheets on Worksample No. 1 Taken the Same Day—417 Cases (r = 0.74)

0.1500	0.1450	0.1400	0.1350	0.1300	0.1250	0.1200	0.1150	0.1100	0.1050	0.1000	0.0975	0.0950	0.0925	0.0900	0.0880	0.0860	0.0840	0.0820	0.0800	0.0780	0.0760	0.0740	0.0720	0.0700	0.0690	0.0680	0.0670	0.0660	0.0650	0.0640	0.0630	0.0620	0.0610	0.0600	0.0590	0.0580	0.0570	0.0560	0.0550	0.0540	0.0530	0.0520	0.0510	0.0500	0.0490	0.0480	0.0470	0.0460	0.0450	0.0440	0.0430	0.0420	0.0410	0.0400	0.0375	0.0350	0.0325	0.0300	Worksample No. 1—Number Sense—Form B
																																																											0.0300
																																														1											1		0.0350
																					1																																		1				0.0400
																									1												1												1		1			1	2				0.0420
																																																	2				2	2	2				0.0440
																														1					1									1			1		1					1		1			0.0460
																																									1							1	2	2	1	2	2	2					0.0480
																																1			1				1					1	1		1		2		2	2	2	1					0.0500
																															1			1		1						1	1	2	1	1	2	1	1	1	1			1					0.0520
																													1		1	1			1					1			1	2	1	2	2	2	2	2					1	1			0.0540
																										1	1			1	1									2	2	1	1	2	1	1	2		1					1	1				0.0560
																												1	1					1		2		1	1	2	1	1		2	2	1	2		1				1						0.0580
																						1					1	1	1		2				1	1	1	1			1	1	2	1	2							1							0.0600
																																		2						1	1		1	1	1		1	2											0.0620
																						2							2	1	1	1			2	2			2		1	1	1	1															0.0640
													1						1							1									2	1		1	2		2						2	1	1				1	1					0.0660
																							1	1		1	1	1	2		1	1	1		1	1	1	1				2	1	1			1				1			1					0.0680
													1		1					1	1						1	2		2		1	1	2	1	1	1				1		2			1				1				1					0.0700
				1																		2		1			1	2			1		2	2	1	1				1											1			1					0.0725
																		1		2	2	2	2					1		1			1							1		2	1	1									1						0.0750
															1	1					1	2	1					1		2	2	1			2	1								1	1														0.0775
											1					1				1		1	2	1	1				1												1			1															0.0800
							1										1	1			1	2	2	2	1	1				1							1											1											0.0825
								1	1								2			1		1	1								1								1			1																	0.0850
															1		1												1		1	1																											0.0875
						1							1				1	1				1			1						1																												0.0900
											1	1		1	1	1	1		1		1	1		1		1				1	1		1						1	1	1																		0.0950
								1		1	2					2		1			1	1	1	1				1		1					1	1	1																						0.1000
													1	1	1				1																																								0.1050
									1	1	1		1		1							2																																					0.1100
									1	1	1			1		1				1	1									1																													0.1150
								2				1							1		1	1																																					0.1200
																1	1			1	1			1																																			0.1250
																			1																																								0.1300
														1																																													0.1350
	1	1																																																									0.1400
		1											1									1		1																																			0.1450
					1			1	1		1	1			1	1					1													1																									0.1500

Worksample No. 1—Number Sense—Form C

TABLE 10

Correlation Between Worksample No. 1, Number Sense, and Worksample No. 43, Word Sense—534 Cases (r = 0.67)

0.1100	0.1075	0.1050	0.1025	0.1000	0.0980	0.0960	0.0940	0.0920	0.0900	0.0880	0.0860	0.0840	0.0820	0.0800	0.0780	0.0760	0.0740	0.0720	0.0700	0.0680	0.0660	0.0640	0.0620	0.0600	0.0580	0.0560	0.0550	0.0540	0.0530	0.0520	0.0510	0.0500	0.0490	0.0480	0.0470	0.0460	0.0450	0.0440	0.0430	0.0420	0.0410	0.0400	0.0390	0.0380	0.0370	0.0360	0.0350	0.0340	0.0330	0.0320	0.0310	0.0300	0.0290	0.0280	0.0270	0.0260	0.0240	0.0220	0.0200	Worksample No. 1, Number Sense
																																																												0.0300
																																																												0.0350
																																												2		1														0.0400
																																													1		1		1		1	1								0.0420
																																										1			2			1				1				1				0.0440
																																							1			1				1										1	1			0.0460
																																					1									1	2	1					1								0.0480
																																		1					1	1	1	2	2	2		2	2		1	1	1		1	1						0.0500
																								1		1							1		1				2		1	1		1	1	2	1			1	1									0.0520
																			1							1	1	1									1		1	1	2	2	2	2	1	2	2	1		2	1	1								0.0540
																									1		2			2				2	2	1		1	1	1	2	2	2	1	2	1	1		1	1										0.0560
																		1					1	1			1		1		1	1	2	2	1	2	2	1	2	2		1	1		1	2	1		2											0.0580
																										1	1	1		1			1	1	1	1		2	2		2	2	2	2	2	2	2	1	1	2	1	2								0.0600
																										1								2	1		1	2	2	1			2		1	1	2	1												0.0620
																			1				1				1		1	1	2			2	2	2	2	1	1		2	2	2	1	2															0.0640
																1			1		1			1	1		1	2			2		1	1	1	2	1	1	1	2		2	1		1	1	1													0.0660
																		1			1		1	2		1	1	2	1		1	2	2	2	2	2	1	1	2	2	2	2	1			1	1	1												0.0680
											1					1				1			1	1	2	2			1		1	2	2	2	2	2	2	1				1								1												0.0700
														1						1	1	2	1	1	1	2		2	1	1	2	2		1	2	1			1	2		1		1	1		1													0.0725
																				1	1	1					1	1		1	1			1	2	2	1	1	1	1			1																	0.0750
																1			1			1	1		2	2	2	1	1	1	1	1				1	1			1	1	1		1																0.0775
									1				1							1	1	2	2	1	1		1	1	2	1	1	1	1	1	1		2				1	1	1																	0.0800
																				1	2		1		1				2		1	1				1		1																						0.0825
	1													1	1					2	2	1			2		2		1					1			1	1		1																				0.0850
												2												1	1	1				1				1																										0.0875
												1	1				1		1			1		1	2	1				1									1																					0.0900
																		1	2			1		1	1		1	1				1		2						1																				0.0950
2		1				1						1	2		1	1		2		1			1	2			2			1			1																											0.1000
		1	2	1			1					1			1	2		1						1	1			1																																0.1050
1				1		1								1		1						1	1		1								1																											0.1100
1																	1						1	1		1																																	0.1150
3			2	1			1			1							2		1		1	1	1	1		1				1																														0.1200
1					1					1								1	1		1																																						0.1250
2																		1																																									0.1300
1		1																																																									0.1350
																		1	1																																								0.1400
																																																												0.1450
4						1																												1																										0.1500
0.1100	0.1075	0.1050	0.1025	0.1000	0.0980	0.0960	0.0940	0.0920	0.0900	0.0880	0.0860	0.0840	0.0820	0.0800	0.0780	0.0760	0.0740	0.0720	0.0700	0.0680	0.0660	0.0640	0.0620	0.0600	0.0580	0.0560	0.0550	0.0540	0.0530	0.0520	0.0510	0.0500	0.0490	0.0480	0.0470	0.0460	0.0450	0.0440	0.0430	0.0420	0.0410	0.0400	0.0390	0.0380	0.0370	0.0360	0.0350	0.0340	0.0330	0.0320	0.0310	0.0300	0.0290	0.0280	0.0270	0.0260	0.0240	0.0220	0.0200	

Worksample No. 43, Word Sense

biological control, there is less space in the universe than one would think for eccentricities. The conditions of modern life, which no one has chosen, impose strict rules on those who survive. As civilization has gradually inflicted upon the individual an ever swelling burden of figures, and held him more rigidly to bonds made of words, selection may conceivably have increased the percentage of symbol minded persons.

Yet, notwithstanding the fact that in the past such a process may have operated, it has probably now reached the limit of its effectiveness. Modern emphasis on evolution leads easily to an erroneous notion. It often portrays man issuing from the murky obscurity of his ancestral background by infinitesimal, imperceptible, acquired steps, each valuable acquisition the culmination of many generations' struggling. Later knowledge casts doubt on this picture, substituting a sudden apparition, the birth of a mutant, different from previous organisms, so fitted to deal with the environment that he replaces his predecessors. At first, the mutant, man, advanced in physical structure, adapting himself to the mandates of the earth. With time, his developmental progress grew less, until his available energy, and that required to support him against his surroundings, reached equilibrium. Another mutant, another creature better fitted to cope with the world, perchance a human offspring, may appear; but man's bodily structure, and even brain capacity, has reached evolutionary maturity. As an animal organism, he must expect nothing from the future. Succeeding years, thus trends modern thought, will supply him no better eyes, no more hands and fingers, no greater brain. A deadlock holds the human race in its firm fixity. Natural selection cannot be depended upon further to improve the species. Guided selection such as science has carried out with other species is, of course, a possibility, but, with the present feeling of society, is temporarily impractical, and may be postponed for many years. For immediate result another process besides biological selection must be sought.

Although countless researches show capacities to descend inviolate from father to son, unchanged by environment, established from time immemorial, a single recent experimental exception breaks the constancy of the mass of evidence which exists and suggests the second of the three processes which may have operated in raising man's facility with numbers. Pavlov,[1] an eminent Russian physiologist, when in this country, told of an extremely interesting experiment. By ringing a bell at every

[1] Transactions of Edinburgh International Congress of Physiology (1923).

feeding of a pair of mice, he ultimately taught them to come to dinner at the sound. The feat required three hundred lessons. The progeny of the original pair, trained in the same way, learned faster, responding to the bell after only one hundred trials. Still easier to teach were the grandchildren, who recognized the meaning the thirtieth time; the greatgrandchildren (the fourth generation) learned in ten, and the fifth in five trials. Untaught, even the fifth generation failed to know the bell's significance; but they inherited a capacity to learn its meaning, sixty times greater than that of their forbears.

This recognition of the dinner bell is an acquired attainment, since mice had not met the same conditions in the past; Pavlov, through patience and persistence, trained the original pair to perform a feat unknown prior to that time. It is barely possible that Pavlov's experiment with mice, although uncorroborated, does show that a child, unable to inherit the knowledge of his parents *in toto*, may receive either a minute fraction or at least a predisposition to gain such facts more easily, so vague and intangible that science cannot as yet measure it, but still sufficient to accumulate; so that the child of today may be handed a vast legacy from the past. A special accomplishment may devolve by inheritance. Although the son of an accountant fail in double entry, and the daughter of a pianist lack the technique of her father, acquired knowledge may be handed down in a potential form, as an almost imperceptible and yet indefeasible predisposition. Inheritance of acquired knowledge would explain the number checking findings, the initial trial betraying the degree of inherent undeveloped ability and the difference between persons showing a difference in heritage. Under these conditions it might be possible for the race to acquire over many years a number checking facility impossible for the individual.

Yet Pavlov's accomplishment, indicating the partial inheritance of such acquired skill, is not substantiated by other laboratory work. For years physiologists have sought to gain a similar result, but never succeeded. Despite Pavlov's research, acquired functions, it is generally conceded, do not enter the germ cell, or play any part in shaping the future offspring. An eminent lawyer, having attained success through unwonted effort and perseverance, cannot, biologists believe, hand to his offspring added capacity in jurisprudence. An enormous amount of experimental research, covering almost every phase of the problem, shows, with an occasional and usually uncorroborated exception, that acquired knowledge is not inherited.

Conklin, realizing the immediate uselessness of relying upon either natural selection or the inheritance of acquired knowledge, suggests the third possibility, *social evolution*, as a means of assisting mankind to progress and not be crushed by the menacing intricacies of its own discoveries. This social evolution he defines as the reduction of the ever increasing complexities of life to simple formulæ, the combination of groups of separate facts into single sentences, so that a conglomerate may be embraced as one thought. Handing to posterity the discoveries of the past, subsumed in the form of well stated laws, will enable the limited mind of man to grasp more fundamentals than at present.

The qualitative existence of social evolution needs no proof, but the furtherance of its quantitative comprehension necessitates the reproduction of the process in the laboratory. The number and word checking tasks, already described, are a first groping step in this direction. Although often thought to follow separate mental channels, the high correlation between them, the fact that he who excels in one does equally well in the other, while he who fails in one does poorly in the other, shows them to call upon the same inclusive faculty.

Yet, because man has formularized his knowledge of words to a greater extent than he has figures, he compares words twice as rapidly as numbers. Almost unconsciously he synthesizes letters into words, so that he pronounces, as a single syllable, thinks as one thought, a group of symbols. Numbers he still reads individually as disconnected entities, except the few which he uses most often, ten, eleven, twelve, twenty, and thirty, which he now pronounces as diagraphs. These have been shown to be far more easily remembered than combinations like thirty-seven, thirty-eight, and forty-two, compound words.

He has for so long pronounced two letters as a syllable, that it now seems an innate necessity, a fundamental characteristic of the alphabet. It is only because he has reduced letters to a more comprehensive system than numbers. Numbers can be juxtaposed in every conceivable manner, certain letter combinations are impossible to pronounce; and yet, because there are twenty-six letters and only ten cardinals, there exist, even within the narrow confines of the English language, more pronouncable aggregates of two letters than possible permutations of two numbers. Man's constant use of words has led him to unite letters, despite the fact that they are more complicated to systemize and more numerous to memorize.

An enormous amount of work is under way to increase efficiency. A group of bankers and scientists, coöperating with one another, might so formulate numbers into simple language that they could be handled with two thirds the present effort and as rapidly as words at present.

The synthesis of multitudinous phenomena into a simple pattern places at the disposal of every mortal, an understanding of the world which, if disconnected, would be too severe an overdose to prescribe for any man. Systematic arrangement of evidence allows the scientist to juggle with thoughts otherwise of too great complexity for even his passionate zest to handle. Whether a fuller cognizance of life and its significance transpires as an increase in intellectual capacity, and consequent ability to embrace more data, or through so happy a formulation of premises as to invest the present brain with power to subtend the new amplifications, is immaterial to the next generation and man's future. The biologist's pessimistic view of human progress, because of man's incapacity further to develop physical structure, or inherit knowledge from the past, is belied by his ability so to relate clusters of separate facts, that an entire collection, the accumulated results of researches conducted in different laboratories, in countries foreign to one another, may be grasped by a single thought.

CHAPTER VI

Genius

Although man can so formulate his discoveries as to enable them to be retained by the present mind structure, and thus gain the effective result achieved with an increase in cranial size, facts at present outstrip understanding and are becoming daily more complicated. They may easily grow so numerous and involved that no brain can grasp them. What practical, immediate steps will keep this complexity from overwhelming humanity?

Progress means speedier advance in comprehending and synthesizing heterogeneous knowledge than in the routine routing out of data. The actual consummation of this accomplishment demands a genius. The psittaceous thinker, the diligent plodder, the hack worker, with an encyclopædic knowledge of the achievements of others, who draws on the platitudes of the past to supply his own abject lack of originality, and applies its findings for his immediate good, lives like a ne'er-do-well son brought up in luxury and ease on the accumulated wealth of his father, and leaves the portion of the world, under his direction, at a standstill for a generation.

Who are the genii needed to synthesize knowledge and so formulate ideas that they can be more readily grasped? Can they be recognized? Can their number be increased? Or must humanity contentedly stand and wait the sporadic appearance of these strange phenomena upon whom rests its future? Can a genius succeed in any field he may select; or does he surpass others only in a specialized region? Can the word *genius*, which means *inborn nature*, almost *divine spirit*, refer to the remarkably nimble-fingered girl who may lack what the world is wont to call *intellect?* may it denote the rapid number checker although he be devoid of *personality?* or designate the fast block assembler? Or is such use wrong, and must the genius possess, instead of a special aptitude, a *spirit* for all things, a gigantic capacity for hard work, an inexhaustible supply of energy which he may turn in any direction?

Bernhard Berenson says: *Florentine painting between Giotto and Michelangelo contains the names of such artists as Orcagna, Massaccio, Fra Filippo, Pollaiuolo, Verrocchio, Leonardo, and Botticelli. Put beside these the greatest names in Venetian art, the Vivarini, the Bellini, Giorgione, Titian, and Tintoret. The difference is striking. The significance of the Venetian names is exhausted with their significance as painters. Not so with the Floren-*

tines. Forget that they were painters, they remain great sculptors; forget that they were sculptors, and still they remain architects, poets, and even men of science.[1] What denotes this striking difference between the Venetians and the Florentines? Were the artists of Florence greater geniuses than the painters of Venice? Could the Venetian workers have focused their attention on sculpture, or poetry, or science, had they so chosen?

The question has been argued for centuries, and will continue under discussion until science, bit by bit, formulates a structure of measured, mundane facts which more and more nearly encircles the moot point. By means of worksamples four disconnected characteristics have been isolated from one another, and there is no evidence that, to the world, one is more important than the others. The number checking, and the block assembly have nothing in common. No *esprit de corps* enables chosen persons to do both well. Finger dexterity is unrelated to either; and personality, as measured by the word responses of Chapter II, unassociated with any of the three. No single essence presages excellence in these four fields. Mentality, as measured by power to perform these tasks, is a group of distinct abilities, to any one of which genius may be narrowly restricted.

[1] Bernhard Berenson, *The Florentine Painters of the Renaissance* (2nd ed. rev., New York: Putnam, 1904), p. 1.

The extensive use of *general intelligence* tests, formerly in the army and now in the schools, and the wide-spread application of the phrase by which they are designated, often portrays the erroneous picture of an indivisible entity, a structure of the brain, relevant to all problems, aiding its possessor in the execution of every undertaking, assisting in the adaptation to any new situation. The labeling of a child as *generally intelligent* or its opposite, although denoting or connoting as diverse ideas as there are writers and speakers, often conveys a notion unjustly misleading.

An actual instance pictures the occasionally tragic consequences. A public school principal, eager to grasp every opportunity which science offers, brought four boys, ranging in age from fourteen to sixteen, to the human engineering laboratory for analysis. They had repeated fourth grade work many times; and, unable to pass, had been labeled *failures*, and placed in an institution for backward children of low mentality. After the schoolmaster, in a private session where the boys could not observe his struggles, had tenaciously persisted eighteen minutes before deciphering the wiggly block, one of the boys solved the problem, with ease, in a minute and a half. Notwithstanding a hopeless inaptitude in comprehending school subjects, the youth analyzed the structural relations of the puzzle perfectly and repeated the assembly thrice, each time as rapidly as at first. The brilliantly intellectual man was not mechanically intelligent; the boy, preëminently so, but lacked school competency to an abnormal degree.

Not long after the above episode, a highly intelligent magazine editor attempted the same assembly, and, at the end of twenty minutes, abandoned it as impossible. Later he called himself feeble-minded. Yes, in a measure, mechanically he was—certainly not in other ways. Most teachers concede immediately the ridiculousness of insisting that an editor master mechanical work. And yet a mechanical boy is kept obstinately year after year at childish studies. Following continued failure, he becomes ever more discouraged and misunderstood. To display his mechanical efficiency, suppressed at home and at school, because it distracts his attention from study, he plays truant, begins picking locks and soon drifts on to worse.

All school failures are not potential mechanics. The practice followed by some localities of shifting to mechanical classes the pupils who fail at classical subjects, harms as many as insistence upon the completion of formal grade work. Mechanical ability is as necessary to mechanical accomplishment as school competence to classical success. Of the four boys brought in for analysis, only one did the blocks well. Two of the four scored A in observation. One failed in everything; and yet if he could have been tried on more samples, he too might have succeeded somewhere.

Accurate figures cannot be obtained, but possibly half of the mental difficulties which come to the surface sufficiently to alter the normal course of life, are not due directly to structural weakness, but result, partly at least, from the feeling of inferiority caused by a variation from the expected type. The occurrences related in a previous chapter show that girls who lack finger dexterity, but undertake work which requires it, either lose their positions through inability; or become discouraged and restlessly shift to other work; or, worse, perchance, than either of the foregoing, gradually grow satisfied with their own indifferent performance; or, fourthly and most serious of all, run the risk of nervous or mental disorders.

The sixteen-year-old, mechanically gifted boy came from a poor family, financially unable to furnish him the workshop he needed, and necessarily dependent upon a public school, too meagrely equipped to help, and unable to discharge the pupil for the law insists that he continue. The boy, in turn, was not satisfied to be labeled *mediocre*, for, mentally unsuited to school work, he knew his own strength in a specific field. There is only a single remaining possibility, mental disorder; and at the time the boy took the block test, he was under psychopathic observation. He was already exhibiting some of the revealing symptoms which lead to serious mental trouble in later life. This boy's difficulties were not necessitated by his structural infirmities, but brought on by the fear, the chagrin, which civilization made him undergo, because he did not fit its standardized mould. Inarticulate inability to dominate in the esoteric struggle and continual association with younger children has instilled in the boy's nature a sense of failure in life, which the future can never overcome. In consequence, he lives in a state institution, operated at the expense of the community, and must continue so. Had the school discovered, immediately after his first failure to pass fourth grade, the latent mechanical instinct, it might have converted him, even with his weaknesses, into a desirable, contributing citizen, an efficient, self-supporting member of society. Throughout the world mediocre mortals struggle despondently for bare existence. Many are fitted for some occupation, and, if in the right location, might achieve positions of worth and happiness. The poorest scholar may do best in business; the inaccurate number checker become an outstanding engineer; the skilful die-maker be the worst selection for an executive. Manual awkwardness handicaps a pianist, a surgeon, or an instrument assembler, and the clumsy boy should avoid such professions, but the same inability passes unnoticed in a lawyer. Civilization offers an enormous diversity of opportunities, and among this array a human being can find his niche. In prehistoric times, man killed his own game, skinned it for clothing, ate it for food; made his own tools, such as they were; built his abode; fought his battles. The splitting up of these duties marked the beginning of civilization. Now science would carry the same process further, and place each member at that vantage point from which he can contribute most.

An individualist, eager to see the full realization of individual possibilities is apt to take a pessimistic view of any evidence pointing to the fixity of human nature. Optimism is equally justifiable. We call one who plays the violin more perfectly than others or one who paints more beautifully than his fellows a genius. Is not the boy who assembles the wiggly block sixty times faster than another equally gifted in his own field? And, can we but guide him to the type of work where he will use his especial prerogative, will he not become as great as the musician and the artist? Either one of the latter, had he chanced upon another life, might easily have failed. And so with the mechanic. Selection of the right course at fifteen or sixteen may lead to the inspired life of genius; the wrong choice to almost certain failure.

When individuals are tried at a large number of different problems, almost every one performs one well. By definition, one half of mankind possesses more than an average amount of any single mental element; one quarter of mankind have two mental elements above average, and by the same token one quarter fall below in the same pair; one eighth have three mental elements and only one in eight lacks all three. If there are ten elements, only one person in a thousand lacks all ten. Something appears at which each excels. Each is naturally gifted for some type of work, and naturally powerless in others.

Abilities are not cosmopolitan, intelligence not general; genius is confined to specific crafts and arts. The capacity for painting which characterized the Venetians, and in many respects has never been equalled, did not necessarily betoken universal superiority. Beyond their art the men of Venice may have been as limited as ordinary mortals. The Florentines, endowed with a corresponding ability to paint, possessed, in addition and isolated, gifts for modelling, for architecture, and for science. The four endowments necessarily reacted upon one another as would a painter, sculptor, architect, and scientist, who found themselves room-mates for life. Could every painter also model, every sculptor write, and solve scientific problems, one would be forced to conclude that abilities are collective, that genius is capacity to apply oneself to any task. Perfect agreement, one group of persons performing every sample well, and another doing all equally poorly, would force the assumption that the first has a cosmopolitan something which the second lacks; and anything enabling its possessor to grade well in all tests, might reasonably be called *general intelligence*. But no such condition appears. Almost every one exhibits particular fortes and express defects which outweigh in importance his average level.

It is true that most performances compare more closely than the number checking and the block construction, the pin assembly, and the word reaction. Ordinarily, more than a quarter of the persons do any two pieces of work above median; more than a quarter, both poorly; and only a few, one well and the other not. Many measured findings appear to reveal, beneath the greater number of accomplishments, a single ability, enabling its possessor to excel in whatever undertaking comes to his attention. This agreement in equality of execution of many tests has led scientists to postulate the concept of a *general intelligence*, which, like the rays of a searchlight, illumines any problem upon which it falls.

But a minute examination of the factors which contribute to the parallelism of performances discloses many, other than intelligence. Sensitive persons, responsive to slight distracting noises or so self-conscious as to feel all eyes upon them, fail in the presence of others, to do their own gifts justice. They dread making themselves conspicuous by being the slowest to finish and rush through, their mind, in part, on the outcome. Others, more apathetic, are little affected by onlookers. This difference in sensibility causes an apparent relation, or as scientists say, a *correlation* between all tests administered to groups, which may easily be interpreted as showing the influence of intelligence in the two cases. Even with individual work, the naturally timid are at a disadvantage unless the nervousness which every one feels in encountering a new problem is carefully eliminated.

Instructions, of some type, introduce every measure. If these are not sufficiently clear, persons who have difficulty in understanding language do poorly, even in tests which measure far different abilities. Collective administration, nervousness, and poor instructions constitute elements which may exist in common between measures of widely varying mental functions, and which, whenever present, create partial correlations which seem to reveal the influence of intelligence at work.

Still more fundamental than either nervousness or poor instructions in causing parallelism between test results is the fact that most thoughts are complexities, as most chemical substances are compounds and not pure elements. The sun, the moon and the stars; the earth with its colored cloak of trees and fruits and vegetables; the sea and its inhabitants; the air, the clouds, and our own bodies, are different combinations of some ninety elementary substances. So the thoughts of the mind which conceived the thundering chords of Wagner, the sweetness of Shelley, the redundancies of Byron and the realities of Velasquez are combinations of a few simple elementary thought processes. Unit functions conjoin in sundry proportions to form many intricate thoughts which correlate with one another, through having an element or elements in common.

One of the questions contained in the *beta* form of the Army Mental Tests requested an examinee to count the number of cubes in each of twenty irregular piles of blocks pictured in perspective. This demands a combination of clerical and mechanical aptitudes. As hydrochloric acid is represented symbolically by HCl, signifying a molecular combination of hydrogen and chlorine; so the thought needed to count the cubes drawn perspectively, is a complicated mental process, a molecular function. The clerk or accountant, gifted with number aptitude, who grades A in checking, but is impotent in the face of concrete material problems—D in block assembly—attacks the cube counting by the method of treatment which he applies daily to his work, and arrives at the correct answer for the sixth pile on the sample sheet, three high, three wide, and three deep, by multiplying three times three times three, obtaining twenty-seven, without attempting to visualize the concealed blocks. Since many of the piles can be done in this way, a correlation exists between number checking and cube counting,[1] that is, the same man excels in both.

The mechanic, wanting number sense, failing in checking, but gifted with unusual mechanical analysis, with an A grade in the wiggly blocks, the antithesis of the clerk, successfully conceals his lack of number sense by lucid mechanical visualization, and counts the same twenty-seven cubes, one at a time, fast enough to make a satisfactory score. Block assembly, therefore, correlates with the cube

[1] $r = 0.27$.

counting,[1] that is, the same man again does well in these two.

Now comes the crucial point so often overlooked. If the man who excels in number checking counts the cubes rapidly, and he who does the wiggly blocks well also succeeds with the cube counting, it would seem at first glance as if this man must be generally intelligent, for he does well in all three tasks. But further analysis shows that he who succeeds in number checking, and consequently in cube counting, is not the same man who does well in the blocks and cube counting. Cube counting requires two distinct modes of thought. An individual's scores in number checking and block assembly combined, predict roughly his success in the task.[2]

The overlappings which exist between the great majority of mental processes and so easily obscure all else are not the salient features. A lack of relationship between two picked tests, even should partial correlations exist between all others, shows that mental processes are of at least two distinct kinds, and to that extent are amenable to analysis.

Careful administration, thorough directions, and controlled conditions, reduce to negligible importance the influence of universally applicable

[1] $r = 0.23$.
[2] $r = 0.46$.

gifts until the study of general intelligence becomes not the understanding of an indivisible entity designated variously as concentration, energy, adaptability, interest, or intelligence, but the careful analysis of distinct mental functions which, combined with one another, make up what is called *thought*. Years of groping, and the study of a vast number of unimportant materials, preceded the recognition of the chemical elements. For a long time, all substances which failed to split into parts, were necessarily considered fundamental, and the list contained many since proved complexities. Only years of painstaking research eliminated, one by one, those which could be divided, until finally enough true elements remained for theorists to recognize a relation between them and create the periodic table. During the early beginnings of human engineering, all the reasoning processes which fail to show relations between one another must, for the moment, be designated elementary. At present, only combined thoughts are recognizable. No test measures, assuredly, an isolated characteristic.

The discovery of more mental elements, and means of measuring them, will enable the breaking down into simple constituents, of even the most complex thought processes—of the mentally deranged, of the criminal mind, of the national moods which, if allowed to ripen, lead to war. All these may, in time, be separated into their component parts, and be better understood. Today it is possible to analyze only a few of the million thoughts which enter every man's mental life, enough, however, to give some indication of what the future has in store.

Genius is extraordinary capacity to perform a particular function so well as to raise the man who possesses it to a level all but incomprehensible to the average human being. But *genius* alone is ineffectual. The men whose names are inscribed in the hall of fame are those who have chanced on the exact occupation for which their genius has best fitted them. To render effective each of these mortals, whom Walter Pater so aptly calls *spiritual adventurers*, science must not only measure the individual mind and isolate the thought processes of which it is most capable; but, in addition, break each problem into its parts, and determine the singular abilities needed for its solution.

CHAPTER VII

Formulating Knowledge

Individual members of the human race, although extraordinarily consistent in conforming to the few scientific laws which have been discovered, differ markedly from one another in the elements with which they start life, and in the degrees to which these are modified and amplified by formal training. Tests for the latter, the extent to which education has taken root, show those gaps in knowledge which study can fill, and aid the school in effectively strengthening the structure which it is its duty to build. But the distant future and the fuller comprehension of the rapidly swelling bulk of knowledge, rising almost menacingly about humanity, depend upon the present recognition of gifted mortals, and the placement in their hands of the problems for whose solution they are peculiarly endowed. Means have been described for measuring individual differences. The human engineer must now determine the significance of these measures in assigning man to his position in the workshops of the world.

Stephen Leacock, in his super-erudite volume *The Garden of Folly* gives, in the chapter on "The

Human Mind Up-To-Date", some extremely stimulating and thought arousing intelligence tests for marine engineers. They aim, he says, at improving the present standard, and Mr. Leacock states decisively that no marine engineer, now considered successful, could possibly pass his examination. Despite Mr. Leacock's fun at the expense of the psychologists, successful marine engineers must stand well in a test for marine engineers. Life must ratify every measure. Satisfactory mechanics must do well in a mechanical work-sample. The personnel of every prosperous organization represents the result of long weeding out. Two, three, four, perhaps five times the present staff has been hired, tried, and let go because unsuited and unsatisfactory. Nearly all workers of two years or more standing should obtain scores above the average on a test for their occupation. A worksample of value should select practically the same people whom years of trying and excluding have already determined upon. The purpose of present day tests is not the revolutionizing of the world, but the careful guidance of boys into the fields of endeavor for which they are best fitted, and the consequent increase, in time, of the number of geniuses who are in the field of work for which they are peculiarly fitted.

In practice, a task is constructed which seems to be a representative sample of mechanical work. Successful mechanics of known excellence then try it, and, as a rule, do poorly. The fact that men of known mechanical ability do a task poorly shows that the task is not a representative sample of mechanical work. It is, therefore, scrapped, and another made. Again successful mechanics try it, and ordinarily, again do poorly. Often as many as thirty must be tried before one is found which successful mechanics do well and unsuccessful poorly.

Seventy-four per cent of the all-round machinists with two or more years good standing, who have tried the wiggly block, make A or B grades. The test thus measures something possessed by good mechanics, but errs on twenty-six per cent. Twenty-nine per cent score A, the highest mark. Of good mechanics, only five per cent make D. A vocational test purposes to segregate, objectively, free from personal judgment or bias, successful workers in a particular line from people in general. Neglecting for the moment B and C scores as too near the average to be clearly differentiated, the A personnel contains six times as many mechanics as the D.

Two interpretations confront one: a criterion, which separates mechanics from non-mechanics, may indicate the presence in the former of an innate ability; or show past experience. Evidence has already been given which indicates that the score in the blocks depends little upon training and measures what, in all probability, is very close to fundamental ability. Here the evidence may be still further strengthened. A sample task which measures training may distinguish perfectly the expert from the novice, and yet fail utterly in picking that particular novice capable of advancing. The first depends upon the possession or lack of experience; the second, on aptitude. As most worksamples involve both acquired skill and natural ability, the integrity of each must be proved, not only on those of accepted merit, but also on a group of novices, to determine just how often, if at all, it delineates the latent capacities of untrained applicants, and predicts ultimate accomplishment.

Three hundred and twenty-seven mechanical and engineering apprentice boys were tested, and their work followed. Forty-four per cent made A grades in the wiggly blocks, and only five per cent, D. If the group had consisted of average persons instead of selected boys, the same number would have obtained D as A. The fact that but five per cent D's appeared, shows that the judgment of those in charge of the apprentice work had eliminated, without test, most of the D applicants.

Tests and judgment still disagree, however, on a few. Judgment hired five per cent who made D on the test. If the criterion had been test grade instead of judgment, these would not have been engaged. Look ahead and see whether their actual performance on the job agrees best with judgment or with the test. Less than a third of these D persons, whom judgment actually hired, but who would not have been engaged had the test scores been used in addition to judgment, are now continuing. Half have been dropped, more have left, and several of the others are poor mechanically. Most who made D in assembling the wiggly blocks could have been eliminated, without losing thereby a good mechanic. Among the eighteen who made C in assembling the block, whom judgment hired but the test would have rejected, a few have since proved good workers, but only a few.

Eliminating B persons is always questionable. Some ultimately do excellent work, and few are ever extremely poor. They represent the hardest of all classes with whom to deal, sometimes mediocre in quality, but hardly poor enough to drop. In the case of the apprentices, one hundred and ten obtained B grades; while one hundred and forty-three made A. Considering only high school graduates, the chances of an A boy passing the interview, being hired, given an opportunity, and remaining on the apprentice course two years or longer are eighty in a hundred. The chances of a B boy are but sixty-six in a hundred, of a C, twenty-nine, and of a D only six in a hundred.

Many, seemingly gifted, have but learned the rules of the game; and yet, because of their ready acceptance of precedent, too often receive high marks in school and the first opportunity which the industrial employment office has to offer. Engineering graduates, from technical colleges of high standing, should solve the blocks rapidly; but, because many have no more than basked for four or five years in the coruscations of erudition flashing about them, and because school is only an anodyne, not a remedy, only sixty per cent succeed, forty per cent fail. Real engineering work gradually eliminates most of this forty per cent poor in the blocks. But more interesting is a comparison of these graduates with mechanics who have had no such opportunities. Skilled mechanics acquire their trade in the shop; and perform, throughout the learning period, a routine task. No one incessantly drives them to reach for knowledge; the emphasis of supervision falls on the productive work, and if they acquit themselves satisfactorily in this, they continue the task indefinitely. Advancement in the art comes of their own volition, and depends upon aptitude for reasoning with concrete construction problems. A man, without ability, working under such conditions, is content to do his daily stint, and does not push on into the higher mechanical positions. Only the born mechanic assimilates the essentials of the craft he sees others about him using, and progresses. The ungifted drop by the wayside.

When existence depended for its continuance upon bodily strength, defective children were early and heartlessly crushed beneath the burdens which their weakened physique failed to support. Today the aids of civilization have abolished physical selection by supplying sustenance to men, wrecked in body, and allowing them to live unmolested. Schooling rapidly achieves the same result in the mental sphere. One might expect educated, highly intelligent, engineers to stand, as a group, better in every test than mechanics, most of whom have progressed little beyond grammar school, and none to college; and instead only sixty per cent of the college trained student engineers reach A and B scores on block construction, while seventy-four per cent of the tool- and die-makers, and machine repair and set-up men succeed equally well.

The engineers would have gained, had they, when unsuited, been forced into other fields. For, on reviewing individuals in the designing department who do the block poorly, few have proved successful. A particular man represents the group, an occupant of an engineer's desk for the past eight years. Today not a single achievement stands to his credit. If other engineers wish knowledge of mechanical formulæ, of stresses, or statistics, they turn to him. He has imbibed, through the constant conning of books, an enormous amount of encyclopædic data; but lacks so completely ability in his chosen line, that ten years from today, he will still claim nothing, will still occupy the same desk, or will have begun slowly to slip back. The school, by stuffing this man with engineering knowledge, ruined his life, which, in another field, might have contributed to human advancement, and been happier. The industrial concern which gives its problems into the hands of such men because they have learned the rules of the past, can hope only to follow, never to lead.

A second worksample emphasizes what seems to be the obvious desirability of mechanical knowledge and shows the care which must be taken to avoid measuring memory when one wishes an indication of innate aptitude. An experienced mechanic, handed the six parts of a pair of dividers, and asked to assemble them, does so in less than a minute and a half; while more than a quarter of all others require over seven minutes, or give up after fifteen. This problem seems, on the

TABLE 11

Correlation between Worksample No. 5, Mechanical Aptitude, and Worksample No. 72, Mechanical Aptitude plus Mechanical Knowledge—143 Cases ($r = 0.49$)

Worksample No. 72, Mechanical Aptitude plus Mechanical Knowledge (columns); Worksample No. 5, Mechanical Aptitude (rows)

	0.20	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.50	5.00	5.50	6.00	7.00	8.00	9.00	10.00	15.00	Imp.	
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2.90														1						2	1		1		1	1	1										2.90
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Worksample No. 5, Mechanical Aptitude

A partial correlation such as this between any two tests indicates that at least one of them is a combination of two or more mental processes. In this case, Worksample No. 72, the assembly of the dividers, is a combination of mechanical aptitude plus mechanical knowledge. The mechanical aptitude which is involved in the assembly of the dividers correlates with Worksample No. 5, the wiggly block.

surface, far more mechanical than the wiggly blocks, and a dozen employment managers, on comparing the two tasks without the actual results, have agreed that they would far rather have a mechanic who can assemble these six pieces to form a pair of dividers, than one who can build the blocks. Yet rapid assembly of the dividers measures, to a considerable extent, acquired knowledge within reach of everyone. Individuals, who assemble the dividers in less than 1.4 minutes, can call them by name, and a majority have used them. Not one who consumes more than seven minutes has previously employed them, and few know their purpose or name. Thus a relation holds, in this task, between past knowledge and performance. Furthermore, in a group of individuals who possess much the same innate mechanical aptitude as shown by equal scores in the wiggly blocks, the mechanics perform the dividers better than the engineers. Something, therefore, which mechanics possess, but which engineers lack, has aided them, and this something is mechanical knowledge. A man who plies this task well but fails in the wiggly block assembly may do routine mechanical work, but in the mechanical or engineering field will probably not be an asset to himself, to the company for whom he works, or to the world, and will leave no mechanical advance to aid future generations. Such a task, despite its obviousness, should not be used in measuring the capacities of youngsters, or predicting their futures, it depends to too great an extent upon the environment of childhood days.

A worksample need not be even so obvious a tool as are these dividers in order to measure the substitution of knowledge for the desired gift. The assembly of eight triangular blocks into an equilateral pyramid, requires, in addition to mechanical aptitude, considerable knowledge of geometry, for the group, as a whole, who have studied geometry do it better than the group who have not.

What then, in specific terms, is the ability, measured by the wiggly blocks, which allows its possessor to see structural relationships but does not measure past knowledge or training or education? A mechanical genius subconsciously recognizes the nine pieces as of three types: corners, sides, and center. The classification represents no perceptible step in his solution of the problem, calls for no obvious effort. One less gifted in this line, but with, nevertheless, a trace of structural instinct, consciously, and often actually, assorts the nine blocks into three separate piles on the table, and then selects as he needs the pieces. One with no such endowment, picks aimlessly any block, without recognizing the three types. This man almost invariably consumes six minutes or longer, as compared with the two or three needed by a gifted mechanic. It has often been said that a scientific problem, clearly stated, is half solved. The distinguishing mark of a good mechanic or successful engineer, is ability to visualize structure so clearly that analysis is made easy.

Mechanics, engineers, and scientists have much in common, for the scientist, even more than the mechanic or engineer, must visualize; and the few scientists who have tried the blocks have done well.

In the introduction to Vallery Radot's *Life of Pasteur*, William Osler writes, *The future belongs to science.* For the moment science reigns, undreamt advances await the next few years; but the far distant future, stretching before humanity to the edge of the horizon, belongs to no man. Science is only a phase of life; the scientist is a species, not the genus. The wiggly blocks select the mechanical genius. They measure an innate aptitude for visualizing the essential relations of structure, as natural to him who does them well as respiration, and cast a glimmer into the incertitude of a slowly dissolving future. Other worksamples are needed. Each type of work must be placed in the hands of its own particularly gifted worker in order to insure human advance.

CHAPTER VIII

Opinion and Prejudice

One of the most important and difficult tasks of an industrial executive is that of knowing his men, both the stable force, and the new workers whom he continually adds to the pay-roll. In the course of a year, business expends as much in salaries as for material commodities; and yet the art of buying goods has reached an advanced stage, whereas that of hiring human beings remains sadly inadequate. A purchasing agent surrounds himself with technical specifications, demanding that such things as rubber, copper, and steel meet a desired tensile strength, elongation, and composition, determined by the physical and chemical laboratories at his disposal, and are not higgled for over a good dinner. No buyer can afford to see half of his purchases scrapped as useless. Yet, in many organizations, the present state of employing man-power differs little from old-time chance bargaining: one half of all new employees leave, or are dismissed, within two years.

Can scientific measures weed out, more accurately than skllied executives, the desirable applicants? If so, they should be used even in their present state of rank crudity; if not, although they may be recognized as the first step toward a desirable goal, they are of no immediate practical value. The accuracy of judgment versus measured facts in predicting those who will soon leave of their own accord or be dismissed is directly susceptible to experimental proof. A small number of girls, thirty-six—not sufficient to give reliable data for a statistical study, but enough to point the trend expected from a larger sample—were carefully questioned by a trained employer, and graded A, B, C, or D, based on his knowledge of their past experience, and his opinion of their fitness. Then, independent of this estimate, they were measured on the three peg board, again scored A, B, C, or D on this basis, and hired, and followed for eight months. At the expiration of that time, their status as exemplified by their presence either on or off the pay-roll, failed to check with the interviewer's prediction, for half of those he considered the most desirable had left, while half marked poorest remained. The personal interview, when faced with cold-blooded, remorseless objectivity, proves an extremely inaccurate indication of the applicant's desirability, little more than a combination of opinion and prejudice. The test, on the other hand, selected, by no means perfectly but fairly well, that group of persons so unfitted for simple assembly work as to sever their connection within eight months. Of those marked A in the three pins only six per cent left; while of those graded D, over half.

The percentage of removals from the pay-roll, for any cause whatsoever, designated labor turnover, is one of the yard-sticks by which modern industrial management measures itself. Few severances indicate a stable organization; the opposite shows almost invariably undesirable conditions somewhere causing dangerous restlessness. Although a certain amount of unrest might be desirable with older men, who occasionally plod too long at the same routine, the turnover among workers of more than five years' service is negligible. One half leaving are of less than six months standing, and nearly three quarters under a year. Employees change, not from becoming tired of a job well done, but as a consummation of innocuous assignment to work so unsuitable as immediately to become onerous. Most separations occur during the training period, or so soon after, that the company derives little or no benefit. Any step which helps match the worker to his task decreases wasteful shifting.

Today's problem of unrest is not one of monotony or working conditions or pay, for, although these all contribute perceptibly when labor turnover reaches a low point, the maladjustment of worker and task, wherever it exists, swamps them to insignificance. A large percentage of the youths who start to leave remain with or later return to the same concern, if placed on other work, often even when the new position pays less than the old, showing dissatisfaction with the particular task and not the working conditions, the management, or the pay. Despite outstanding instances to the contrary, many, who leave of their own will, are poor workers at the particular task, adding again to the conclusion that, realizing themselves unsuccessful, those who depart were originally misplaced. Practically all shifting takes place within the first two years with a new company, when the greatest problem is adjustment to the job. Failure in solving this satisfactorily leads to seeking employment elsewhere.

Every man, out of work, is a danger to himself and to the state. Loafing exaggerates the slightest tendency toward harmful day-dreams and noxious reveries. A youth, without work, with no responsibility to an employer, to all intents an outcast in the community, is an easy prey to every suggestion, feeling that he can lose nothing by his conduct.

An employer, in a district of great restlessness, where the labor turnover reached a figure sufficiently large to give a trustworthy comparison, selected six hundred new workers by the customary interview method, including checking of references and past experience. At the same time, he chose six hundred others with similar care, but with, in addition, a knowledge of their measured aptitudes as a part of the material on which he made his decision as to whether they should be hired or not. They were then followed. The labor turnover among those hired without a measured analysis was more than twice that of those measured.

To industry, when rightly used, accurate indices of inborn abilities, simple tasks, carefully selected, accurately standardized, and properly conducted, which foretell, with considerable precision, future possibilities for larger undertakings, will save thousands, perhaps millions of dollars annually. Each year, an enormous number of workers, both in industry and the professions, become restless because success is not in sight, and shift to other employment. This necessitates the engaging and training of new recruits to fill the ranks. Some corporations of two thousand employees spend as much as one hundred thousand dollars a year in hiring and teaching new workers to take the places of those who leave. In one instance where work-samples are employed as an aid to good judgment in assigning the younger generation to tasks where they are happily at home, their use has cut restlessness, as measured by labor turnover, in half, and, if extended, might cut the present training cost of novices in general in half. Furthermore, by selecting persons naturally suitable, work-samples lessen again, by fifty per cent, the necessary learning time of those engaged, with the saving of another quarter. From the employer's standpoint, sample tasks more than pay their way.

Although scientific human analysis, even in its present state of immaturity, supplies data obtainable in advance by no other means, the question is invariably asked: Can selection be used during periods of marked labor shortage, when the employment manager, hounded for help by every executive in the organization, deluged with unfilled requests, buries his head in the sand, like the proverbial ostrich, and hires every mortal he can inveigle into the organization? Of what value are measures at such a time?

With an unlimited labor supply at hand, many executives acknowledge the desirability of scientific selection, but when every one who applies must be hired, can tests be used? An examination of the group who score D makes an impartial observer, not too closely bound by past precedents, question the advisability of hiring every one. Of those who make D, a large percentage leave within three months. Even in times of the greatest labor shortage, it is questionable whether the enormous expense due to this turnover among D people should be assumed. And this forms but a portion of the cost, for only two D persons from every hundred do *excellent* work. Ninety-eight per cent of the D's added to an organization, mean poor product to the customer, ultimate complaints and loss of business. In all but the exceptional case an order should be refused rather than given to a D grade worker to execute.

Even, however, in times of the greatest labor shortage, D's need never be hired. Worksamples are not an arbitrary system of eliminating applicants, and should never be so used. Nearly every prospect scores high in some test. Types of work and their requirements are as multitudinous as human beings, and, since every individual differs a little from others, each man fits to advantage somewhere. By using worksamples as a means of studying applicants and apportioning them properly, all who apply can be accepted without locating one on work for which he scores D in the sample. The sorting on a basis of capacities, the guiding of a portion toward one occupation and a part away, and the stationing of each mortal where he renders the greatest service, presents a momentous human engineering problem to which the twentieth century is applying itself, much as the nineteenth century undertook the development of natural science.

Under conditions where every available man must be accepted, whether or not he seems wholly satisfactory, when standards must be reduced, although never to the extent of hiring D grade men, employment tests are in the same position as accounting in hard financial times. One may as well demand, when money is lost, or little profit made: *Why keep track of it?* as to ask, *Why measure new employees when poor ones must be hired?* Worksamples furnish unchanging criteria by which to compare new workers with previous standards. If last year only A applicants were engaged, and this year, because of a smaller supply, B's are taken, labor turnover will be higher and training time longer. Prices must increase, or profits lessen or disappear. When production runs smoothly, with a plentiful offering of applicants from whom to choose, hiring is simple and the prediction of future labor turnover comparatively easy. But when orders increase, and the demand for help surpasses the available supply of satisfactory candidates, an objective measure of desirability becomes a necessity. Without tests no manager carries a clear mental picture of his labor conditions from year to year.

Reduction in labor turnover is but one aim of the modern employment department; in addition, it endeavors to assign no one to work at which he later fails. How does measuring such simple accomplishments as finger ability, or number checking speed, or puzzle solving aptitude, contribute toward the realization of this purpose? In the years 1923, 1924, and 1925, one thousand and twenty-one women, applying for employment with an industrial concern, took the three pin work-sample. The employment office subsequently allocated seventy-seven of them to fine work requiring finger dexterity. Six of the seventy-seven, the foreman later dismissed for poor work. These six should not have been assigned to such an occupation. Nothing, however, appeared, during the customary employment office interview, to distinguish them from the others. One differentiating characteristic, which marked the failures—the fact that all required more than 7.70[1] minutes to distribute the three hundred pins—could not be discovered by talking with the applicants. The six failures would have been eliminated by refusing this type of work to those using more than 7.70 minutes in performing the pin test.

The cost of a failure is high, for the money paid an individual during learning amounts to a

[1] This figure represents the total time for the entire test. For the new scoring method see p. 215.

substantial sum, while the poor work which the failure turns out not only represents a financial loss but may pass an inspector, reach the customer, and cause a complaint and general dissatisfaction. Perhaps more important than all, one poor worker lowers the standard of quality of an entire department.

But merely excluding the unsuccessful is inadequate, as a manager might gain such a result by hiring no one. The efficient employment department must, in addition, engage a large percentage of the applicants who later make good. Among the seventy-seven women, assigned to fine work, sixty proved satisfactory. Had the employer refused to place women, slow on the pin task, in order to forestall the failures, he would have eliminated only nine (fifteen per cent) of the sixty who later attained efficiency. Nearly every concern can afford to turn away fifteen per cent of the potential successes, if, by such a procedure, it eliminates all failures. Most employers now reject more than this percentage of the good candidates, without checking afterwards to realize the fact. If applicants, with the finger dexterity reflex, shown by the pin test, are assigned to fine work, and ones without the reflex located elsewhere, eighty-five per cent of the ultimately satisfactory applicants will be hired, and few fail.

Some types of work have come to be recognized as preëminently belonging to women. Miniature instrument assembly, the fabricating of delicate electrical instruments, is one of these tasks. A comparison of the finger dexterity distribution curves for men and women, shows instantly the reason. Miniature instrument assembly requires, above all else, the particular type of finger dexterity measured by the three pin board. The average (median) time for women is 7.6 minutes, for men, 8.4, ten per cent longer. One quarter of the women who have tried the test have assembled the pins in less than 7.0 minutes, while but four per cent of the men have done equally well. It is, therefore, extremely difficult to find men who perform the test as well as A grade women. It is natural that all of those types of work which require this particular finger dexterity should become the prorogative of women.

Not only should an executive learn the value and quality of new men and women whom he adds to his pay-roll, but he ought also to discover the present capacities and future possibilities of all under him, without which he cannot make full use of his organization. Scientific measures supply this knowledge in an objective form, free from personal judgment and human inconsistencies. In one concern, a group of executives, in consultation and with objective records of past performance, graded thirty-five clerks, whom they had supervised for at least two years, and the quality of whose work they knew well. When measured later, twenty-two of the thirty-five made A in the number checking, and four, D scores. The measured grades checked well with the ratings based on several years' past experience; not one who measured D proved a desirable clerk, for one was about to be dismissed, and the others could have been turned away at the employment office, with material saving. Reviewing the three who scored C reiterated the same story; eliminating them would have profited all concerned; and yet, because of the average foreman's loathness to snap the last thread which binds a man to his work, these recognized failures had continued from month to month, giving little in return for their wages, and losing valuable time, which they might have devoted to succeeding in another line. Scientific measures select, with an objective surety, the five or ten per cent of a department who should be transferred to other work. Of the twenty-two scoring A in the worksample, seventeen were thought excellent workers.

Scientific measures can supply, in one hour, knowledge of workers as accurate as that gained from several years' association and, in many cases, more accurate, for, when subjected to the implacable analysis applied in the fields of chemistry, physics, and astronomy, an executive's knowledge of those under him is appallingly inaccurate. One, noted for keenness of understanding, graded carefully the judgment of fifty foremen and department heads working under him, all of whom he knew well. To check his opinions, another ranked, independently, the same group of fifty. The estimates of the two differed radically. The agreements which occurred were largely coincidences. At least one of the two executives might almost as well have thrown the fifty names in a hat and ranked them in the order of drawing. To decide which of the two erred, a third rated the same fifty, again independently. His opinions agreed with neither of the first. None of the three men knew much about the judgment of the fifty minor executives under them.

Possibly the seat of the trouble lies in the quality *judgment*, which conveys but a poor, vague meaning. The three executives, therefore, rated the same men on twelve other characteristics; and, in most cases, agreed no better than before. Of *quality of work*, they knew a little, but so little that any science based on their knowledge would be founded on a precarious foundation.

This apparent ignorance of men results from the fact that a good supervisor dismisses C and D grade workers, segregating them with considerable surety and justice from the higher ones, because they are extreme cases. He even eliminates some B employees, so that a large percentage of those whom he keeps, in an efficiently running department, are *excellent* or *good*—A grade or B. The ensuing small gradations within the remainder are imperceptible in the customary sizing up of men. No one, however good his judgment, can arrange such a narrowly confined collection in exact order of excellence. One can heft weights and, with a little experience, learn to assort fifty or a hundred into two or four groups, placing most of the largest in one pile, and the smallest in another; but, if the steps be sufficiently small, no one can scale them perfectly. The finer the steps, the more necessary is a mechanical measure. An executive, with a knowledge of men, and an opportunity to watch their work, agrees with the measures in selecting the extreme cases, the best and the poorest workers. Unaided judgment goes no further. A measure, however, whose reliability has been proved, can gradate the same group by often as many as ten or fifteen small steps, from best to poorest.

Oftener than nine times out of ten, when one estimate is replaced by another founded on longer experience and data of greater value, the new one approaches nearer the test mark; and one is tempted to draw the sweeping conclusion that the more accurate and extensive a supervisor's knowledge of his men's work, the more nearly will his opinion agree with the measured score.

As important as an exact manifestation of an employee's present value, is a knowledge of his future possibilities, for industrial existence, a decade hence, depends upon the youngsters now in training and their capacity to assume the responsibilities which descend upon their shoulders. Scientific criteria have already illustrated their reliability in selecting, more happily than human judgment, new workers who prove satisfactory the first and second years. It is not beyond contingency, not even beyond the result of such simple indices as exist today, to point out men who, in years to come, will adequately assume the guidance of special branches of endeavor.

Human engineering has not, as yet, existed long enough to have followed careers for ten or fifteen years, to learn which lead to executive responsibility, which to routine drudgery and obscurity. But, without the protracted delay imposed by life, which doles out facts so slowly, the scientist may draw aside a little the curtains of time and peer, if only dimly and uncertainly, into the future. As the astronomer, who cannot tarry whilst the stars age, to follow a stellar span from birth to death, traces in detail the course of celestial existence by arranging, in imagination, the luminous points of the sky in order of age; so may the human engineer picture and foretell the business life of a youngster without awaiting its fruition.

A college graduate, charged with the desire for life, enthusiastically enters an accounting department. Within a year, he begins to find a niche or drops the work and shifts to another occupation. Four or five years later he acquires definite duties and fills a place peculiar to his talents. A decade after entrance, he finds himself in one of three situations: Because of a special fitness for the task and outstanding achievements to his credit, he is an executive; or the want of a vague indefinable something has proved him a routine worker; or, once more, he may have severed connection with the organization.

Accounting leaders of the future should grade A in the number checking sample and few, if any, score B, C, or D. All A's need not necessarily become administrators, because the test measures only a single characteristic and many others are needed. But if this one is of sufficient importance, no one without it should ultimately become a truly commanding accountant.

A department head chose, from a group of business school graduates, those whom he considered most outstanding and promising prospects to develop into accounting executives. All, of even such a carefully culled group, are not destined to succeed. But the school ejects, through close contact with its pupils, many of the unfit, and the executive, with his knowledge of men, further improves the selection, until the distribution of the residue approaches perfection. By definition, twenty-five per cent of any heterogeneous assemblage, composed of various types, grade A; a hundred per cent of a perfectly chosen group should reach A. The distribution of test scores among the picked school graduates fell midway between that of a wholly unselected heterogeneity and the predicted grouping of ultimately successful accountants. Twenty-five per cent of a representative sampling of men grade A in number checking; fifty-five per cent of the elected group; and one hundred per cent of successful accountants. Turning to the other extreme, while twenty-five per cent of an unselected group score D in number checking, only five per cent of the selected group scored D, and no truly successful accountant should.

The preferred men were hired and attentively followed for two years. This period of actual work banned a few still unsuited, who had escaped the previous sorting methods. The distribution within the issuing group approached still nearer the ideal result, for seventy per cent were men who had initially graded A in the number checking, and none had original D's.

Actual following shows that two years in a department weeds out one half of those who fall to the lowest test grade; and indicates that the balance of the D's are unsuited to the occupation represented by the sample they do poorly. With knowledge of two years of history, the scientist is justified in continuing the curve and predicting that five years will altogether banish the D men, thought ill-adapted at the close of two. As practice in accounting does not measurably improve the number checking score, the scientist may check this prediction by measuring five year accountants. Here the distribution approaches still nearer that which should result if the number checking is an accurate indication of those unsuited to accounting work; for five years leaves none who originally graded D, and few C's. Three quarters are then men who originally graded A.

Fifteen years in a department determines the balance of life, for it brings man to the period when he seeks to enjoy the fruition of the past. Thereafter little advancement comes other than that already foreshadowed by the quality of previous work. If the first decade and a half prove unproductive, age approaches too rapidly to allow the unsuccessful worker to start life anew, like a worn paper he persists in folding along the old creases. Of eleven accounting executives, leaders in the field for fifteen years, ten scored A in number checking and the eleventh B+, within two points in a thousand of an A. As experience does not improve the scores, these are the same marks the men would have obtained years before. Thus, the number checking measures, with excellent accuracy, a characteristic of these accounting leaders; and since the scores which they obtain are, all the evidence seems to show, the same they would have obtained fifteen years earlier, the number checking indicates, today, the group among which will appear the accounting leaders of the future. Nearly every accounting leader of fifteen years hence possesses, today, the clerical aptitude shown by the number checking, and the men today who lack this aptitude have hardly a chance of reaching the first ranks of the accounting profession.

Despite the cost, an industrial concern can hire a worker to replace one who fails, but six months or a year, spent at a task for which a boy is ill-adapted, never returns. And worse than the time lost, inability to perform work of one nature satisfactorily, often so discourages a man that success may never afterward be gained. Worksamples, although not infallible in their present state of development, predict with mathematical certainty the probability of success or failure.

Adverting back to the number checking, how do tests affect the individual, considering his own personal good? An A candidate for an office position, accounting, auditing, and pay office work, typing, book-keeping, and stenography, has twice as many chances as a B of arriving, at the end of a year, in the meritorious class. An individual making C should interpret it to portend danger, for he has only one third the opportunity of a B, and but one sixth that of an A. Only two of every hundred persons scoring D in number checking make good on clerical work. Ninety-eight per cent placed at tasks for which they are so unfitted as to score D on a representative sample, become dissatisfied, not as the result of an incomprehensible mishap, but as a predictable consequence. Not even the guileless enthusiasm of youth can afford to take so slim a chance; want of number sense, when disregarded, arises, obstinate, like a haunting spirit of the past, at every turn of the way toward clerical success, to divert one into the waters of oblivion; for, when the waves of time begin to lap monotonously, the energy of early manhood speedily wears away and the solid strength of an inherent ability is needed to withstand the buffets.

CHAPTER IX

The Dangers of Human Engineering

Material plenitude has been humanity's beseeching cry throughout the ages. Now the appeal, as a universal want, no longer resounds. Great educational and industrial research organizations have eliminated national famines. Production outstrips need. More can be created than man readily desires. No longer a dearth, but an ever swelling plethora worries the world. Advertising campaigns teach new ways of ameliorating life. The age old prayer for plenty has been answered.

But man is not yet supremely happy; for happiness lies within the individual, and not in the external world. The chemist and physicist and engineer have gathered together a vast array of often insignificant but measurable incidents and pieced them into the consummate understanding of nature which redounds to the bodily comfort of the twentieth century. Science is a strange road by which to seek the unlocking of the slavish fetters binding men to materialism, but philosophy and poetry and art have tried for three thousand years, and now biology and physiology and human engineering must aspire to gain the end and store minute but measurable bits of man's thought processes until they form a comprehensive pattern for his inward happiness. To enhance the aggregation of intuitive and spontaneous workers, the human engineer must measure, substantively, each man and ascertain the elements of thought which his particular mind most readily subtends; and, in addition, and equally important, analyze situations, problems, and occupations, and so establish the unit characteristics required; and then match the two—the man with the problem.

Yet, even granting the full benefit of such advantages, danger lurks in the allocation of individuals to tasks for which their inborn abilities best fit them. Obliterating the hopeless strivings to succeed at unsuitable work may conceivably weaken mankind by rendering accomplishment too simple. Although the apportioning of boys to appropriate stations is of obvious immediate value, those who survive the present travail gain physical and mental vigor in the titanic struggle, while men confronted with low barriers, easily mounted, grow weak and flabby for want of effort. Success must not be turned too readily. Worksamples must not merely appoint men to tasks which they have ample ability to complete; but, in addition to calling attention to the particular occupations an individual can safely enter, show those so humble as not to require his entire complement of powers. No gift, however meagre, should fall into desuetude. Dispensing each member of society a problem just sufficiently obscure to reveal his utmost capacity, and not so gigantic as to crush him by its size or so light as to be borne without strain, need not lead to leisure and luxury. When human engineering reduces life to the enervating level where the metal of man receives too slight forging to toughen it, and there is danger of general inanition, it can, by graded selection, assign weighted duties which leave no spare time for fancy foibles. Far more economical of human energy than the haphazard piling of gruelling burdens on some and light loading others, and just sufficiently taxing a few, would be the scientific appraising of each task and each man, and the accurate matching of the two.

Every one wishes to excel; but the satisfaction of accomplishment when achieved is not lasting and leads to more pioneering. All strive, often blindly, for the simultaneous fulfilment of these antagonistic desires: achievement and struggle; and the methods of adjustment are as multitudinous as the toilers. Many never solve the dilemma. Where the will to power is unfulfilled, as so often at present, the restless longing contributes directly to mental discord and often physical violence and actual war. The soldier craves battle that he may fulfil his ambition and exert his belligerent energies to the full; the failure in life wishes war that he may try his hand at something new with another chance of success. Locating each man on work which, with utmost exertion, he just performs well, should gratify, to a great extent, the longing for prosperity.

Furthermore, answering the simple riddles of today by placement in the hands of men capable of deciphering them, will uncover others less readily fathomable, requiring greater genius to render them transparent; and the saving grace of humanity is that a few individuals eagerly attack the highest mountains, the coldest regions, the most difficult passes; and this constant groping should keep mankind from growing fatuous and inane without knowing it. The adventurers will drag enough followers with them into uncomfortable situations never completely to enfranchise civilization from the burden of curiosity.

More harm than rendering life too clear, lurks in the cramped development of individuals along one narrow isolated groove, the unrealized transformation of mankind into a collection of glorified ants, each with his exclusive track. When Haldane portrays advance, in coming centuries, as resulting from carefully controlled breeding, dictated by the laws of biological inheritance, he predicts race adaptation to a degree almost equivalent to H. G. Wells' *Men in the Moon*, where the monarch, in order to think more clearly, grows a head four feet in diameter, encasing processes of such energy that cooling water must continually flow over its surface. The extensive application of occupational measures may bring about the same extreme individual modification Haldane expects from biology. Scores in worksamples alone show that persons are preëminently adapted for designated tasks. Assigning generation after generation of a family to the same vocation, because the members inherit similar aptitudes, may induce warped freaks; and, although man's future progress depends upon specialization, any such stifling restriction of one family, whether brought about through biology or through mental tests would jeopardize individuality.

Under present conditions of education and employment, vague aptitudes, even when sufficient to attract attention, are too slight to determine vocational choice. Men drift into the first opening. But should worksamples reach these underlying propensities, and a family persistently learn the same occupation, until, as with Pavlov's mice, the necessary training time diminish to one fiftieth, a highly differentiated civilization would gradually emerge. The human engineer must face this possibility squarely, and meet it dispassionately; for few persons look ahead while the present proceeds smoothly; industries, schools, and individuals encounter severe reverses by rushing blindly into an apparently facile future, and recognizing a potential danger often precedes forestalling it.

To avoid such specialization, human engineers must make every effort to broaden individuals, to bring into play more muscles, more senses, and a larger portion of the personality, and never limit functions to specified groups. Mankind is not an array of ingeniously contrived pegs each fitting into its corresponding and expected hole. Youth should be spent in widening the horizon and extending the view to its furthest circumference.

Howbeit responsibilities begin to descend. Boys must too often provide for themselves, either in part or in whole, through the last years of high school. Twentieth century girls, with parents well able to care for their needs, occasionally feel that a calling renders them more independent. Even when the need is not present, to demand action in material form, a trade, well learned at an early age, on which one can fall back in a moment of need, forms a foundation for future courage, and gives a mental anchor of tremendous strength throughout the storms to come. Nevertheless, despite the advantages of early vocational training and the desirability of furnishing a re-enforcement upon which to rely in an emergency, these must be gained without too disturbing a sacrifice. Dedication of any considerable portion of the fourteenth, fifteenth, and sixteenth years to imbibing particularized skill, too often forebodes a narrow life. Except in a few cases the sacrifice of more than a small part of the school period to gaining a trade is distinctly harmful.

The boy, forced to pick a calling in his youth, when he knows little of himself and the sophistical world, should be piloted into the channel which his distinctive personality best prepares him to navigate. Here he has greater chance of success, gains confidence for future undertakings and courage to face life. Failure at the first task furnishes a poor beginning. To one floundering about in an unknown land, attempting to find his place, an understanding of himself is of immeasurable value; and scientific knowledge, properly applied, need neither restrict growth nor lead to greater specialization; but may exert a continually broadening influence from the age of fourteen and its childish vocational preference, to the settled steadiness of life at forty. Carefully standardized sample tasks descry the covert qualities; furnish a chart of the land, that the whole of youth need not be squandered in aimlessly ranging the coast of life.

In a single morning one may try a complete set of worksamples, the essences of many occupations, vignettes which introduce the chapters of life, and perhaps prove oneself wholly unfit for half, thereby saving many potential failures and years of wasted striving. One who learns his first job quickly is at liberty to devote the balance of his energies to extending his latitude and conning other regions. Easy achievement in the field of his own abilities frees valuable time which he can expend in drilling himself in the many subjects where attainment waits upon hard work; for time wings its implacable flight as rapidly over the mortal who is groping and, in the meantime, idling away life, as over one who turns the pages with surety.

No mortal enjoys sensing the boundaries of his capacity; and few, therefore, relish peremptory tests which, like medical examinations, are apt to discern a poignant weakness in the structure of the organism and confine its future. One, who uneasily postpones opening the pages of his future for fear of the hidden uncertainty, hoping, in some way, to circumvent fate, should brave the ordeal before the resilience of youth departs and naught remains but the thin, plaintive finale of the man who would not face himself.

APPENDICES

APPENDIX A

AN INTERPRETATION OF WORKSAMPLE GRADES

Science cannot predict the unfailing success of any given individual. It can but name the chances of success or failure, based upon a statistical study of like cases from the past. This must constantly be borne in mind in considering the suggestions presented in the following pages. Furthermore, as norms for children under fourteen are as yet but poorly known, less confidence should be placed in grades attained before this age.

List the numbers of the worksamples in which you, or the individual in whom you are interested, grade A or B—ignoring all others—and seek the resulting combination in the following pages.

Combinations in which one grades A or B:

Worksample No.		
1, 5, 17	Clerical Aptitude Mechanical Aptitude Tweezer Dexterity	p. 188
1, 5, 35	Clerical Aptitude Mechanical Aptitude Group Contact or Retiring Personality	p. 190
1, 16, 17	Clerical Aptitude Finger Dexterity Tweezer Dexterity	p. 191
1, 16, 35	Clerical Aptitude Finger Dexterity Group Contact or Retiring Personality	p. 192
1, 17, 35	Clerical Aptitude Tweezer Dexterity Group Contact or Retiring Personality	p. 193
5, 16, 17	Mechanical Aptitude Finger Dexterity Tweezer Dexterity	p. 194
5, 16, 35	Mechanical Aptitude Finger Dexterity Group Contact or Retiring Personality	p. 195
5, 17, 35	Mechanical Aptitude Tweezer Dexterity Group Contact or Retiring Personality	p. 196
16, 17, 35	Finger Dexterity Tweezer Dexterity Group Contact or Retiring Personality	p. 196

Worksample No.		
1, 5, 16, 17	Clerical Aptitude Mechanical Aptitude Finger Dexterity Tweezer Dexterity	p. 197
1, 5, 16, 35	Clerical Aptitude Mechanical Aptitude Finger Dexterity Group Contact or Retiring Personality	p. 198
1, 5, 17, 35	Clerical Aptitude Mechanical Aptitude Tweezer Dexterity Group Contact or Retiring Personality	p. 199
1, 16, 17, 35	Clerical Aptitude Finger Dexterity Tweezer Dexterity Group Contact or Retiring Personality	p. 201
5, 16, 17, 35	Mechanical Aptitude Finger Dexterity Tweezer Dexterity Group Contact or Retiring Personality	p. 202
1, 5, 16, 17, 35	Clerical Aptitude Mechanical Aptitude Finger Dexterity Tweezer Dexterity Group Contact or Retiring Personality	p. 203

Worksample No. 1—Clerical Aptitude—Grade A or B

The boy or girl, man or woman, who grades A in Worksample 1, has seventy chances in a hundred of success in one of the clerical occupations:

	Machine Calculating
	Adding Machine Operating
	Comptometer Operating
	Clerical Work—Unclassified
Stock and Production Work	Stock Ordering and Recording
	Stock Checking or Accumulating
	Requisition Recording
Typing	Typing or Stencilling
	Ediphone or Dictaphone Transcribing
	Stenography
	Secretarial Work
Accounting	Time-keeping
	Book-keeping
	Banking—Clerical Departments
	Pay-roll Accounting
	Cost Accounting (see 1, 5, p. 176)
	General Accounting
	Certified Public Accounting
	Auditing

One who grades B in Worksample 1 has thirty chances in one hundred of equal success in the same clerical field; one who grades C, ten chances; and D, two chances. The two men, or women, in one hundred who grade D in the worksample, and yet succeed in clerical work, do equally as well as the seventy A persons; but of one hundred D's only two, while of one hundred A's seventy reach this eminence.

The choice of a particular clerical line, the decision between one specialty and another, rests in part upon schooling; in part upon acquired, detailed knowledge and training; and in part upon scores in other work-samples. This one shows general clerical aptness.

The types of work appear in the list roughly in order of the schooling necessary. In the third group of occupations, headed typing, which applies more to women than to men, the first two, typing or stencilling, ediphone or dictaphone transcribing, require usually a junior high school girl; while the next, stenography, necessitates almost invariably a senior high school graduate. In secretarial work a college woman is apt to succeed more easily. One who undertakes typing with the hope of advancing should make every effort to obtain the formal schooling required by the next step ahead.

The girl who possesses this clerical aptitude, as shown by Worksample 1, but lacks finger dexterity, as shown by Worksample 16, should not be persuaded to undertake filing work with the hope of advancing to higher clerical positions; for, in all probability, she will fail on filing work because of her poor dexterity, and not be given the opportunity to advance into the clerical field where she can show her strong point.

In the fourth group, headed Accounting, which applies more to men than women, the first two, time-keeping and book-keeping, can be done well ordinarily by high school men; while the last two, certified public accounting and auditing, require, not invariably, by any means, but usually, some college training or its equivalent.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 43—Clerical Aptitude—Grade A or B

Worksample 43 measures the same aptitude as Worksample 1, and should be used as confirmation. Where Worksamples 1 and 43 agree, confidence can be placed in the results of Worksample 1; where they disagree, Worksample 1 is the more reliable, but should be used with caution.

For an interpretation of this combination return to Worksample 1 alone (p. 167).

Worksample No. 5—Mechanical Aptitude—Grade A or B

The boy or man, who grades A or B in Worksample 5, easily visualizes mechanical structure in three dimensions, an ability which, for want of a more fitting name, has been called mechanical aptitude, and which is an important element of success in the following occupations:

Box Making or Packing
Angle-iron Constructing
Millwrighting

	Welding Sheet-metal Fabricating Mechanical Assembling of all Types (from blue prints)
Machining	Punch Press Operating (set-up) Drill Press Operating (set-up) Screw Machine Operating Machine Setting-up and Repairing All-round Machine Work Tool- and Die-making (see 5, 17, p. 182).
Student Training	Mechanical Apprentice Work Apprentice Drafting Student Engineering
Drafting	Detailing Designing Drafting
Engineering	Electrical Testing Laboratory Research Apparatus Designing Commercial Engineering (see 5, 35, p. 184)
Medical Work	Surgery (see 5, 17, p. 182)
Scientific Work	Physical Research (see 5, 35, p. 184) Crystal Structure Work (see 5, 35, p. 184) Astronomical Research (see 5, 35, p. 184) Physical-chemical Research (see 5, 35, p. 184)

Architecture probably also requires this ability to visualize structure; but not sufficient work has been done to prove the fact or to know the numerical chances of success of the A boy.

Although labeled a "mechanical aptitude" measure, this worksample does not show skill in handling tools or manual dexterity of any kind, but the mental endowment which underlies success in every occupation which demands the visualization of concrete structure from machining to surgery.

In order to gain a clearer idea of the meaning of an A grade in mechanical aptitude it should be remembered that the boy, who scores A and enters any type of work dependent upon this ability, has sixty-five chances in a hundred of success; one grading B, thirty chances in a hundred of equal success in the same type of work; one making C, ten chances in a hundred; and one grading D, only two chances. The two D men in every hundred become as successful engineers or mechanics as the sixty-five A men; but one's chances of success are fewer in the type of work where one rates D than in another where one ranks A.

A boy, who possesses this mechanical aptitude, and who, at the same time, is below the average of his age in school work, should not ordinarily try to attend an engineering college, but should, if so inclined, enter a vocational school where he will have training in die-making, tool-making, or all-round machine work. If he later enters industry as a mechanic, he will find many opportunities to use any engineering or inventive ability which he may have; and, if he be outstanding, may ultimately reach as high a position as the technically trained man.

The boy, above average for his age scholastically, who grades A in Worksample 5, has seventy to eighty chances in one hundred of success in an engineering or technical college in either mechanical or electrical work. While such a boy need not enter one of the exact occupations listed, he should make an effort to use his mechanical aptitude in some way.

A boy who scores below average in Worksample 5 (C or D) may ultimately become a successful engineer, but statistically his chances are few. Consequently he should not begin to specialize too early. Probably he should not attend a purely technical school but choose rather a general college where he can take some scientific work. If, as he matures, he discovers that his love for engineering was not as deep-seated as he supposed he can change without handicapping his future.

As men do markedly better than women in this worksample, the field of work to which it applies is recognized as man's domain. The woman who enters it will come in direct competition with men and should, therefore, grade herself on men's norms.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 75—Mechanical Aptitude—Grade A or B

Worksamples 5 and 75 measure very nearly the same ability ($r = 0.76$). Of the two, Worksample 5 is at present better understood and, therefore, more reliable. Where the grades in the two agree, one may feel reasonably certain that they represent true ability. Where they disagree, Worksample 5 should be followed, but with extreme caution and judgment.

Worksample No 16—Finger Dexterity—Grade A or B

Women who grade A or B in this worksample have excellent chances of success in any type of factory work demanding finger dexterity and rapid finger motions. A few factory occupations to which this ability has been proved to apply are:

Meter Work	Pivot Setting Register Gear Train Assembling Meter Element and Final Assembling
Instrument Work	Instrument Armature Assembling Miniature Instrument Assembling (see 16, 17, p. 185) Instrument Assembling
Clock Work	Clock Assembling
	Small Rapid Hand Work Small Lathe Work Machine Winding

Where earnings are paid on a piece-work or Bedaux basis, those who grade A in this worksample average, as a group, nearly twice as much as those who grade D, and from ten to twenty-five per cent more than those who grade B.

The girl, good in Worksample 16 but poor in Worksample 1, should not be drawn into clerical filing work; for, while she may do well temporarily because of her dexterity, her chances of advancement to higher clerical positions are only ten in a hundred, if she grade C; and but two in a hundred if she grade D in Worksample 1.

This worksample does not apply to men.

Worksample No. 17—Tweezer Dexterity—Grade A or B

Men and women who grade A or B in this worksample possess the type of dexterity needed in all factory operations in which tweezers are employed:

Watch and Clock Work	Watch and Clock Repairing Watch and Clock Assembling Many Detailed Jobs of Watch Manufacture
Instrument Work	Instrument Spring Handling Instrument Armature Assembling Miniature Instrument Assembling
Inspection	Jewel Inspecting Jewel Work in General

Strange as it may seem, this worksample applies almost equally well to:

	Machine and Hand Glass Work

Here large tweezers are used in shaping the glass, and although quite different in size and appearance from those employed in watch work, necessitate apparently the same type of dexterity.

Worksample No. 35—Group Contact or Retiring Personality

Worksample 35 distinguishes two types of personality. It does not show the presence or the absence of ability in the same sense as Worksamples 1 and 5. It cannot, therefore, be graded A to D, for one extreme is not superior to the other. Persons giving thirty-nine or more most common responses (Group Contact grade A) are endowed with a characteristic which may be roughly designated as *group contact*. Those scoring twenty-two or fewer such responses (Retiring Personality grade A) are apt to be more retiring, possibly quieter and more nearly individual workers. Those falling between are not sufficiently marked in either the one direction or the other to be accurately classified by this measure.

In general, the types of work which require group contact are those which throw one in constant contact with other human beings; selling of any type and, to a certain extent, the whole business and industrial field.

The retiring personality finds greatest satisfaction in those occupations which call for individual effort: music,[1] poetry, painting, and art, and, to a certain

[1] Boys and girls interested in following music as a profession should take the six musical tests standardized by Prof. Carl E. Seashore. These are devised to measure Tonal Memory, Sense

extent, all professional life, where men are much more individual workers than in either business or industry.

This is the vaguest, most indefinite, and least understood of the worksamples; and, although considerable work is underway to extend its usefulness and increase its reliability, it should at present be used with caution to corroborate a conviction already present, or to strengthen a little a presentiment perhaps never squarely faced.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

One who scores above average in both of these worksamples has two choices before him.

He may, in selecting a profession, ignore his clerical aptitude, and follow one of the occupations listed under Worksample 5 (p. 169). In the types of work there catalogued he has the same chance of success as one who grades A in Worksample 5 alone. Symbols play so large a part in this era of civilization that one can find almost daily use for clerical aptitude without entering an occupation directly demanding it; and for the man

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of Rhythm, Sense of Pitch, Sense of Time, Sense of Intensity, and Sense of Consonance, and have been standardized on successful musicians. They are described in detail in his book, *The Psychology of Musical Talent* (New York: Silver, Burdett & Co., 1919).

primarily mechanically inclined, there is no harm in ignoring the clerical side.

The high school boy who grades well in these two, and is above the average of his age in school work, can undertake a scientific, technical, or engineering course with reasonable assurance of success, and will find that his clerical aptitude, although not directly used, will contribute its share toward his success.

If one's natural inclinations and training are toward accounting rather than mechanics, one, with this combination of abilities, should follow cost accounting or estimating which involves visualizing three dimensional structures. A cost accountant, for instance, is expected to visualize from a flat two dimensional blue print, the finished three dimensional apparatus so clearly that he not only determines the material involved but judges accurately the handling and machining operations necessary in manufacture.

He, who grades high in Worksamples 1 and 5, should avoid professions, such as general accounting, which involve clerical aptitude alone and give no opportunity for the use of mechanical ability. Every effort should be made to use one's full complement of powers. Mechanical aptitude especially, when left unemployed, causes an unaccountable sense of dissatisfaction and restlessness. Often, when this feeling persists, an attempt is made to use the latent mechanical sense as a basis for an avocation; but the result is seldom satisfactory.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Two diverse courses offer themselves to the woman who scores high in these two tasks.

She may, especially if she be a high school or college graduate, apply the clerical aptitude shown by a high score in Worksample 1, as a basis for future work; and use the finger dexterity shown by Worksample 16 to aid in the filing and sorting operations which are often the first steps in the clerical ladder.

Some girls, who have excellent clerical aptitude, and who might, therefore, become typists or stenographers, or even private secretaries, never find opportunity to show their excellence because they start with routine clerical filing and fail there, not through want of clerical aptitude but because of poor finger dexterity. This sometimes leads to the erroneous impression that the girl who starts by filing may never advance. A girl, good in both clerical aptitude and finger dexterity, should not hesitate to start with routine filing for she will in all probability advance.

Instead of choosing the office, a girl successful in these two worksamples may elect the factory. Here an inspector is often responsible for an accurate record of the number of pieces which pass through her hands. The keeping of this record is similar to many book-keeping operations, and necessitates a high score in Worksample 1. If the parts to be inspected are small and necessitate, therefore, rapid handling, with what is sometimes known in industry as a short cycle, the finger dexterity shown by Worksample 16 is a necessity.

A boy or man who possesses this particular combination of aptitudes should probably ignore completely his finger dexterity in choosing his life work. Even should he grade A in finger dexterity as compared with other men, he will, in all probability, never be able to compete with women in the field. He should follow the advice given under Worksample 1, Clerical Aptitude, alone.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

The handling of jewels in large quantities, especially jewel inspection, is a specific type of work known to necessitate this particular pair of aptitudes. Jewels are handled almost exclusively with tweezers. This requires the dexterity measured by Worksample 17. An accurate record is also kept of the exact number in process, handed from one worker to another. This calls upon the clerical aptitude measured by Worksample 1.

Page 174, under Worksample 17, lists other types of work which require tweezer dexterity alone. Any one of these, combined with recording parts in process, necessitates the combination of Worksamples 1 and 17.

If uninterested in factory work the high school man or woman, with this combination of aptitudes, may ignore Worksample 17, Tweezer Dexterity, and follow the dictates of Worksample 1, Clerical Aptitude, p. 167.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

One who has taken these two worksamples and is interested in clerical work should be guided by his score in Worksample 1, Clerical Aptitude (p. 167); and use the results of Worksample 35, Group Contact or Retiring Personality (p. 175 and Chapter II) only in so far as it aids in a better adjustment to life as a whole. No reliable data exists as yet which indicates the kind of personality likely to contribute to the greatest happiness in clerical work, either in typing, stenography, accounting, or auditing.

SELLING

High group contact, coupled with clerical aptitude, contributes materially to success in all types of selling work. An important element of successful selling is ability to approach other men and women easily. The man who grades high in Group Contact, Worksample

35, is usually happier in his general approach to humanity than is the retiring personality.

Almost every salesman, in addition to his actual selling work, must fill out orders accurately and keep some record of his sales. Clerical aptitude contributes materially to this part of selling work, so much so that we have tested several salesmen who have failed in their work because of poor clerical ability, despite the fact that they could actually make sales. A man who grades D in clerical aptitude is apt to find that the clerical part of his work not only absorbs too much time but worries him enough to affect his whole personality. One who has high group contact but lacks clerical aptitude should probably avoid most types of selling work, unless some special arrangement can be made by which he is not called upon to keep his own records.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

The significance of this combination of gifts continues as yet an unknown quantity. As men greatly excel women in Worksample 5, and women far surpass men in Worksample 16, the two rarely exist together. The few persons found to have both to any great degree have been skilful laboratory technicians, die makers of standing, or instrument makers. Not sufficient data exists to consider the combination of prognostic value.

The boy or man who scores high in both should ignore Worksample 16 and consider one of the occupations listed under Worksample 5, Mechanical Aptitude, (p. 169). The girl or woman with this pair of aptitudes should follow the suggestions under Worksample 16, Finger Dexterity, and ignore her mechanical aptitude, unless it is extremely high (three minutes or less) in which case she may, if she has a real love for the work, undertake designing drafting, engineering, or some type of scientific research.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

One, gifted with this combination of mechanical aptitude and tweezer dexterity, has opportunity in the more delicate types of die-making. A successful worker in this occupation must see the completed piece so clearly within his finished die that each stroke of the tool advances the work toward the destined goal. This visualization of structure is more important to the mechanic than any other single gift. But the dexterity, demonstrated by a skilful handling of tweezers in Worksample 17, aids greatly in the use of small tools, and adds to the chances of success in practically all delicate mechanical work, such as the higher grades of die-making, watch and clock repairing, and instrument work.

Worksamples 5 and 17 give no inkling of acquired tool- or die-making knowledge, or technique in working within close limits.

Another man, with a love for the work and a willingness to undergo the years of training necessary, will find in this combination of endowments, two of the gifts helpful in surgery. Not, for a moment, should the conclusion be drawn that two A's here predict surgical success, for these are but two of many necessary qualities; but an A in Worksample 5 shows, as in die-making, a clear visualizing of structure, while Worksample 17 demonstrates manipulative, tweezer dexterity required to an extreme degree in surgery. The fact that so few women score well in Worksample 5 is probably one of the reasons why so few become successful surgeons. The woman, especially poor at this task, should hesitate a long while and consider the problem from all sides before she attempts to specialize in surgery.

One may also ignore the A or B in Worksample 17, and follow the findings given on p. 169, under Worksample 5, Mechanical Aptitude. Although it is wise for one who can use his hands to employ the gift if practicable, no special harm results from neglecting it. Most men, skilful with their hands, find in their avocations sufficient opportunity to make use of the ability. Even here, however, care must be taken, for, occasionally, if the score in Worksample 17 predominates over Worksample 5, an avocation may assume a constantly growing importance, and ultimately absorb sufficient attention to harm success in daily work.

With men a high grade in Worksample 5 should never be ignored as may Worksample 17. Every possible effort should be made to use mechanical aptitude whenever it exists (see p. 169, Worksample 5, Mechanical Aptitude).

Women may, on the other hand, disregard their mechanical aptitude and follow the dictates of Worksample 17 (p. 174), unless they score three minutes or less in Worksample 5, in which case they are so outstanding that they should attempt in some way to use the aptitude.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

One who scores extremely high in group contact, thirty-nine or more most common responses, (grade A) should probably make use of the fact either specifically in some sales engineering, or commercial engineering position, or more generally by entering industry or business in some mechanical, engineering, or scientific capacity which necessitates contact with men. (For the desirability of clerical aptitude in selling work see Worksamples 1 and 35, p. 180).

Every man who scores high in mechanical aptitude should first refer back to Worksample 5 (p. 169) and study the possibilities there outlined. He should then read the analysis of Worksample 35 (p. 175) and also

Chapter II "Personality", as a clear conception of the results cannot be conveyed here in a short space.

One whose score is average, B or C grade, or one not interested in selling, should ignore Worksample 35, and follow Worksample 5 alone (p. 169).

The types of work which specifically require mechanical aptitude and retiring personality are:

Die-making
Tool-making

Designing Drafting

Designing Engineering

Laboratory Experimenting
Scientific Research

Here again, however, as with the combination of Worksample 5 and group contact, unless the indication of retiring personality is extreme, one should ignore it, and follow Worksample 5 alone (p. 169.).

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

This pair of abilities appears more often among women than among men; but is rare with both, since women do strikingly better in Worksample 16 than men, while men slightly exceed women in Worksample 17.

The finger dexterity of Worksample 16 is so universally applicable that it adds to the chances of success in almost every type of factory work. Tweezer dexterity, on the other hand, is employed only in specific jobs. One with both abilities should endeavor to find work requiring tweezer dexterity, and should study the suggestions given under the heading Worksample 17, Tweezer Dexterity, (p. 174). In the tasks there listed tweezer aptitude alone goes far toward assuring success, but, in almost every instance, especially with work performed by women, a high mark in Worksample 16, coupled with one in Worksample 17, adds to the chances of success.

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

Worksample 16 applies primarily to special manual operations which are found most often in factory work. One who grades extremely retiring—twenty-two or fewer most common responses—on Worksample 35 will not feel as well adjusted in the factory as one with group contact. One with extreme retiring personality and finger dexterity should analyze carefully his or her own opportunities, and personality, and try to fit the two as well as possible. No specific advice can be given.

One who scores high in Worksample 16, and has group contact, based on Worksample 35, will ordinarily succeed best in some factory work, and should see the occupations listed under Worksample 16 alone.

WORKSAMPLE NO. 17—TWEEZER DEXTERITY—GRADE A OR B

WORKSAMPLE NO. 35—GROUP CONTACT OR RETIRING PERSONALITY

Worksample 35 separates crudely the personality happiest in business or industrial life from that which finds greatest contentment in what may be called roughly, the professional field. One who grades high in this particular combination should study carefully the types of work which require tweezer dexterity, Worksample 17 (p. 174), and then attempt to analyze these in terms of his own personality. One who scores high in group contact should, on the whole, favor some one of the types of manufacturing work listed. One who scores high, on the other hand, in retiring personality, should attempt to find a laboratory opening of some kind, where he or she would be more of an individual worker, and not constantly in contact with other persons.

WORKSAMPLE No. 1—CLERICAL APTITUDE—GRADE A OR B

WORKSAMPLE No. 5—MECHANICAL APTITUDE—GRADE A OR B

WORKSAMPLE No. 16—FINGER DEXTERITY—GRADE A OR B

The combination of mechanical aptitude and finger dexterity is so rarely found that it is, as yet, little understood.

The man who scores high in these three worksamples should refer back to the combination of Worksamples 1 and 5, and follow the interpretation of that pair.

A woman who scores high in these three may follow the suggestions given under the combination of Worksamples 1 and 16 (p. 178), and should review them carefully; or, if her mechanical aptitude is extremely high—three minutes or less on Worksample 5—she should refer to the combination of Worksamples 1 and 5.

WORKSAMPLE No. 1—CLERICAL APTITUDE—GRADE A OR B

WORKSAMPLE No. 5—MECHANICAL APTITUDE—GRADE A OR B

WORKSAMPLE No. 17—TWEEZER DEXTERITY—GRADE A OR B

Clerical aptitude, as shown by an A grade in Worksample 1, should never be wholly ignored, as its neglect may lead to a feeling of dissatisfaction with work which does not require it.

A girl who scores high in these three worksamples *should turn back to* Worksample 1, study the possibilities listed there, and attempt to find work somewhere in the clerical field.

The college woman who grades above average in these three worksamples and exceptionally high (three minutes or less) in Worksample 5, Mechanical Aptitude, possesses many of the abilities necessary for success in scientific laboratory research. Worksample 5 shows *the gift for visualizing three dimensional structure* required of every scientist. Worksample 1 indicates inherent ease and accuracy in handling numbers, not absolutely essential but distinctly helpful in dealing with scientific data. Worksample 17 betrays facility with tweezers, indispensable to the physiologist in operating and dissecting and microscopic work, and to the laboratory chemist in glass blowing, and to the laboratory physicist in innumerable instances of daily occurrence. A girl should not, however, enter this field without a real love of the work.

With men clerical aptitude leads to success in accounting and auditing. As described under Worksample 1, *outstanding success in this field* necessitates usually a high school education. The boy or man with only a grammar school training, who grades high in this combination, should probably enter factory work, and follow the suggestions listed under the combination of Worksamples 5 and 17; but, at the same time, attempt to find one of the many types of factory work which necessitate the keeping of a record either of time or of parts in process. In this way clerical aptitude is employed sufficiently to avoid the restlessness caused by its complete disuse.

The college man or the boy who expects to attend college, and who is above the average for his age scholastically, should neglect his high score in Worksample 17 and follow the advice given under the combination of Worksamples 1 and 5.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

High group contact, coupled with both clerical and mechanical aptitudes, is specifically required by commercial or sales engineering. The validity of Worksample 5 in predicting engineering success is given on p. 171; while the importance of clerical aptitude in selling appears under the combination of Worksamples 1 and 35 (p. 180). One, keenly interested in selling work, who grades A in these three worksamples, has as many as eighty chances in one hundred of success in sales engineering.

The clerically inclined boy or man should ignore Worksample 35, except in so far as it aids in a better adjustment to life in general, and follow the combination of Worksamples 1 and 5 (p. 176).

One who scores other than high in group contact, Worksample 35, should also follow the suggestions under the combination of Worksamples 1 and 5 (p. 176).

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

In the clerical field this particular group of abilities is used in multigraphing, and the woman, who scores above average in these three samples, has excellent chances of success at this occupation, probably better than ninety chances in a hundred if the work interests her. By the same token, the combination probably also predicts success in hand type-setting, although the latter work has not been studied sufficiently as yet.

As in almost every combination of clerical aptitude and manual dexterity, men, and usually women also, with high school or college training should ignore Worksample 16, and probably Worksample 17, and follow Worksample 1, Clerical Aptitude (p. 167). In the occupations there listed they have a slightly better chance of success than the individual who scores equally high in Worksample 1 alone, and lacks dexterity.

Persons with not more than a grammar school education, who might succeed temporarily in clerical work but would probably never advance far, should attempt to make use of their tweezer dexterity on factory work which requires this peculiar ability, and at the same time, demands the keeping of an accurate record of the parts in process. A few types of work demanding the combination of tweezer dexterity and clerical aptitude are listed under Worksamples 1 and 17. The possession of finger dexterity, Worksample 16, in addition, adds to the chances of success.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The boy or man gifted with these three aptitudes should, in the majority of cases, ignore his finger dexterity and consider the possibilities under the combination of Worksamples 1 and 35.

The girl or woman, who grades high in these three, should be guided by the combination of Worksamples 1 and 16, keeping continually in mind the fact that one with high group contact finds, ordinarily, the fullest development of her own personality in the business or industrial world, while the retiring personality is happiest in professional life, which calls for more isolated individual effort. For a fuller discussion of the effect of personality one should also read the combination of Worksamples 16 and 35 (p. 186); and Worksamples 1 and 35 (p. 180).

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The man or woman whose inclinations are toward an occupation in which he can use his hands, should allow his tweezer dexterity to influence him; and, if he scores high in group contact, find some type of factory work which necessitates the ability shown by Worksample 17 (p. 174). He should also, if possible, make use of his clerical aptitude as described under the combination of Worksamples 1 and 17 (p. 179).

If he scores extremely retiring in Worksample 35, he should find work where he will be in more nearly a professional capacity and yet, at the same time, use his tweezer dexterity. The exact positions which require this particular combination of aptitudes are so diverse in nature that it is impossible to list them, and each individual must analyze his own situation and attempt to make as full use as possible of his entire personality. In making this analysis of himself, he should turn back to the separate combinations: Worksamples 1 and 17, and Worksamples 17 and 35.

The man or woman with at least a high school education who leans toward clerical rather than manual work should ignore Worksample 17 and follow the suggestions under Worksamples 1 and 35 (p. 180).

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Of this collection the most significant to men is Worksample 5, Mechanical Aptitude. The dictates of this ability, as described on p. 169, should be followed almost without thought of Worksamples 16 and 17. The dexterity shown by high scores in the latter two is an aid, often a substantial aid, to success in:

Delicate Mechanical Work

Tool-making
Die-making

Tool Designing
Designing Drafting

Laboratory Experimenting

But dexterity, when present, should not be allowed to influence materially the choice of an occupation.

To women who wish to do factory work Worksamples 16 and 17 are of predominant importance (p. 185) and should be followed without thought of Worksample 5.

To the college women of high scholastic standing who score three minutes or less in Worksample 5, this particular group of aptitudes guarantees nearly ninety chances in one hundred of success in laboratory research and, as hardly one woman in one hundred possesses it, this possibility should be carefully considered before entering another occupation.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

As will be seen by referring to Worksamples 5 and 16 combined, mechanical aptitude and finger dexterity rarely appear together in the same individual. This results from the fact that women far outstrip men in dexterity, while men, as a group, excel mechanically.

Men, who score high in these three tasks, should ignore their finger dexterity and follow the interpretation of the combination of Worksamples 5 and 35.

Women, who score high in all three, should neglect their mechanical aptitude, unless extremely high—three minutes or less—and follow the suggestions under the combination of Worksamples 16 and 35.

In the exceptional case, where a woman is outstandingly gifted mechanically and obtains a score in Worksample 5 equivalent to an A grade for men, she should follow the advice given for men and refer to the combination of Worksamples 5 and 35.

Worksample No. 5 – Mechanical Aptitude—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

Men who score high in mechanical aptitude and tweezer dexterity, and have a retiring personality should study the opportunities given in the combination of Worksamples 5 and 17. They should also read Chapter II, "Personality". The man gifted with both mechanical aptitude and tweezer dexterity has two important qualities which greatly add to his chances of success in practically all delicate mechanical work, and also in surgery.

Women who score high in these three worksamples should ignore their mechanical aptitude, unless it be outstanding, and refer to the combination of Worksamples 17 and 35 (p. 187).

The man who scores high in group contact and is outstanding in mechanical aptitude and tweezer dexterity should read the combination of Worksamples 5 and 35 (p. 184).

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The significance of high scores in Worksamples 16 and 17 has been studied most completely in connection with factory employment. On the whole, persons with extreme retiring personality, should probably avoid such work; but no hard and fast rule can be laid down; and one who scores less than twenty-two most common responses in Worksample 35 should reread Chapter II and attempt to apply its findings to his own particular case.

No doubt a large number of occupations exist necessitating Worksamples 16, 17, and 35 (Retiring Personality); but they have not as yet been studied in sufficient detail to list with precision.

One who does not score retiring on Worksample 35 should follow the suggestions under Worksamples 16 and 17, (p. 185).

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

The woman who scores above average in these four measures should not attempt to enter any type of mechanical work unless her score is extremely high. She should read carefully the combination of Worksamples 1, 16, and 17, and if possible, decide the type of work in which she would find the most happiness.

The college graduate, or the boy who expects to attend college, who scores high in these four worksamples, should take care to enter some occupation which demands both his mechanical and clerical aptitude. He should study the possibilities given under the combination of Worksamples 1 and 5 (p. 176).

The boy or man, interested in factory work, who grades high in these four measures, should ignore his finger dexterity, and follow the suggestions given under the combination of Worksamples 5 and 17, and, if possible, enter one of the types of factory work where he will be called upon to keep some clerical record of his work. This will give him an opportunity to make use of his clerical ability.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The boy or man with this group of abilities should ignore his finger dexterity, Worksample 16, and, guided by Worksample 35, Personality, study the possibilities on p. 176, under the combination of Worksamples 1 and 5. Clerical and mechanical aptitudes, whenever they exist together, are apt to contend with one another, and draw the individual in opposite directions. Men, especially, should take care to enter one of the occupations which demand both.

The girl or woman scoring high in these four should, on the other hand, give little or no heed to her mechanical aptitude, Worksample 5, unless it be extremely high—three minutes or less. She should be guided by the combination of Worksamples 1 and 16.

Having determined upon a future, this boy or girl, man or woman, should read p. 203, (1, 5, 16, 17, 35) for he is apt to find himself in the same position as the one there described.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The boy or girl with a large number of separate aptitudes should make every effort to find work in which he can use as many of his abilities as possible.

Unemployed aptitudes are apt to cause a submerged feeling of restlessness and dissatisfaction with work and even with life in general. As it is often impossible for a young person to find exactly the position which he ultimately wishes, he should consider his aptitudes in, as nearly as possible, the order of their importance.

Of this combination Worksample 5, Mechanical Aptitude, is apparently apt to cause the most trouble if not used in some way. One should, therefore, read very carefully p. 169, and obtain an idea of the general field covered by this aptitude.

Worksample 1, Clerical Aptitude, is probably the next most important. Although this ability is used in so many different fields of work that the man who possesses it can almost always make use of it, a few of the types of work, which have been studied, and which require these two aptitudes are described under Worksamples 1 and 5, (p. 176).

Personality, as measured by Worksample 35, perhaps comes next in importance. Chapter II and also p. 175 should be read carefully, and each individual should attempt to apply the results to his own situation.

Tweezer dexterity, as measured by Worksample 17, can often be neglected, especially by men and women of high scholastic standing.

Although this order of importance holds in general, there are individual cases where Worksample 17, Tweezer Dexterity, should be considered the most important and used as a basis for selecting an occupation. Each individual should read the significance of the separate tests, and then attempt to combine them and apply them to his own particular situation.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

A grammar school or a high school girl who grades A in finger dexterity and tweezer skill, that is, in Worksamples 16 and 17, has more than eighty chances in a hundred of success in delicate factory operations, such as watch or clock assembling, or miniature instrument work. One, who, at the same time, grades A in clerical aptitude, Worksample 1, should attempt to find a position which, in addition to manipulative skill, requires the keeping of records of parts in process. Clerical aptitude, wherever it exists to the extent of an A in Worksample 1, should not be wholly neglected.

A clerically inclined high school or college girl should follow primarily her clerical aptitude, considering finger dexterity and tweezer skill of secondary consequence, and undertake stenography or secretarial work, as suggested under Worksample 1 alone, rather than a manual task.

The grade in Worksample 35 should be interpreted here as in the other combinations. A girl or woman with high group contact will find greatest happiness in working with others in an organization. One with a retiring personality should, ordinarily, avoid group work, such as factory work or clerical work in large organizations, and attempt to find a position in which she will be more nearly an individual worker.

This combination of abilities is more important to a woman than to a man, for women so far excel men in finger dexterity that most tasks necessitating this gift have been taken over by them. A man with this particular group of endowments, especially if he be a high school or college graduate, should, ordinarily, neglect his finger dexterity and tweezer skill in making a decision as to a life work, and follow the suggestions given under Worksample 1 alone, or under the combination of Worksamples 1 and 35.

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

The man or woman who possesses this group of abilities should turn back to the combination of Worksamples 5, 16, and 17 (p. 194); then, with a clear understanding of Worksample 35 in mind, fit the facts into his or her own life. Such a group of gifts presents so many possibilities that specific advice is apt to be more harmful than helpful.

Worksample No. 1—Clerical Aptitude—Grade A or B

Worksample No. 5—Mechanical Aptitude—Grade A or B

Worksample No. 16—Finger Dexterity—Grade A or B

Worksample No. 17—Tweezer Dexterity—Grade A or B

Worksample No. 35—Group Contact or Retiring Personality

This man, so far as these particular measures are concerned, can do almost anything in which he is interested. Yet, during the past few years, several brilliant boys have been followed who, because of their wide range of aptitudes, have wandered from one type of work to another. A man with many gifts is in constant danger of restless shifting. Choosing first perhaps clerical work, he soon realizes that he is employing only a part of himself, and changes, hoping to gain fuller satisfaction. In the new work he uses other abilities than before, but still only a portion of his complete personality, and again he moves.

The larger the number of gifts the greater should be the ultimate goal gained but, all too often, because of the uneasiness engendered by unemployed aptitudes, the gifted man, wasting year after year, ultimately ends as a failure.

The highly endowed boy should not specialize too early, for the wider his training and the more inclusive his interests, the greater will be his ultimate achievement; and yet, as soon as possible, he should be given a goal for which to aim, and little by little helped to gather together the many threads of his life.

The moment this boy reaches sufficient maturity to take his life in his own hands he should consciously plan it, fix his own objective and persistently strive toward it. This does not mean that such a one must continue at the same monotonous task for fear of change. On the contrary he should consciously grasp every opportunity which presents itself to extend his experience. But in so doing and at every new turn he must answer the question, "Will this opportunity advance me toward my goal; or is mere restlessness alluring me?" and in so far as he answers correctly, he will succeed.

APPENDIX B

Detailed Description of the Apparatus, the Administration, and the Scoring of the Individual Tests

Worksample No. 1—Clerical Aptitude

APPARATUS

Form A

First column	*Second column*	*Same*	*Different*
96	96	________	________
64	68	________	________
55	55	________	________
43	63	________	________
80	80	________	________
392	397	________	________
653	653	________	________
659	656	________	________
8672	8762	________	________
1983	1983	________	________
34289	34298	________	________
93416	93416	________	________
et cetera.			

So many attempts have been made, by inexperienced workers, to reprint this worksample, that it seems best to omit the complete form. If the norms and results which are given in the following pages are to be used, the form of the test must be identical in every way with that on which they were based, even to such minute details as the exact numbers, type, spacing, and size of paper.

ADMINISTRATION

Introduce Worksample 1, Form A, as follows: HERE ARE TWO COLUMNS OF NUMBERS. THE FIRST TWO, 96 AND 96, ARE THE SAME: THEREFORE, CHECK OPPOSITE THEM IN THE THIRD COLUMN, HEADED "SAME". Trace with a pencil from the first 96 through the second to the proper place in the third column and make a check. THE NEXT TWO NUMBERS, 64 AND 68, ARE DIFFERENT; THEREFORE, CHECK OPPOSITE THEM IN THE FOURTH COLUMN, HEADED "DIFFERENT". At the completion of twelve lines, including the two checked by the examiner, call the examinee's attention to all errors and allow him to correct them, making certain that he understands the reason for the alteration: THAT IS A PRACTICE SHEET. THIS IS SIMILAR (referring to Form B) BUT WITH DIFFERENT FIGURES. NOW CHECK THROUGH TO THE END, AND I SHALL MEASURE THE LENGTH OF TIME IT TAKES. IF YOU HAPPEN TO NOTICE AN ERROR WHICH YOU MAKE, CROSS IT OFF AND CHECK CORRECTLY. Measure with a stop-watch the time in minutes and hundredths from the making of the first check-mark to the last. Should one mark be crossed out and another made, count as correct the last one. Examine carefully with each examinee the errors he has made. On the basis of the two components, time and accuracy, compute the score. Tell the examinee his letter grade, and, if it is low, explain whether due to time or errors. When Form B is thoroughly understood, give Form C as follows: IT IS A LITTLE FAIRER TO TAKE THE AVERAGE OF TWO (2) TRIALS. TRY THIS SHEET IN EXACTLY THE SAME WAY.

Occasionally an examinee begins checking the larger numbers at the bottom of the sheet first, intending to work up instead of down. In such a case explain that the total length of time required will be longer because by starting with the long numbers, the examinee sets himself a slow pace which he will continue, more or less, throughout. If he commences with the short numbers at the top, he sets himself a faster pace. Although he cannot continue this to the end his average speed will be greater, starting at the top than at the bottom. When the examinee attempts to use a paper or straight edge to follow lines, explain that he will experience no difficulty in checking correctly without a guide, and using one lengthens the time materially.

SCORING

First Trial (Form B)

Time (T) __________

Errors (E) __________ × 2 __________

30 − 2E __________

$S_1 = \left(\frac{T}{30 - 2E}\right)$ __________

Use the following when No. 1 is given after No. 43

$S_1 = 1.10\left(\frac{T}{30 - 2E}\right)$ __________

Second Trial (Form C)

Time (T)	______
Errors (E) ______ × 2	______
$30 - 2E$	______
$\left(\frac{T}{30 - 2E}\right)$	______
$S_2 = 1.12\left(\frac{T}{30 - 2E}\right)$	______
Use the following when No. 1 is given after No. 43	
$S_2 = 1.16\left(\frac{T}{30 - 2E}\right)$	______
$S_1 + S_2$	______
$S = \frac{S_1 + S_2}{2}$	______
$S \times$ *Age Factor*	______

When Form B (first trial) grades "C" or "D" and Form C (second trial) an "A" or when Form B grades "D" and Form C a "B," the test has been poorly administered. S_2 is the more nearly correct. Ignore S_1.

AGE	AGE FACTORS	
Last Birthday	*Male*	*Female*
16	.86	1.00
17	.97	1.00
18 and over	1.00	1.00

NORMS

GRADE	SCORE	
	Male	*Female*
A...	0–0.0590	0–0.0528
B...	0.0591–0.0706	0.0529–0.0619
C...	0.0707–0.0886	0.0620–0.0770
D...	0.0887–up	0.0771–up

Worksample No. 5—Mechanical Aptitude

APPARATUS

The apparatus for Worksample 5 is pictured opposite p. 28. It consists of nine irregular pieces which, when fitted together, form a solid block. It has not been found satisfactory to give the specifications, because it is almost impossible to follow them closely enough to make a block that is identical. A very slight difference would mean that the norms and results which are given here could not be used.

ADMINISTRATION

Place the nine blocks, assembled, before the examinee with one end toward him and say, THIS IS MADE UP OF NINE BLOCKS, LIKE THIS. Take one of the top corner blocks in the hand, showing it to the examinee and say, I SHALL MIX THEM UP, AND GET YOU TO PUT THEM TOGETHER AGAIN. Replace top corner block in original position, and proceed as follows: NOTICE CAREFULLY HOW IT IS MADE. IT IS CUT THROUGH INTO THREE PILES, WITH THREE BLOCKS IN EACH PILE. While saying this separate the blocks into three vertical piles, three blocks in each. In giving description gesture freely so that a person may understand from the motions, if he has difficulty in following the language. Move the hand down as if cutting the formation twice through into three piles. Touch each pile when it is mentioned and also the separate blocks. Next push the three piles together again, making the block once more as originally assembled. IT IS ALSO CUT THROUGH INTO THREE LAYERS WITH THREE BLOCKS IN EACH LAYER. While saying this remove the top two layers of three each, and place them on the table beside the bottom layer, a few inches from it. Then lift the top layer of three from the middle layer, and place it so that the three layers are arranged before the examinee in this order: bottom, middle, and top. These blocks should be moved so that the movement in disassembling will be from the examinee's left to his right. Separate the three blocks in the lower layer keeping them parallel, leave them a moment and then push them together again. In the same way separate the three blocks, for a moment, in the middle layer, and then in the top. Reassemble again by placing the middle layer on the bottom three and then the top layer above these. REMEMBER THAT IT IS THREE (touch bottom block) BLOCKS (touch middle block) HIGH (touch top block) AND THREE (touch left top block) BLOCKS (touch middle top block) WIDE (touch right top block). NOW I SHALL MIX THEM UP. Do not hurry the explanation; allow plenty of time for each step of the description to be followed and understood.

Take the assembled block apart with the examinee looking on. This is better than asking him to look away. Take up each block by one end; do not hold by the middle, as this makes the turning end for end too obvious. All blocks not turned end for end should be given at least a quarter turn on own axis. Make the motions rather slow; rapid ones disturb the examinee with the idea that you are trying to confuse him. Turn the two upper corner blocks end for end, and put them on the table. Place the middle block from the top, and the two side blocks from the middle layer with the first two, without turning end for end. In the same way, the center block in the middle layer and two corner blocks in the bottom layer turn end for end and place in the pile. The middle block in the bottom layer put in the pile without turning end for end. The blocks to be turned are marked with crosses (X) on the accompanying cross-section diagram.

X		X
	X	
X		X

Now mix the blocks thoroughly but slowly, so that the examinee cannot follow individual ones, but take care not to turn any end for end. Then spread out once more. Each block, except of course the center one, should have a flat edge resting on the table top. No blocks should have flat faces toward each other. When the examinee starts reassembling, the blocks should be arranged in a neat row, parallel to one another, an inch or so apart, and with one end of each block toward the examinee. They should not be piled on top of one another or left in an irregular order.

Leave a free space of approximately a foot between the examinee and the blocks for the assembling operation.

Arrange the test to indicate, as nearly as possible, mechanical ingenuity and to be affected as little as possible by the dexterity of the examinee, or any other complicating characteristic. Piling the blocks in a heterogeneous pile immediately before the examinee, without leaving working room, requires more dexterity in reassembling than arranging the blocks neatly, providing free space for assembling. Give no help of any kind (other than encouragement if necessary) during reassembling. Time, in minutes and hundredths of a minute, the reassembling. Tell the examinee whether he has been fast or slow, using judgment in doing so, not to discourage him unduly if he has done poorly. Having answered any questions which the examinee has to ask, proceed as follows: WE TAKE THE AVERAGE OF THREE TRIALS SIMPLY BECAUSE IT IS A LITTLE FAIRER THAN GIVING ONLY ONE. TRY IT AGAIN IN JUST THE SAME WAY. Mix the blocks as before with no more explanation than the above. Repeat a third time with the words, TRY IT ONCE MORE. THIS IS THE LAST TIME.

SCORING

First ________	$\times$ 1.0	________
Second ________	$\times$ 1.4	________
Third ________	$\times$ 1.7	________
Sum		________
S = Average		________
S $\times$ Age Factor		________

The score in this worksample is unreliable when the first trial grades D, and the last two A.

AGE Last Birthday	AGE FACTORS Male	Female
16	.62	Use
17	.77	male
18	.83	factors
19	.87	
20 and over	1.00	

NORMS

GRADE	SCORE Male	Female
A	0–2.74	0–4.00
B	2.75–3.98	4.01–6.50
C	3.99–6.13	6.51–9.50
D	6.14–up	9.51– up

Worksample No. 16—Finger Dexterity

APPARATUS

Use three hundred and ten brass pins, 0.072 inch in diameter and 1 inch in length; and a metal plate $\frac{7}{8}$ inch in thickness, $5\frac{3}{4}$ inches wide, by 12 inches long. In one half of the plate drill one hundred holes, arranged in ten lines of ten each, $\frac{1}{2}$ inch apart both ways, depth of holes, $\frac{3}{4}$ inch, diameter of holes, 0.196 inch (No. 9 drill). The other half of the plate consists of a shallow tray approximately 5 by 6 inches with gently sloping sides so that the pins cannot be lifted by gathering them against the side of the tray.

ADMINISTRATION

Seat the examinee comfortably at a table thirty inches in height. Place the board before him about a foot from the edge of the table with a shallow tray at the right if the right hand is to be used, and at the left if the left hand is preferred. Suggest that he draw the chair close to the table in order that he may rest his arms on its surface. The tray should contain 310 pins. The board should be at an angle of about 90 degrees to the examinee's working hand, but the examinee may change this position if he desires. Say, HERE IS A BOARD WITH ROOM FOR THREE PINS IN EACH HOLE. (AFTER I HAVE TIPPED THEM OUT), PICK UP THREE AT A TIME AND FILL THE HOLES, PLACING THREE PINS IN EACH AS FAST AS YOU CAN. USE ONLY ONE HAND. Illustrate with three holes. START IN THE FARTHEST CORNER AND WORK TOWARD YOU, LIKE THIS (gesturing). IF YOU START IN THIS CORNER (nearest) YOUR SLEEVE (OR FINGERS) MAY CATCH THE PINS. Show, by gesturing, that the holes are to be filled from left to right, for a right-handed examinee, and each row completed before the next is started. FILL EACH ROW COMPLETELY BEFORE YOU START THE NEXT. DO NOT SKIP AROUND. THERE ARE EXTRA PINS IN THE TRAY SO THAT IF YOU DROP ONE OR TWO ON THE FLOOR YOU WILL STILL HAVE ENOUGH LEFT; DO NOT STOP TO PICK THEM UP. Explain that the elbow may rest on the table but do not give this or any other of the suggestions in a mandatory form; say, for example, SOME PEOPLE LIKE TO . . . . etc. Allow examinee to place thirty pins, thus filling the top line of ten holes, for practice. Tip out these thirty again, allow a moment's rest, and then time accurately in minutes and hundredths, with separate stop-watches, first, the time required from the filling of the first hole to the filling of the fiftieth; and, second, from the filling of the fifty-first hole to the last. If either two or four pins are assembled by mistake in one or two of the holes, do not count this against the examinee. The test measures finger dexterity, not accuracy in counting.

SCORING

Time (first five rows)	__________ × 1.00	__________
Time (second five rows)	__________ × 1.10	__________
Sum		__________
Score (average)		__________

NORMS

GRADE	SCORE *Male*	*Female*
Fastest Person	3.08	2.87
A (Fastest Quarter)	0–4.08	0–3.66
B (Second Quarter)	4.09–4.40	3.67–3.98
C (Third Quarter)	4.41–4.76	3.99–4.29
D (Slowest Quarter)	4.77–up	4.30–up
Slowest Person	8.50*	7.50*

* Approximately.

Worksample No. 17—Tweezer Dexterity

APPARATUS

Use one hundred and five brass pins, 0.072 inch in diameter and 1 inch in length; a pair of tweezers, size 00; and a metal plate $\frac{7}{8}$ inch in thickness, $5\frac{3}{4}$ inches wide, by 12 inches long. In one half of the plate drill one hundred holes, arranged in ten lines of ten each, $\frac{1}{2}$ inch apart both ways, depth of holes, $\frac{3}{4}$ inch, diameter of holes, 0.082 inch (No. 45 drill). The other half of the plate consists of a shallow tray approximately 5 by 6 inches with gently sloping sides.

ADMINISTRATION

Place the board before the examinee with the tray to the right if the right hand is to be used, and to the left if the left hand is preferred. The tray should contain 105 pins. Say, HERE IS A BOARD WITH ROOM FOR ONE PIN IN EACH HOLE. (AFTER I HAVE TIPPED THEM OUT), PICK UP WITH THE TWEEZERS AND PLACE ONE PIN IN EACH HOLE AS FAST AS YOU CAN. (Illustrate). PICK UP THE PINS BY THE END OPPOSITE OR FARTHEST AWAY FROM YOU. USE ONLY THE HAND IN WHICH YOU HOLD THE TWEEZERS. (Illustrate). Continue giving such explanation as will give the examinee the fullest possible understanding of the best technique for placing the pins. Say, for example, PICK UP THE PIN RATHER LIGHTLY, SO IT WILL FALL INTO VERTICAL BY ITSELF, ALL READY TO DROP INTO THE HOLE,—SO. (Placing pin in upper left-hand corner from examinee.) THAT IS THE BEST WAY. YOU SEE IF YOU HOLD THE PIN TIGHTLY LIKE THIS—(placing pin) OR PICK IT UP BY THE MIDDLE, LIKE THIS——(placing pin) OR BY THE WRONG END, LIKE THIS——(placing pin), IT TAKES AN AWKWARD TWIST OF THE WRIST TO GET IT IN. BUT THIS WAY IT GOES JUST

NATURALLY. Illustrate while you are talking, filling three holes more in the correct manner. IT IS EASIEST TO START IN THE FARTHEST CORNER AND WORK TOWARD YOU LIKE THIS (gesturing). IF YOU START IN THIS CORNER (NEAREST) YOUR SLEEVE (OR FINGERS) WILL CATCH THE PINS. THERE ARE ENOUGH EXTRA PINS IN THE TRAY SO THAT IF YOU DROP ONE OR TWO ON THE FLOOR YOU WILL STILL HAVE ENOUGH LEFT. DO NOT STOP TO PICK THEM UP. Allow examinee to place ten pins, thus filling ten holes, for practice. Tip out these ten again, allow a moment's rest, and then time accurately with a stop-watch in minutes and hundredths the time required to fill the board, from placing the first pin to placing the last.

SCORING

Score (time).......................... __________

NORMS

GRADE	SCORE *Male*	SCORE *Female*
A.........................	0–5.00	0–5.40
B.........................	5.01–5.60	5.41–6.20
C.........................	5.61–6.20	6.21–7.30
D.........................	6.21–up	7.31–up

WORKSAMPLE NO. 35—GROUP CONTACT OR RETIRING PERSONALITY

APPARATUS

The form for this worksample contains one hundred stimulus words and their common responses. A copy of this measure appears on p. 43.

ADMINISTRATION

I SHALL SAY A WORD AND YOU TELL ME INSTANTLY THE FIRST WORD WHICH COMES TO YOUR MIND. FOR INSTANCE, SUPPOSE I SAY "BOOK" WHAT IS THE FIRST WORD WHICH OCCURS TO YOU? If the examinee gives one word, say: YES, THAT IS CORRECT. To the examinee who answers a phrase or sentence, explain that a single word is desired. Request one who delays his replies longer than two seconds, not to reason, but to respond with his first reaction. Read, one at a time, the one hundred words listed on the individual sheet for Worksample 35. Enter each reply in its exact grammatical form.

SCORING

Score (number of most common responses)... ____________

NORMS

GRADE	SCORE	
	Male	*Female*
A........................	100–39	100–40
B........................	38–32	39–35
C........................	31–23	34–24
D........................	22–lower	23–lower

WORKSAMPLE NO. 43—CLERICAL APTITUDE

APPARATUS

Form A

First column	*Second column*	*Same*	*Different*
go	go	____________	____________
of	or	____________	____________
ox	ox	____________	____________

Form A—continued

First column	*Second column*	*Same*	*Different*
an	in	____________	____________
me	me	____________	____________
him	his	____________	____________
out	out	____________	____________
but	tub	____________	____________
girt	grit	____________	____________
keep	keep	____________	____________
metre	meter	____________	____________
mangy	mangy	____________	____________

et cetera.

So many attempts have been made, by inexperienced workers, to reprint this worksample that it seems best to omit the complete form. If the norms and results which are given in the following pages are to be used, the form of the test must be identical in every way with that on which they were based, even to such minute details as the exact numbers, type, spacing, and size of paper.

SCORING

First Trial (Form B)

Time (T) ____________

Errors (E) ____________ × 2 ____________

30 − 2E ____________

$$S_1 = \left(\frac{T}{30 - 2E}\right)$$ ____________

Use the following when No. 43 is given after No. 1.

$$S_1 = 1.10\left(\frac{T}{30 - 2E}\right)$$ ____________

Second Trial (Form C)

Time (T) ____________

Errors (E)____________$\times 2$ ____________

$30 - 2E$ ____________

$\left(\frac{T}{30 - 2E}\right)$ ____________

$S_2 = 1.08 \left(\frac{T}{30 - 2E}\right)$ ____________

Use the following when No. 43 is given after No. 1.

$S_2 = 1.13 \left(\frac{T}{30 - 2E}\right)$ ____________

$S_1 + S_2$ ____________

$S = \frac{S_1 + S_2}{2}$ ____________

When Form B (first trial) grades a "C" or "D" and Form C (second trial) an "A" or when Form B grades a "D" and Form C a "B," the test has been poorly administered. S_2 is the more nearly correct. *Ignore S_1.*

NORMS

GRADE	SCORE	
	Male	*Female*
A................	0–0.0432	0–0.0351
B................	0.0433–0.0522	0.0352–0.0400
C................	0.0523–0.0657	0.0401–0.0480
D................	0.0658–up	0.0481–up

Worksample No. 57—Screw-driver Skill

APPARATUS

The apparatus for Worksample 57 is pictured opposite p. 60. An exact reproduction of this measure cannot be made from written specifications.

ADMINISTRATION

Give the screw-driver worksample for three half-minute periods, with rests between in order to overcome fatigue. Say to examinee, PUT FIRST FINGER ON TOP AND TURN WITH THUMB AND MIDDLE FINGER. DO NOT USE ANY OTHER FINGERS TO TURN SHAFT. TURN AS RAPIDLY AS POSSIBLE IN THE DIRECTION OF A SCREW-DRIVER. At the end of each half minute note the reading.

SCORING

First 30 seconds (turns)	________
Second 30 seconds (turns)	________
Third 30 seconds (turns)	________
Sum	________
S = Average	________

NORMS

GRADE	SCORE Male	SCORE Female
A....................	Above–36	Above–30
B....................	35–28	29–25
C....................	27–25	24–22
D....................	24–lower	21–lower

WORKSAMPLE NO. 68—MECHANICAL APTITUDE PLUS ENGINEERING KNOWLEDGE

APPARATUS

The apparatus for Worksample 68 consists of an equilateral pyramid and eight triangular blocks. The exact specifications are not given here, because it is almost impossible to follow every minor detail accurately enough to use the norms given here.

ADMINISTRATION

HERE IS A THREE-SIDED PYRAMID. IT IS EQUILATERAL; THAT IS, THE EDGES ARE ALL OF EQUAL LENGTH, AND THE SIDES ARE ALL THE SAME. FIT THESE EIGHT BLOCKS TOGETHER TO MAKE A PYRAMID IDENTICALLY LIKE THIS ONE—THIS SAME SIZE AND SHAPE.

SCORING

Score (time)........................ __________

GRADE SCORE

NORMS

	Male	Female
A	0– 8.00	Use
B	8.01–18.00	norms
C	18.01–up	for
D	or imp.	men

WORKSAMPLE NO. 72—MECHANICAL APTITUDE PLUS MECHANICAL KNOWLEDGE

APPARATUS

The apparatus for Worksample 72 is a pair of dividers.

ADMINISTRATION

Disassemble the dividers before the examinee sees them, and without allowing him to see the disassembly.

Twist the adjustment bar through one hundred and eighty degrees. Turn the wire eye through which the adjustment bar passes through eighty degrees.

HERE ARE SIX PIECES THAT GO TOGETHER. (WILL YOU) TRY PUTTING THEM TOGETHER WITHOUT KNOWING (BEING TOLD) WHAT IT IS THEY MAKE? PERHAPS YOU WILL RECOGNIZE THEM IMMEDIATELY, BUT TRY IT ANYWAY. Put the pieces on the table before the examinee. YOU MAY START ANY TIME. When the examinee picks up the first piece, start the watch. Stop the watch as soon as he starts turning the thumb nut on the adjustment bar, just prior to the completion of the task.

SCORING

Practice (time) ____________

Errors ______________________________________

____

Score (time) ____________

NORMS

GRADE	SCORE	
	Male	*Female*
A......................	0–1.40	0– 3.00
B......................	1.41–2.80	3.01– 5.20
C......................	2.81–6.60	5.21–10.00
D......................	6.61– up	10.00– up

WORKSAMPLE NO. 75— MECHANICAL APTITUDE

APPARATUS

The exact specifications of the apparatus for Worksample 75 are not given here, because it is almost impossible to follow every minor detail accurately enough to use our norms, and results.

ADMINISTRATION

Place the formboard before the examinee about six inches from the edge of the table. When in position, the three irregular designs must be nearest the examinee. Take all of the pieces and place them on the table before the examinee, to the right of the formboard. When placing the pieces be careful to have no two pieces on top of each other, and to have no two pieces of the same design assembled. Say, THESE PIECES ARE USED IN MAKING UP THE *DIFFERENT FORMS*. THERE ARE FOUR PIECES TO EACH DESIGN. Time in minutes and hundredths from the picking up of the first piece to the placing of the last. As the examinee completes his first design say, THEY FIT RATHER LOOSELY.

SCORING

Time (T) (Form . . . .)	__________
Time (T) (Form 4B)	__________

NORMS

Use the following norms when Worksample 75, Form 4B, is given without practice on formboards and before Worksample 5.

Form 4B

GRADE	SCORE *Male*	*Female*
A.	0– 5.00	Use
B.	5.01– 9.50	norms
C.	9.51–14.50	for
D.	14.51–up	men

APPENDIX C

Responses Given by Two Thousand People in the Free Association Experiment

WORD ASSOCIATIONS

The following frequency tables give the free association replies of two thousand individuals to the one hundred stimulus words selected by Doctor Grace Helen Kent and Doctor A. J. Rosanoff and published by them in *The American Journal of Insanity*, Volume LXVII, Nos. 1 and 2, 1910.

The first column tabulates the responses to the stimulus printed at the top.

The second column lists the number of individuals in the one thousand measured by Doctor Kent and Doctor Rosanoff who gave each response. This thousand contained both men and women. To quote directly from *The American Journal of Insanity*, "Over two hundred of the subjects, including a few university professors and other highly practised observers, were professional men and women or college students. About five hundred were employed in one or another of the New York State hospitals for the insane, either as nurses and attendants or as workers at various trades; the majority of these were persons of common school education, but the group includes also, on the one hand, a considerable number of high school graduates; and on the other hand, a few laborers who were almost or wholly illiterate. Nearly one hundred and fifty of the subjects were boys and girls of high school age, pupils of the Ethical Culture School, New York City. The remaining subjects form a miscellaneous group, consisting largely of clerks and farmers."

The third column, headed O'Connor, shows the number of times each response occurred in testing one thousand adult men largely from industry. The last column, total percentage, contains the per cent of individuals who made each answer, based on the total two thousand.

Responses made by fewer than one per cent (1%) of either group are combined under the heading, miscellaneous, at the bottom. Every scientist aims to consider only those facts which can be reproduced and re-established in other laboratories. Of the reactions given by at least ten individuals among the one thousand measured by Doctor Kent and Doctor Rosanoff, ninety-nine per cent (99%) are found among the second thousand tested, and sixty-eight per cent (68%) have been given by ten or more among the new thousand. Eight thousand two hundred and eleven (8211) responses which appear in the Kent-Rosanoff frequency tables are unique; that is answered by only one individual. Of these only eighteen per cent (18%) have been given by any one among the second thousand tested. Unique responses cannot, therefore, be reproduced, and for this reason should not be used as a basis for scoring.

THE FREQUENCY TABLES

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
1. TABLE			
board	14	5	0.95
book	7	21	1.40
chair	267	333	30.00
cloth	57	19	3.80
cover	17	46	3.15
desk	11	25	1.80
dinner	26	10	1.80
dishes	40	14	2.70
eat	63	40	5.15
eating	34	11	2.25
floor	7	11	0.90
food	29	12	2.05
furniture	75	16	4.55
lamp	1	12	0.65
leg	13	116	6.45
legs	10	39	2.45
round	10	3	0.65
stand	36	7	2.15
top	2	40	2.10
wood	76	84	8.00
miscellaneous responses made by fewer than 1% of either group	205	136	17.05

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
2. DARK			
black	76	85	8.05
bright	15	1	0.80
color	28	9	1.85
gloomy	11	6	0.85
light	427	626	52.65
night	221	162	19.15
room	22	15	1.85
white	9	11	1.00
miscellaneous responses made by fewer than 1% of either group	191	85	13.80
3. MUSIC			
amusement	10	1	0.55
beautiful	7	11	0.90
dance	17	3	1.00
dancing	15	4	0.95
enjoyment	13	2	0.75
harmony	45	29	3.70
instrument	21	17	1.90
joy	11		0.55
melody	24	10	1.70
noise	16	28	2.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
note	2	23	1.25
notes	17	48	3.25
piano	180	205	19.25
play	7	13	1.00
pleasant	10	2	0.60
pleasure	31	6	1.85
sheet	5	26	1.55
sing	12	38	2.50
singing	48	35	4.15
song	68	125	9.65
sound	95	85	9.00
sweet	47	19	3.30
violin	21	41	3.10
miscellaneous responses made by fewer than 1% of either group	278	229	25.35

4. SICKNESS

bad	15	7	1.10
bed	54	52	5.30
death	115	166	14.05
disease	29	24	2.65
doctor	62	115	8.85
health	142	168	15.50
hospital	9	21	1.50
ill	48	99	7.35
illness	71	85	7.80
medicine	29	9	1.90
nurse	15	4	0.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
pain	36	5	2.05
sorrow	24	2	1.30
suffering	12	2	0.70
trouble	20	1	1.05
unwell	11	4	0.75
weakness	11	5	0.80
well	49	101	7.50
miscellaneous responses made by fewer than 1% of either group	248	130	18.90
5. MAN			
animal	12	7	0.95
being	19	7	1.30
boy	44	57	5.05
child	10	11	1.05
father	15	3	0.90
girl	6	10	0.80
good	10	2	0.60
human	22	26	2.40
lady	7	13	1.00
large	11	5	0.80
male	99	53	7.60
person	30	13	2.15
strength	32	6	1.90
strong	8	12	1.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
tall	12	5	0.85
woman	394	561	47.75
work	17	8	1.25
miscellaneous responses made by fewer than 1% of either group	252	201	22.65
6. DEEP			
dark	28	30	2.90
depth	31	58	4.45
down	27	16	2.15
far	3	16	0.95
high	37	44	4.05
hole	32	20	2.60
hollow	13	5	0.90
light	4	13	0.85
long	18	9	1.35
low	51	30	4.05
narrow	3	13	0.80
ocean	93	56	7.45
river	13	20	1.65
sea	90	91	9.05
shallow	180	296	23.80
thought	14	1	0.75
water	134	113	12.35
well	44	51	4.75
wide	12	9	1.05
miscellaneous responses made by fewer than 1% of either group	173	109	14.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
7. SOFT			
bed	12	20	1.60
butter	12	3	0.75
cotton	28	16	2.20
cushion	25	20	2.25
easy	34	38	3.60
feathers	24	5	1.45
hard	365	548	45.65
light	8	13	1.05
loud	5	15	1.00
mellow	11	1	0.60
mud	15	9	1.20
mush	10	3	0.65
mushy	12	13	1.25
pillow	53	42	4.75
pliable	8	10	0.90
putty	4	11	0.75
silk	10	2	0.60
smooth	27	12	1.95
sponge	22	13	1.75
spongy	8	10	0.90
velvet	15	6	1.05
miscellaneous responses made by fewer than 1% of either group	292	190	24.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
8. EATING			
appetite	28	6	1.70
apple	4	10	0.70
apples	6	12	0.90
bread	46	18	3.20
chewing	27	11	1.90
digestion	10	14	1.20
dinner	31	43	3.70
drinking	166	144	15.50
fasting	5	22	1.35
food	170	252	21.10
good	23	9	1.60
hunger	19	10	1.45
hungry	44	46	4.50
masticating	11	1	0.60
meals	10	13	1.15
meat	11	15	1.30
nourishment	11	1	0.60
pleasure	10	2	0.60
satisfaction	12	7	0.95
sleeping	17	61	3.90
starving	4	11	0.75
table	21	18	1.95
miscellaneous responses made by fewer than 1% of either group	314	274	29.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
9. MOUNTAIN			
climb	9	17	1.30
climbing	27	16	2.15
height	73	25	4.90
high	246	171	20.85
hill	184	364	27.40
hills	32	26	2.90
peak	16	31	2.35
plain	11	14	1.25
rock	10	15	1.25
rocks	18	17	1.75
snow	10	5	0.75
steep	12	3	0.75
top	5	26	1.55
trees	17	17	1.70
valley	90	107	9.85
miscellaneous responses made by fewer than 1% in either group	240	146	19.30
10. HOUSE			
abode	15	9	1.20
barn	74	98	8.60
brick	23	10	1.65
building	78	55	6.65
bungalow	2	13	0.75
chimney	5	19	1.20
cottage	42	27	3.45

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
door	16	24	2.00
dwelling	68	55	6.15
furniture	11	2	0.65
garage		18	0.90
garden	10	2	0.60
home	103	103	10.30
land	10	6	0.80
large	24	10	1.70
live	33	14	2.35
living	19	16	1.75
lot	18	53	3.55
mansion	14	6	1.00
paint		15	0.75
people	11	4	0.75
residence	19	5	1.20
roof	12	46	2.90
room	9	11	1.00
shack		10	0.50
shelter	22	8	1.50
top	5	25	1.50
white	9	13	1.10
window	9	20	1.45
wood	31	63	4.70
yard	10	12	1.10
miscellaneous responses made by fewer than 1% of either group	298	228	26.30

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
11. BLACK			
cat	8	10	0.90
cloth	17	5	1.10
color	129	63	9.60
dark	172	181	17.65
darkness	36	16	2.60
dress	29	4	1.65
ink	14	8	1.10
light	12	65	3.85
mourning	17	4	1.05
night	51	50	5.05
white	339	505	42.20
miscellaneous responses made by fewer than 1% of either group	176	89	13.25
12. MUTTON			
animal	9	10	0.95
beef	97	115	10.60
broth	15	1	0.80
chop	34	15	2.45
chops	33	27	3.00
eat	14	9	1.15
eating	10	3	0.65
flesh	10	1	0.55
food	30	17	2.35

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
lamb	121	276	19.85
meat	257	190	22.35
sheep	204	215	20.95
tallow	6	11	0.85
veal	30	34	3.20
miscellaneous responses made by fewer than 1% of either group	130	76	10.30
13. COMFORT			
bed	42	50	4.60
chair	31	57	4.40
discomfort	24	39	3.15
ease	165	247	20.60
easiness	11	5	0.80
easy	61	68	6.45
happiness	50	7	2.85
happy	17	6	1.15
hard	2	11	0.65
hardship	7	29	1.80
health	15	10	1.25
home	63	40	5.15
luxury	23	31	2.70
peace	12	6	0.90
pillow	2	12	0.70
pleasure	77	33	5.50
rest	53	32	4.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
sleep	10	12	1.10
soft	2	19	1.05
solid	11	1	0.60
uncomfortable	10	17	1.35
miscellaneous responses made by fewer than 1% of either group	312	268	29.00

14. HAND

arm	63	116	8.95
body	48	34	4.10
face	7	10	0.85
feel	11	6	0.85
feet	35	16	2.55
finger	39	95	6.70
fingers	83	127	10.50
flesh	19	12	1.55
foot	204	305	25.45
glove	20	20	2.00
leg	4	18	1.10
limb	48	19	3.35
member	14	2	0.80
mouth	4	10	0.70
person	10	2	0.60
right	11	6	0.85
ring	23	7	1.50
use	12	5	0.85
useful	24	3	1.35

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
white	15	4	0.95
work	49	14	3.15
writing	11	9	1.00
miscellaneous responses made by fewer than 1% of either group	246	160	20.30

15. SHORT

distance	10	8	0.90
dwarf	11	5	0.80
girl	11	1	0.60
height	13	5	0.90
length	18	6	1.20
little	15	9	1.20
long	279	354	31.65
low	11	6	0.85
man	20	29	2.45
pencil	6	10	0.80
person	15	3	0.90
small	136	90	11.30
stocky		10	0.50
stout	24	15	1.95
stubby	9	17	1.30
tall	168	284	22.60
miscellaneous responses made by fewer than 1% of either group	254	148	20.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
16. FRUIT			
apple	157	344	25.05
apples	102	56	7.90
banana	11	41	2.60
bananas	8	20	1.40
eat	62	47	5.45
eatable	33	10	2.15
eatables	15	1	0.80
eating	35	14	2.45
food	22	13	1.75
good	24	8	1.60
grapes	14	9	1.15
orange	25	63	4.40
oranges	20	13	1.65
peach	17	11	1.40
peaches	32	6	1.90
pear	24	37	3.05
pears	11	8	0.95
sweet	24	8	1.60
tree	35	58	4.65
trees	27	9	1.80
vegetable	75	96	8.55
vegetables	28	27	2.75
miscellaneous responses made by fewer than 1% of either group	199	101	15.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
17. BUTTERFLY			
animal	24	19	2.15
beautiful	24	22	2.30
beauty	20	4	1.20
bee	31	13	2.20
bird	64	97	8.05
birds	10	6	0.80
bug	11	20	1.55
caterpillar	37	43	4.00
cocoon	6	13	0.95
color	12	12	1.20
flower	13	13	1.30
flowers	12	4	0.80
fly	44	48	4.60
flying	20	11	1.55
grasshopper	5	13	0.90
insect	261	196	22.85
moth	30	114	7.20
net	6	14	1.00
pretty	39	31	3.50
summer	17	16	1.65
wasp	11	10	1.05
wing	11	20	1.55
wings	31	80	5.55
worm	12	9	1.05
yellow	37	27	3.20
miscellaneous responses made by fewer than 1% of either group	212	145	17.85

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
18. SMOOTH			
easy	12	18	1.50
even	30	36	3.30
flat	14	8	1.10
floor	15	14	1.45
glass	56	46	5.10
glossy	11	11	1.10
hard	41	80	6.05
ice	14	13	1.35
iron	13		0.65
level	52	25	3.85
marble	10	3	0.65
plain	17		0.85
plane	23	25	2.40
road	4	10	0.70
rough	277	416	34.65
soft	79	63	7.10
surface	25	23	2.40
table	29	25	2.70
velvet	29	12	2.05
water	10	3	0.65
miscellaneous responses made by fewer than 1% of either group	239	169	20.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
19. COMMAND			
army	16	34	2.50
authority	14	1	0.75
captain	7	15	1.10
demand	18	19	1.85
direct	2	11	0.65
do	27	20	2.35
general	43	26	3.45
go	25	22	2.35
halt	4	23	1.35
obedience	12	1	0.65
obey	230	221	22.55
officer	30	36	3.30
order	171	297	23.40
power	10	1	0.55
request	11	19	1.50
soldier	16	7	1.15
stop		10	0.50
teacher	14	1	0.75
tell	15	4	0.95
miscellaneous responses made by fewer than 1% of either group	335	232	28.35
20. CHAIR			
back	1	12	0.65
bench	13	4	0.85

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
comfort	21	11	1.60
cushion	12	3	0.75
desk	9	31	2.00
floor	10	4	0.70
furniture	83	35	5.90
leg	7	60	3.35
legs	11	26	1.85
rest	45	14	2.95
rocker	17	5	1.10
rocking	15	1	0.80
seat	127	141	13.40
sit	107	118	11.25
sitting	56	25	4.05
stool	38	20	2.90
table	191	309	25.00
wood	49	47	4.80
miscellaneous responses made by fewer than 1% of either group	188	134	16.10

21. SWEET

apple	11	9	1.00
bitter	50	74	6.20
candy	82	84	8.30
fruit	9	10	0.95
good	26	21	2.35

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
honey	12	18	1.50
nice	33	13	2.30
orange	1	10	0.55
pleasant	31	4	1.75
sour	301	441	37.10
sugar	224	157	19.05
taste	57	27	4.20
tasty	11	8	0.95
miscellaneous responses made by fewer than 1% of either group	152	124	13.80

22. WHISTLE

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
bird	15	7	1.10
blow	95	84	8.95
boy	56	37	4.65
call	26	16	2.10
engine	15	5	1.00
holler	5	10	0.75
lips	5	18	1.15
loud	27	29	2.80
mouth	27	27	2.70
music	44	39	4.15
noise	173	205	18.90
pucker	4	12	0.80

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
shrill	26	32	2.90
sing	75	132	10.35
song	12	27	1.95
sound	103	44	7.35
steam	3	13	0.80
train	6	14	1.00
tune	18	28	2.30
wind	10	4	0.70
miscellaneous responses made by fewer than 1% of either group	255	217	23.60

23. WOMAN

beautiful	17	7	1.20
child	45	34	3.95
clothes	6	14	1.00
dress	28	28	2.80
female	134	97	11.55
feminine	10	13	1.15
girl	59	74	6.65
human	11	7	0.90
lady	41	62	5.15
man	292	459	37.55
mother	30	20	2.50
person	17	6	1.15
pretty	10	12	1.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
wife	15	12	1.35
miscellaneous responses made by fewer than 1% of either group	285	155	22.00
24. COLD			
chilly	30	13	2.15
feeling	10	1	0.55
freezing	23	14	1.85
heat	37	29	3.30
hot	151	325	23.80
ice	114	51	8.25
sick	4	10	0.70
sickness	6	16	1.10
snow	45	31	3.80
uncomfortable	10	7	0.85
warm	166	196	18.10
weather	49	12	3.05
winter	120	91	10.55
miscellaneous responses made by fewer than 1% of either group	235	204	21.95
25. SLOW			
easy	63	44	5.35
fast	316	604	46.00
horse	14	15	1.45

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
lazy	28	5	1.65
molasses	20	*8*	*1.40*
motion	7	11	0.90
quick	56	10	3.30
quiet	~~12~~		0.60
smart	~~10~~		0.50
snail	62	20	4.10
speed	7	10	0.85
sure	27	7	1.70
time	14	7	1.05
train	18	20	1.90
turtle	9	17	1.30
miscellaneous responses made by fewer than 1% of either group	337	222	27.95

26. WISH

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
bone	19	12	1.55
desire	*197*	*266*	*23.15*
dream	2	11	0.65
fairy	*11*	*2*	*0.65*
get	14	21	1.75
good	19	14	1.65
grant	*7*	*12*	*0.95*
granted	15	10	1.25
gratify	11	2	0.65
happiness	18	10	*1.40*
have	18	16	1.70

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
home	12	5	0.85
hope	51	100	7.55
long	10	4	0.70
longing	18	8	1.30
luck	9	13	1.10
money	32	18	2.50
something	15	3	0.90
think	18	19	1.85
thought	47	46	4.65
want	66	97	8.15
wishbone	14	20	1.70
miscellaneous responses made by fewer than 1% of either group	377	291	33.40
27. RIVER			
boat	20	8	1.40
brook	20	73	4.65
creek	10	18	1.40
deep	35	33	3.40
flow	24	30	2.70
flowing	17	12	1.45
Hudson	33	3	1.80
lake	65	61	6.30
Mohawk	1	11	0.60
mountain	10	3	0.65

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
ocean	17	25	2.10
sea	14	7	1.05
stream	117	224	17.05
water	393	324	35.85
miscellaneous responses made by fewer than 1% of either group	224	168	19.60

28. WHITE

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
black	308	522	41.50
clean	10	9	0.95
clear	2	12	0.70
cloth	17	9	1.30
color	170	103	13.65
colorless	11	6	0.85
dark	35	45	4.00
dress	34	3	1.85
light	51	57	5.40
paint	5	11	0.80
paper	17	21	1.90
pure	20	11	1.55
purity	19	3	1.10
sheet	6	12	0.90
snow	91	71	8.10
miscellaneous responses made by fewer than 1% of either group	204	105	15.45

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
29. BEAUTIFUL			
fine	8	10	0.90
flower	13	12	1.25
flowers	42	19	3.05
girl	24	25	2.45
grand	40	3	2.15
handsome	86	69	7.75
homely	27	90	5.85
lovely	64	30	4.70
magnificient	10	5	0.75
nature	16	4	1.00
nice	73	29	5.10
picture	19	19	1.90
pleasant	14	5	0.95
pleasing	16	7	1.15
pretty	113	245	17.90
scenery	23	13	1.80
sky	16	8	1.20
sweet	4	11	0.75
trees	10	2	0.60
ugly	66	103	8.45
woman	29	58	4.35
wonderful	1	15	0.80
miscellaneous responses made by fewer than 1% of either group	286	218	25.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
30. WINDOW			
air	12	4	0.80
curtain	13	3	0.80
door	57	107	8.20
frame	5	12	0.85
glass	316	282	29.90
house	22	24	2.30
large	11	3	0.70
light	186	87	13.65
look	15	9	1.20
open	19	15	1.70
opening	16	16	1.60
pane	82	248	16.50
sash	20	17	1.85
see	9	16	1.25
shade	8	12	1.00
sill	13	11	1.20
transparent	24	9	1.65
view	15	5	1.00
miscellaneous responses made by fewer than 1% of either group	157	120	13.85
31. ROUGH			
board	10	5	0.75
coarse	29	18	2.35

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
hard	38	65	5.15
harsh	10	2	0.60
ocean	27	12	1.95
road	21	27	2.40
rock	10	13	1.15
rocks	10	5	0.75
rocky	12	7	0.95
rugged	22	13	1.75
sandpaper	13	17	1.50
sea	15	14	1.45
smooth	346	491	41.85
soft	4	16	1.00
stone	12	8	1.00
surface	6	13	0.95
uneven	38	44	4.10
water	21	14	1.75
miscellaneous responses made by fewer than 1% of either group	356	216	28.60

32. CITIZEN

alien	14	82	4.80
American	35	100	6.75
city	27	7	1.70
country	17	31	2.40
foreigner	19	27	2.30
good	26	15	2.05
inhabitant	23	17	2.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
law	11	1	0.60
man	278	272	27.50
native	25	26	2.55
naturalized	5	14	0.95
patriot	2	14	0.80
people	41	24	3.25
person	64	37	5.05
resident	20	8	1.40
state	10	6	0.80
United States	19	44	3.15
vote	13	8	1.05
voter	35	38	3.65
miscellaneous responses made by fewer than 1% of either group	316	229	27.25

33. FOOT

ankle	11	8	0.95
arm	11	19	1.50
body	34	26	3.00
feet		24	1.20
hand	185	295	24.00
large	14	8	1.10
leg	54	98	7.60
limb	58	25	4.15

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
member	10		0.50
shoe	146	107	12.65
shoes	17	11	1.40
small	22	2	1.20
toe	30	84	5.70
toes	41	61	5.10
walk	106	43	7.45
walking	38	14	2.60
miscellaneous responses made by fewer than 1% of either group	223	175	19.90
34. SPIDER			
animal	38	34	3.60
bite	20	4	1.20
bug	58	81	6.95
cobweb	12	15	1.35
crawl	14	10	1.20
crawling	11	3	0.70
fly	136	112	12.40
insect	276	232	25.40
legs	27	37	3.20
poison	10	5	0.75
web	188	340	26.40
miscellaneous responses made by fewer than 1% of either group	210	127	16.85

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
35. NEEDLE			
eye	17	71	4.40
instrument	26	7	1.65
pin	147	174	16.05
pins	11		0.55
point	40	66	5.30
prick	10	17	1.35
sew	134	68	10.10
sewing	107	63	8.50
sharp	152	130	14.10
steel	53	32	4.25
thimble	15	4	0.95
thread	160	280	22.00
useful	12	1	0.65
miscellaneous responses made by fewer than 1% of either group	116	87	10.15
36. RED			
apple	13	6	0.95
black	61	175	11.80
blood	71	31	5.10
blue	99	87	9.30
bright	40	36	3.80
bull	2	11	0.65
color	254	228	24.10
danger	14	11	1.25
dress	18	2	1.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
fire	31	15	2.30
flag	16	20	1.80
green	30	38	3.40
rose	15	5	1.00
white	97	164	13.05
yellow	15	19	1.70
miscellaneous responses made by fewer than 1% of either group	224	152	18.80

37. SLEEP

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
awake	94	140	11.70
bed	75	118	9.65
comfort	30	21	2.55
dream	28	30	2.90
dreams	10	3	0.65
eat	4	22	1.30
eyes	10	1	0.55
night	49	65	5.70
repose	31	8	1.95
rest	300	225	26.25
resting	14	2	0.80
slumber	20	28	2.40
sound	16	12	1.40
tired	26	38	3.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
unconscious	12	6	0.90
wake	60	74	6.70
miscellaneous responses made by fewer than 1% of either group	221	207	21.40

38. ANGER

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
angry	6	12	0.90
bad	13	3	0.80
calm	7	15	1.10
cross	44	13	2.85
fear	9	21	1.50
fight	8	20	1.40
fury	4	12	0.80
hate	9	36	2.25
hatred	26	16	2.10
ire	2	60	3.10
mad	121	230	17.55
madness	19	17	1.80
man	6	14	1.00
passion	51	30	4.05
rage	16	16	1.60
sorrow	10	18	1.40
temper	149	52	10.05
vexed	13	2	0.75

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
wrath	52	113	8.25
miscellaneous responses made by fewer than 1% of either group	435	300	36.75
39. CARPET			
Brussels	14	4	0.90
cloth	20	18	1.90
comfort	15	1	0.80
cover	27	14	2.05
covering	76	35	5.55
floor	256	245	25.05
house	4	11	0.75
mat	6	19	1.25
matting	10	1	0.55
room	17	10	1.35
rug	163	354	25.85
rugs	14	2	0.80
smooth	8	11	0.95
soft	78	59	6.85
sweep	7	10	0.85
sweeper	10	9	0.95
tack	8	25	1.65
tacks	3	11	0.70
walk	15	32	2.35
wool	10	3	0.65
miscellaneous responses made by fewer than 1% of either group	239	126	18.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
40. GIRL			
beautiful	8	15	1.15
boy	350	449	39.95
child	49	16	3.25
dress	8	34	2.10
female	77	70	7.35
lady	20	28	2.40
maiden	13	7	1.00
man	7	31	1.90
nice	11	4	0.75
person	18	6	1.20
pretty	29	23	2.60
school	19	4	1.15
sister	6	12	0.90
woman	61	100	8.05
young	31	20	2.55
youth	24	5	1.45
miscellaneous responses made by fewer than 1% of either group	269	176	22.25
41. HIGH			
above	9	10	0.95
aeroplane		18	0.90
altitude	14	22	1.80

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
building	24	17	2.05
distance	11	11	1.10
elevated	11	4	0.75
height	14	18	1.60
hill	20	6	1.30
house	24	2	1.30
lofty	20	18	1.90
low	328	515	42.15
mountain	157	84	12.05
mountains	16	3	0.95
sky	17	17	1.70
steep	13	5	0.90
steeple	12	3	0.75
tall	57	70	6.35
tower	12	9	1.05
tree	19	10	1.45
up	26	37	3.15
miscellaneous responses made by fewer than 1% of either group	196	121	15.85

42. WORKING

busy	51	15	3.30
day	6	11	0.85
doing	10	7	0.85
employed	10	6	0.80
exercise	15	4	0.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
hard	105	93	9.90
idle	44	14	2.90
idleness	10	1	0.55
industrious	13	5	0.90
job	1	11	0.60
labor	147	153	15.00
laboring	20	46	3.30
lazy	18	18	1.80
loafing	5	106	5.55
man	50	73	6.15
occupation	13	2	0.75
playing	22	58	4.00
rest	17	10	1.35
resting	24	30	2.70
shop	7	10	0.85
sleeping	8	34	2.10
tired	28	9	1.85
miscellaneous responses made by fewer than 1% of either group	376	284	33.00

43. SOUR

acid	23	17	2.00
apple	27	12	1.95
apples	10	6	0.80
bitter	70	79	7.45
disagreeable	18	3	1.05
distasteful	4	10	0.70

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
grapes	36	26	3.10
lemon	78	28	5.30
lemons	17	4	1.05
milk	31	18	2.45
pickle	15	22	1.85
pickles	26	23	2.45
sweet	349	570	45.95
tart	17	10	1.35
taste	55	28	4.15
unpleasant	16	8	1.20
vinegar	91	38	6.45
miscellaneous responses made by fewer than 1% of either group	117	98	10.75

44. EARTH

brown	17	4	1.05
clay	71	15	4.30
dark	10	5	0.75
dirt	115	200	15.75
globe	16	16	1.60
grass	11	4	0.75
ground	166	234	20.00
heaven	31	14	2.25
land	28	53	4.05

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
moon	11	20	1.55
mud	16	19	1.75
planet	17	12	1.45
round	61	56	5.85
sky	31	47	3.90
soil	37	24	3.05
water	10	9	0.95
world	46	45	4.55
miscellaneous responses made by fewer than 1% of either group	306	223	26.45

45. TROUBLE

anger	6	24	1.50
anxiety	15	5	1.00
bad	11	13	1.20
bother	4	13	0.85
care	27	22	2.45
comfort	6	10	0.80
death	16	9	1.25
difficulty	1	23	1.20
ease	4	19	1.15
fight	5	18	1.15
grief	26	5	1.55
happiness	19	28	2.35
hardship	6	16	1.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
maker		10	0.50
mind	10	1	0.55
misery	14	5	0.95
misfortune	6	13	0.95
pain	20	20	2.00
peace	15	31	2.30
pleasure	10	15	1.25
sadness	13	7	1.00
sickness	47	55	5.10
sorrow	202	111	15.65
unhappiness	13	5	0.90
work	8	10	0.90
worry	65	58	6.15
miscellaneous responses made by fewer than 1% of either group	431	454	44.25

46. SOLDIER

army	137	181	15.90
boy	23	41	3.20
brave	46	10	2.80
citizen	14	41	2.75
fight	17	25	2.10
fighter	12	11	1.15
fighting	12	5	0.85
gun	27	34	3.05
man	189	152	17.05
march	12	7	0.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
marine	1	14	0.75
military	17	13	1.50
officer	12	24	1.80
sailor	58	102	8.00
uniform	39	46	4.25
war	94	73	8.35
warrior	12	13	1.25
miscellaneous responses made by fewer than 1% of either group	278	208	24.30
47. CABBAGE			
beef	11	3	0.70
cauliflower	17	26	2.15
corned beef		19	0.95
eat	30	30	3.00
farm	11	1	0.60
food	22	25	2.35
fruit	7	22	1.45
garden	43	25	3.40
good	13	1	0.70
green	44	19	3.15
head	30	66	4.80
leaf	9	31	2.00
leaves	11	16	1.35
lettuce	11	43	2.70
patch	16	10	1.30

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
plant	48	66	5.70
potatoes	18	2	1.00
sauerkraut	17	20	1.85
smell	11	4	0.75
turnip	20	28	2.40
vegetable	394	378	38.60
vegetables	10	10	1.00
miscellaneous responses made by fewer than 1% in either group	207	155	18.10
48. HARD			
brick	12	11	1.15
easy	17	7	1.20
firm	11	4	0.75
floor	16	5	1.05
iron	44	22	3.30
rock	38	53	4.55
rough	11	24	1.75
smooth	15	12	1.35
soft	367	574	47.05
solid	15	24	1.95
steel	14	30	2.20
stone	102	34	6.80
tough	12	14	1.30
wood	66	11	3.85
work	19	8	1.35
miscellaneous responses made by fewer than 1% of either group	241	167	20.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
49. EAGLE			
American	12	8	1.00
bird	568	618	59.30
eye	12	21	1.65
flight	22	11	1.65
fly	46	82	6.40
flying	23	12	1.75
hawk	13	9	1.10
high	21	41	3.10
mountain	14	3	0.85
nest	12	10	1.10
soaring	14	2	0.80
strength	11		0.55
wing	8	11	0.95
wings	16	26	2.10
miscellaneous responses made by fewer than 1% of either group	208	146	17.70
50. STOMACH			
abdomen	32	25	2.85
ache	31	59	4.50
anatomy	21	23	2.20
belly	6	27	1.65
body	99	123	11.10
bowels	13	16	1.45
chest	18	6	1.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
digest	6	17	1.15
digestion	50	26	3.80
eat	45	65	5.50
eating	27	19	2.30
food	102	94	9.80
head	9	11	1.00
heart	24	10	1.70
indigestion	17	12	1.45
intestine	28	35	3.15
intestines	32	63	4.75
liver	13	16	1.45
man	5	14	0.95
mouth	3	11	0.70
organ	81	57	6.90
pain	28	24	2.60
sick	10	17	1.35
sickness	7	10	0.85
trouble	25	51	3.80
miscellaneous responses made by fewer than 1% of either group	268	169	21.85

51. STEM

apple	43	40	4.15
branch	33	19	2.60
bud	4	10	0.70

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
end	10	8	0.90
flower	259	279	26.90
fruit	14	16	1.50
handle	20	9	1.45
leaf	96	80	8.80
long	18	9	1.35
pipe	70	84	7.70
plant	74	78	7.60
root	27	16	2.15
rose	21	7	1.40
stalk	21	26	2.35
stick	14	5	0.95
tree	44	26	3.50
trunk	3	10	0.65
twig	7	12	0.95
watch	7	64	3.55
wind	3	28	1.55
miscellaneous responses made by fewer than 1% of either group	212	174	19.30

52. LAMP

black	5	10	0.75
bright	12	18	1.50
burn	20	5	1.25
burning	10	1	0.55
candle	13	4	0.85
chimney	37	27	3.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
electric	5	10	0.75
globe	7	14	1.05
light	650	578	61.40
oil	49	9	2.90
post	5	18	1.15
shade	37	113	7.50
table	8	33	2.05
wick	23	46	3.45
miscellaneous responses made by fewer than 1% of either group	119	114	11.65

53. DREAM

awake	11	18	1.45
bad	16	4	1.00
bed	11	23	1.70
imagination	12	6	0.90
night	42	67	5.45
nightmare	24	25	2.45
pleasant	38	12	2.50
pleasure	13	2	0.75
sleep	339	453	39.60
sleeping	39	14	2.65
slumber	20	9	1.45
sweet	14	14	1.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
think	29	31	3.00
thought	38	16	2.70
thoughts	22	5	1.35
true	2	11	0.65
vision	48	40	4.40
wake	9	11	1.00
wish		10	0.50
miscellaneous responses made by fewer than 1% of either group	273	229	25.10
54. YELLOW			
black	24	92	5.80
blue	41	66	5.35
bright	23	20	2.15
brown	13	9	1.10
buttercup	11	7	0.90
butterfly	8	16	1.20
color	301	330	31.55
flower	38	18	2.80
gold	13	10	1.15
green	41	54	4.75
light	14	26	2.00
orange	47	32	3.95
pink	13	6	0.95
red	34	46	4.00
sun	21	3	1.20
white	70	85	7.75
miscellaneous responses made by fewer than 1% of either group	288	180	23.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
55. BREAD			
biscuit	14	4	0.90
butter	151	172	16.15
cake	15	13	1.40
dough	26	18	2.20
eat	148	208	17.80
eatable	28	9	1.85
eating	44	26	3.50
flour	88	64	7.60
food	191	220	20.55
good	21	4	1.25
life	23	15	1.90
loaf	7	19	1.30
meat	5	12	0.85
water	9	19	1.40
wheat	21	35	2.80
white	15	26	2.05
miscellaneous responses made by fewer than 1% of either group	194	136	16.50
56. JUSTICE			
court	64	109	8.65
courts	2	15	0.85
equality	9	12	1.05
fair	32	11	2.15
fairness	21	15	1.80

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
good	14	9	1.15
injustice	26	73	4.95
judge	91	93	9.20
law	74	118	9.60
liberty	11	12	1.15
man	13	3	0.80
mercy	28	33	3.05
peace	143	212	17.75
right	157	71	11.40
righteousness	13	10	1.15
rights	11	2	0.65
truth	14	12	1.30
miscellaneous responses made by fewer than 1% of either group	277	190	23.35
57. BOY			
ball	10	1	0.55
child	86	45	6.55
girl	319	509	41.40
lad	7	17	1.20
male	63	38	5.05
man	104	112	10.80
mischief	11	4	0.75
person	11	8	0.95
play	20	22	2.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
school	11	9	1.00
small	14	10	1.20
son	3	11	0.70
young	22	24	2.30
youth	33	19	2.60
miscellaneous responses made by fewer than 1% of either group	286	171	22.85

58. LIGHT

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
bright	47	38	4.25
brightness	21	5	1.30
color	19	23	2.10
dark	231	415	32.30
darkness	93	58	7.55
day	81	47	6.40
electric	7	10	0.85
electricity	8	18	1.30
gas	21		1.05
heat	8	18	1.30
lamp	82	113	9.75
moon	10	1	0.55
see	24	14	1.90
sun	85	36	6.05
sunshine	11	4	0.75
white	8	16	1.20
window	15	13	1.40
miscellaneous responses made by fewer than 1% of either group	229	171	20.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
59. HEALTH			
beauty	10	1	0.55
body	9	17	1.30
comfort	26	12	1.90
condition	6	11	0.85
doctor	4	25	1.45
exercise	3	10	0.65
feeling	12	8	1.00
good	94	73	8.35
happiness	111	60	8.55
ill	3	10	0.65
illness	13	31	2.20
pleasure	14	2	0.80
sick	9	33	2.10
sickness	153	257	20.50
strength	112	28	7.00
strong	31	25	2.80
vigor	11	21	1.60
wealth	76	77	7.65
well	63	80	7.15
miscellaneous responses made by fewer than 1% of either group	240	219	22.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
60. BIBLE			
book	338	405	37.15
church	50	72	6.10
God	43	60	5.15
good	28	22	2.50
goodness	12	2	0.70
history	26	4	1.50
holy	57	49	5.30
prayer	19	14	1.65
prayer-book	13	3	0.80
read	31	47	3.90
reading	19	5	1.20
religion	89	93	9.10
scripture	17	17	1.70
story	4	12	0.80
study	6	16	1.10
testament	24	8	1.60
truth	17	11	1.40
miscellaneous responses made by fewer than 1% of either group	207	160	18.35
61. MEMORY			
bad	19	8	1.35
brain	46	42	4.40
forget	25	34	2.95
forgetfulness	37	62	4.95
good	68	62	6.50

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
head	9	10	0.95
mind	138	148	14.30
past	8	10	0.90
poor	23	14	1.85
recollection	16	18	1.70
remember	27	63	4.50
remembrance	18	20	1.90
test	5	15	1.00
think	58	44	5.10
thinking	38	10	2.40
thought	81	78	7.95
thoughts	28	22	2.50
miscellaneous responses made by fewer than 1% of either group	356	340	34.80

62. SHEEP

animal	225	188	20.65
animals	18	12	1.50
cattle	47	46	4.65
cow	22	15	1.85
field	12	7	0.95
flock	24	34	2.90
goat	17	76	4.65
goats	10	15	1.25
herd	4	13	0.85
lamb	151	231	19.10
lambs	36	10	2.30

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
mutton	60	50	5.50
pasture	27	23	2.50
shepherd	15	11	1.30
white	18	6	1.20
wool	143	149	14.60
woolly	10	1	0.55
miscellaneous responses made by fewer than 1% of either group	161	113	13.70

63. BATH

bathe	2	13	0.75
bathtub		10	0.50
clean	120	149	13.45
cleanliness	109	61	8.50
cold	14	8	1.10
dirty	5	11	0.80
hot	10	2	0.60
Saturday		12	0.60
shower	3	13	0.80
soap	13	25	1.90
swim	10	22	1.60
take	1	11	0.60
towel	6	11	0.85
tub	71	128	9.95
wash	102	113	10.75
washing	16	3	0.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
water	339	299	31.90
wet	5	10	0.75
miscellaneous responses made by fewer than 1% of either group	174	99	13.65

64. COTTAGE

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
building	31	3	1.70
bungalow	13	36	2.45
camp	1	11	0.60
comfort	15	6	1.05
country	36	10	2.30
dwelling	23	8	1.55
farm	4	22	1.30
home	85	106	9.55
house	461	549	50.50
lake	5	30	1.75
live	17	9	1.30
mansion	15	4	0.95
sea	10	16	1.30
small	30	24	2.70
wood	11	12	1.15
miscellaneous responses made by fewer than 1% of either group	243	154	19.85

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
65. SWIFT			
arrow	13	10	1.15
automobile	11	10	1.05
bird	16	6	1.10
current	7	14	1.05
eagle	8	10	0.90
fast	222	414	31.80
horse	28	5	1.65
hurry	12		0.60
quick	117	15	6.60
quickly	13	4	0.85
rapid	27	15	2.10
river	18	21	1.95
run	19	11	1.50
runner	13	5	0.90
running	20	4	1.20
slow	190	255	22.25
smart	16		0.80
speed	29	25	2.70
speedy	7	25	1.60
stream	8	11	0.95
train	18	9	1.35
water	11	8	0.95
miscellaneous responses made by fewer than 1% of either group	177	123	15.00

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
66. BLUE			
black	38	75	5.65
color	256	270	26.30
dark	24	40	3.20
dress	18	6	1.20
gray	10	9	0.95
green	54	83	6.85
ocean	12	9	1.05
red	54	80	6.70
sky	239	178	20.85
white	47	55	5.10
yellow	27	29	2.80
miscellaneous responses made by fewer than 1% of either group	221	166	19.35
67. HUNGRY			
appetite	57	26	4.15
bread	26	18	2.20
desire	11	3	0.70
dinner	31	12	2.15
dog	14	7	1.05
eat	126	164	14.50
eating	64	22	4.30
empty	13	23	1.80

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
famished	11	35	2.30
fast	3	11	0.70
food	136	194	16.50
full	9	26	1.75
man	5	15	1.00
satisfied	14	8	1.10
starvation	10	9	0.95
starve	8	22	1.50
starved	15	11	1.30
starving	29	24	2.65
stomach	13	19	1.60
thirst	12	22	1.70
thirsty	61	89	7.50
tired	12	25	1.85
want	25	8	1.65
wolf	10	3	0.65
miscellaneous responses made by fewer than 1% of either group	285	204	24.45

68. PRIEST

Bible	3	10	0.65
bishop	6	14	1.00
black	13	8	1.05
Catholic	36	64	5.00
church	166	207	18.65
clergy	30	30	3.00
clergyman	62	40	5.10
father	15	28	2.15
holy	15	9	1.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
man	75	39	5.70
minister	178	232	20.50
nun	12	8	1.00
parson	11	3	0.70
pastor	11	11	1.10
preacher	35	32	3.35
religion	57	57	5.70
robe	12	14	1.30
miscellaneous responses made by fewer than 1% of either group	263	194	22.85

69. OCEAN

Atlantic	11	19	1.50
blue	25	43	3.40
deep	87	37	6.20
depth	10	5	0.75
lake	12	19	1.55
river	36	19	2.75
rough	12	2	0.70
salt	10	11	1.05
sea	75	223	14.90
ship	24	8	1.60
ships	11	5	0.80
steamer	14	2	0.80
water	427	429	42.80
wave	12	13	1.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
waves	45	33	3.90
wet	2	11	0.65
wide	15	14	1.45
miscellaneous responses made by fewer than 1% of either group	172	107	13.95

70. HEAD

arm	2	10	0.60
body	146	152	14.90
brain	58	20	3.90
brains	32	28	3.00
cabbage	7	12	0.95
cranium	11	1	0.60
eyes	10	16	1.30
face	13	11	1.20
feet	26	35	3.05
foot	64	122	9.30
hair	159	163	16.10
hand	11	6	0.85
hat	17	23	2.00
knowledge	17	5	1.10
large	19	3	1.10
man	14	33	2.35
mind	14	12	1.30
neck	17	32	2.45
person	15	4	0.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
round	21	9	1.50
shoulder	1	14	0.75
shoulders	12	30	2.10
tail	3	19	1.10
think	9	14	1.15
thought	16	6	1.10
top	31	42	3.65
miscellaneous responses made by fewer than 1% of either group	255	178	21.65
71. STOVE			
black	59	65	6.20
burn	12	5	0.85
chimney	1	10	0.55
coal	25	40	3.25
cook	24	27	2.55
cooking	34	9	2.15
fire	217	157	18.70
furnace	6	27	1.65
heat	213	215	21.40
hot	86	133	10.95
iron	51	39	4.50
kitchen	11	8	0.95
lid	4	17	1.05
pipe	18	28	2.30
polish	10	7	0.85
range	19	7	1.30

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
warm	32	41	3.65
warmth	42	24	3.30
wood	7	10	0.85
miscellaneous responses made by fewer than 1% of either group	129	131	13.00

72. LONG

distance	81	37	5.90
far	8	11	0.95
grass	4	26	1.50
length	50	54	5.20
lengthy	6	16	1.10
mile	13	5	0.90
narrow	15	17	1.60
pole	20	9	1.45
river	15	10	1.25
road	32	11	2.15
short	413	573	49.30
tall	26	23	2.45
time	15	9	1.20
miscellaneous responses made by fewer than 1% of either group	302	199	25.05

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
73. RELIGION			
atheist	4	13	0.85
belief	39	57	4.80
Bible	52	99	7.55
Catholic	56	39	4.75
Christian	14	9	1.15
church	161	228	19.45
creed	33	28	3.05
denomination	11	3	0.70
faith	47	69	5.80
God	31	32	3.15
good	46	25	3.55
goodness	10	4	0.70
holy	10	6	0.80
minister	15	15	1.50
piety	13	1	0.70
pious	13	5	0.90
prayer	21	7	1.40
priest	28	40	3.40
Protestant	30	35	3.25
sect	3	21	1.20
thought	12	5	0.85
worship	14	11	1.25
miscellaneous responses made by fewer than 1% of either group	337	248	29.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
74. WHISKY			
alcohol	50	33	4.15
bad	35	21	2.80
beer	46	45	4.55
beverage	9	21	1.50
booze	10	30	2.00
bottle	29	18	2.35
brandy	24	15	1.95
drink	232	351	29.15
drinking	17	2	0.95
drunk	31	44	3.75
drunkard	18	6	1.20
drunkenness	26	10	1.80
gin	8	49	2.85
good	15	4	0.95
intoxicant	13	10	1.15
intoxicating	14	3	0.85
intoxication	14	8	1.10
liquid	12	3	0.75
liquor	70	94	8.20
prohibition	2	19	1.05
rum	23	58	4.05
rye	9	10	0.95
saloon	15	2	0.85
spirits	23	3	1.30
stimulant	38	2	2.00
wine	16	12	1.40
miscellaneous responses made by fewer than 1% of either group	201	127	16.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
75. CHILD			
baby	193	146	16.95
boy	64	159	11.15
children		38	1.90
girl	45	62	5.35
infant	122	94	10.80
innocence	16	2	0.90
innocent	11	2	0.65
little	11	4	0.75
man	41	88	6.45
mother	55	46	5.05
person	18	14	1.60
play	14	19	1.65
pretty	10		0.50
small	52	68	6.00
woman	18	19	1.85
young	30	22	2.60
youth	29	14	2.15
miscellaneous responses made by fewer than 1% of either group	271	203	23.70
76. BITTER			
bad	10	7	0.85
disagreeable	10	1	0.55
distasteful	10	8	0.90

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
gall	42	6	2.40
lemon	8	11	0.95
medicine	37	20	2.85
quinine	23	4	1.35
sour	222	180	20.10
sweet	305	518	41.15
taste	66	55	6.05
unpleasant	19	8	1.35
vinegar	17	6	1.15
miscellaneous responses made by fewer than 1% of either group	231	176	20.35
77. HAMMER			
axe	11	7	0.90
blow	6	12	0.90
carpenter	13	12	1.25
chisel	10	6	0.80
drive	17	3	1.00
handle	5	18	1.15
hard	53	47	5.00
head	2	33	1.75
heavy	13	3	0.80
hit	21	79	5.00
instrument	38	6	2.20
iron	45	18	3.15

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
knock	35	19	2.70
nail	185	316	25.05
nails	98	51	7.45
noise	36	8	2.20
pound	51	62	5.65
pounding	12	7	0.95
saw	9	30	1.95
sledge	10	2	0.60
steel	20	14	1.70
strike	28	14	2.10
tacks	11		0.55
tongs	29	33	3.10
tool	69	79	7.40
miscellaneous responses made by fewer than 1% of either group	173	121	14.70

78. THIRSTY

drink	206	305	25.55
drinking	23	4	1.35
dry	218	219	21.85
hungry	41	79	6.00
quench	12	10	1.10
water	341	273	30.70
wet	3	11	0.70
miscellaneous responses made by fewer than 1% of either group	156	99	12.75

79. CITY

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
Boston	5	25	1.50
buildings	20	20	2.00
country	74	31	5.25
crowd	11	4	0.75
houses	52	19	3.55
inhabitants	12	3	0.75
large	62	45	5.35
Lynn		28	1.40
metropolis	6	17	1.15
New York	99	8	5.35
noise	12	4	0.80
people	48	54	5.10
place	37	10	2.35
population	19	19	1.90
Schenectady		14	0.70
state	26	14	2.00
street	3	15	0.90
streets	11	3	0.70
town	258	452	35.50
village	44	67	5.55
miscellaneous responses made by fewer than 1% of either group	201	148	17.45

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
80. SQUARE			
angle	11	3	0.70
block	71	68	6.95
box	36	13	2.45
central		13	0.65
circle	22	53	3.75
city	4	21	1.25
corners	18	8	1.30
even	19	8	1.35
four	10	5	0.75
geometry	10	3	0.65
level	10	3	0.65
long	18	6	1.20
Madison	12		0.60
market		12	0.60
oblong	32	28	3.00
park	14	10	1.20
place	4	10	0.70
rectangle	15	9	1.20
round	250	425	33.75
street	9	26	1.75
table	47	9	2.80
tool	13	5	0.90
triangle	11	2	0.65
miscellaneous responses made by fewer than 1% of either group	364	260	31.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
81. BUTTER			
bread	206	262	23.40
cheese	41	24	3.25
cow	29	28	2.85
cows	11	2	0.65
cream	34	21	2.75
eat	34	37	3.55
eatable	12	3	0.75
eggs	11	26	1.85
fat	21	60	4.05
fly	7	14	1.05
food	63	70	6.65
good	14	3	0.85
grease	76	27	5.15
lard	15	19	1.70
milk	101	120	11.05
salt	13	23	1.80
soft	65	56	6.05
sweet	12	18	1.50
yellow	80	53	6.65
miscellaneous responses made by fewer than 1% of either group	155	134	14.45
82. DOCTOR			
good	17	3	1.00
health	18	26	2.20

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
illness	21	19	2.00
lawyer	36	161	9.85
man	68	34	5.10
medical	19	10	1.45
medicine	149	155	15.20
nurse	41	74	5.75
patient	23	12	1.75
physician	213	126	16.95
sick	52	96	7.40
sickness	104	131	11.75
miscellaneous responses made by fewer than 1% of either group	239	153	19.60

83. LOUD

boisterous	38	23	3.05
cannon	12	3	0.75
easy	12	3	0.75
harsh	3	14	0.85
high	14	1	0.75
holler	16	8	1.20
low	57	25	4.10
noise	205	161	18.30
noisy	112	76	9.40
quiet	32	29	3.05
soft	165	406	28.55

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
sound	25	13	1.90
speak	3	10	0.65
speaker		15	0.75
talk	12	13	1.25
voice	27	15	2.10
whistle	17	12	1.45
miscellaneous responses made by fewer than 1% of either group	250	173	21.15
84. THIEF			
bad	14	6	1.00
beggar	3	10	0.65
burglar	118	120	11.90
criminal	15	19	1.70
crook	3	86	4.45
dishonest	11	2	0.65
honest	18	14	1.60
jail	11	7	0.90
man	29	19	2.40
money	16	13	1.45
night	16	10	1.30
police	8	20	1.40
policeman	12	14	1.30
robber	126	190	15.80
robbery	10	17	1.35
rogue	19	4	1.15

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
steal	212	237	22.45
stealing	69	12	4.05
stolen	9	14	1.15
theft		10	0.50
miscellaneous responses made by fewer than 1% of either group	281	176	22.85
85. LION			
animal	326	321	32.35
bear	17	25	2.10
beast	67	41	5.40
cage	14	10	1.20
cub	5	13	0.90
den	13	38	2.55
ferocious	16	8	1.20
fierce	36	8	2.20
king	16	6	1.10
lamb	6	10	0.80
lioness	10	22	1.60
mane	13	10	1.15
mouse	27	17	2.20
roar	46	51	4.85
strength	30	5	1.75
strong	15	9	1.20
tamer	1	17	0.90
tiger	102	237	16.95

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
wild	12	10	1.10
wolf	10	3	0.65
miscellaneous responses made by fewer than 1% of either group	218	139	17.85
86. JOY			
bliss	10	6	0.80
comfort	11	1	0.60
glad	27	18	2.25
gladness	44	32	3.80
gloom		18	0.90
good	7	11	0.90
grief	18	19	1.85
happiness	215	236	22.55
happy	71	80	7.55
laughter	15	14	1.45
peace	23	12	1.75
pleasure	121	100	11.05
sad	1	10	0.55
sadness	13	34	2.35
sorrow	135	221	17.80
miscellaneous responses made by fewer than 1% of either group	289	188	23.85
87. BED			
chair	11	15	1.30
clothes	12	14	1.30
comfort	35	21	2.80

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
comfortable	12	1	0.65
cot	11	9	1.00
couch	26	32	2.90
furniture	26	6	1.60
lie	21	19	2.00
mattress	21	14	1.75
night	11	12	1.15
pillow	17	16	1.65
rest	132	62	9.70
room	16	14	1.50
sheet	6	15	1.05
sleep	345	514	42.95
sleeping	41	11	2.60
soft	31	49	4.00
spread	5	11	0.80
spring	1	11	0.60
miscellaneous responses made by fewer than 1% of either group	220	154	18.70
88. HEAVY			
big	3	11	0.70
burden	12	7	0.95
drowsy	10		0.50
hard	38	47	4.25
iron	70	39	5.45
large	18	10	1.40
lead	60	25	4.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
light	273	468	37.05
load	57	47	5.20
soft	5	28	1.65
stone	17	10	1.35
tired	21	4	1.25
ton	4	10	0.70
weight	177	122	14.95
weighty	22	19	2.05
miscellaneous responses made by fewer than 1% of either group	213	153	18.30

89. TOBACCO

bad	10	2	0.60
chew	28	33	3.05
chewing	13	6	0.95
cigar	19	8	1.35
cigars	17	3	1.00
cigarette	12	43	2.75
cigarettes	6	21	1.35
habit	12	15	1.35
juice	7	16	1.15
leaf	17	9	1.30
narcotic	10	4	0.70
nicotine	18	28	2.30
pipe	69	65	6.70
plant	38	9	2.35
smoke	387	583	48.50

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
smoking	98	35	6.65
snuff	15	1	0.80
weed	44	17	3.05
miscellaneous responses made by fewer than 1% of either group	180	102	14.10
90. BABY			
boy	32	62	4.70
carriage	28	25	2.65
child	239	323	28.10
cradle	22	22	2.20
cry	37	39	3.80
crying	29	21	2.50
girl	26	35	3.05
infant	168	103	13.55
innocence	10	1	0.55
little	12	12	1.20
man	4	14	0.90
mother	41	49	4.50
sleep	4	12	0.80
small	42	64	5.30
sweet	23	4	1.35
woman	5	12	0.85
young	12	19	1.55
miscellaneous responses made by fewer than 1% of either group	266	183	22.45

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
91. MOON			
bright	52	31	4.15
full	10	12	1.10
light	231	175	20.30
night	66	78	7.20
planet	23	34	2.85
round	33	18	2.55
shine	26	76	5.10
shining	12	6	0.90
shiny	12		0.60
sky	73	64	6.85
star	32	25	2.85
stars	93	98	9.55
sun	120	194	15.70
yellow	11	15	1.30
miscellaneous responses made by fewer than 1% of either group	206	174	19.00
92. SCISSORS			
cloth	35	33	3.40
cut	347	482	41.45
cutting	114	63	8.85
instrument	36	7	2.15
knife	66	63	6.45
sewing	10	8	0.90
sharp	190	116	15.30

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
shears	40	90	6.50
steel	23	16	1.95
thread	4	10	0.70
tool	10	9	0.95
miscellaneous responses made by fewer than 1% of either group	125	103	11.40
93. QUIET			
calm	20	13	1.65
country	21	5	1.30
easy	49	15	3.20
loud	48	207	12.75
night	38	24	3.10
noise	50	69	5.95
noiseless	16	21	1.85
noisy	*113*	*117*	*11.50*
peace	26	38	3.20
peaceful	52	47	4.95
rest	68	30	4.90
restful	19	9	1.40
room	6	17	1.15
silence	13	16	1.45
silent	15	16	1.55
sleep	24	27	2.55
soft	10	72	4.10
still	136	74	10.50
stillness	16	7	1.15
woods	10	1	0.55
miscellaneous responses made by fewer than 1% of either group	250	175	21.25

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
94. GREEN			
apple	8	12	1.00
black	13	23	1.80
blue	46	56	5.10
color	200	256	22.80
dark	8	11	0.95
field	12	1	0.65
fields	10	3	0.65
grass	284	237	26.05
Irish	14	7	1.05
lawn	5	11	0.80
leaves	13	7	1.00
pink	11	1	0.60
red	42	95	6.85
tree	10	8	0.90
trees	29	11	2.00
white	31	32	3.15
yellow	54	80	6.70
miscellaneous responses made by fewer than 1% of either group	210	149	17.95
95. SALT			
bitter	40	48	4.40
butter	7	10	0.85

	KENT-ROSANOFF	O'CONNOR	TOTAL PERCENTAGE
eat	17	23	2.00
flavor	21	7	1.40
food	46	35	4.05
fresh	11	12	1.15
meat	18	7	1.25
mineral	37	20	2.85
ocean	36	57	4.65
pepper	142	213	17.75
savor	10	2	0.60
sea	18	17	1.75
season	12	9	1.05
seasoning	31	17	2.40
shaker	4	12	0.80
sour	18	42	3.00
sugar	88	110	9.90
sweet	27	50	3.85
table	14	7	1.05
taste	87	57	7.20
water	34	46	4.00
white	36	16	2.60
miscellaneous responses made by fewer than 1% of either group	246	183	21.45
96. STREET			
alley	18	29	2.35
avenue	63	101	8.20
block	12	1	0.65
car	10	21	1.55
city	82	86	8.40

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
highway	7	20	1.35
house	11	3	0 70
houses	21	4	1.25
lane	21	24	2.25
light	1	35	1.80
long	29	19	2.40
narrow	21	12	1.65
number	12	7	0.95
passage	11	3	0.70
path	12	3	0.75
paved	13	13	1.30
pavement	25	48	3.65
people	22	8	1.50
place	16	3	0.95
road	91	124	10.75
sidewalk	26	39	3.25
straight	17	9	1.30
thoroughfare	23	25	2.40
town	26	19	2.25
traffic	7	13	1.00
walk	78	61	6.95
walking	23	5	1.40
way	14	25	1.95
wide	35	29	3.20
miscellaneous responses made by fewer than 1% of either group	253	211	23.20
97. KING			
country	13	8	1.05
crown	63	52	5.75

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
Edward	30	1	1.55
emperor	11	10	1.05
England	20	16	1.80
George	2	14	0.80
kingdom	5	14	0.95
man	43	13	2.80
monarch	49	49	4.90
power	18	8	1.30
prince		16	0.80
queen	354	487	42.05
rule	10	11	1.05
ruler	162	106	13.40
throne	21	25	2.30
miscellaneous responses made by fewer than 1% of either group	199	170	18.45

98. CHEESE

bread	56	26	4.10
butter	136	194	16.50
cow	9	10	0.95
crackers	30	25	2.75
cream	30	21	2.55
eat	67	107	8.70
eatable	19	6	1.25
eating	29	5	1.70
food	91	89	9.00
good	15	7	1.10
green	5	17	1.10

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
holes	2	18	1.00
Limburger	13	24	1.85
mice	25	13	1.90
milk	106	107	10.65
mouse	13	17	1.50
rat	8	11	0.95
sandwich	8	12	1.00
smell	33	14	2.35
soft	7	19	1.30
sour	5	11	0.80
strong	12	3	0.75
Swiss	16	18	1.70
yellow	32	23	2.75
miscellaneous responses made by fewer than 1% of either group	233	203	21.80
99. BLOSSOM			
apple	50	49	4.95
beautiful	10	9	0.95
bloom	28	39	3.35
bud	23	17	2.00
cherry	4	11	0.75
flower	467	551	50.90
flowers	73	41	5.70
fruit	39	30	3.45
plant	13	8	1.05
pretty	15	16	1.55

	KENT-ROSANOFF	O'CONNOR	TOTAL PER-CENTAGE
rose	17	10	1.35
spring	23	33	2.80
sweet	15	7	1.10
time		15	0.75
tree	40	33	3.65
trees	17	13	1.50
miscellaneous responses made by fewer than 1% of either group	166	118	14.20
100. AFRAID			
brave	18	40	2.90
courage	11	20	1.55
coward	53	38	4.55
danger	15	12	1.35
dark	114	50	8.20
darkness	16	8	1.20
fear	197	285	24.10
fearful	8	12	1.00
fright	9	16	1.25
frightened	48	34	4.10
nervous	55	7	3.10
night	12	11	1.15
scared	106	247	17.65
timid	55	15	3.50
unafraid		19	0.95
miscellaneous responses made by fewer than 1% of either group	283	186	23.45

INDEX

Sans Tache

Sans Tache

IN THE "elder days of art" each artist or craftsman enjoyed the privilege of independent creation. He carried through a process of manufacture from beginning to end. The scribe of the days before the printing press was such a craftsman. So was the printer in the days before the machine process. He stood or fell, as a craftsman, by the merit or demerit of his finished product.

Modern machine production has added much to the worker's productivity and to his material welfare; but it has deprived him of the old creative distinctiveness. His work is merged in the work of the team, and lost sight of as something representing him and his personality.

Many hands and minds contribute to the manufacture of a book, in this day of specialization. There are seven distinct major processes in the making of a book: The type must first be set; by the monotype method, there are two processes, the "keyboarding" of the MS and the casting of the type from the perforated paper rolls thus produced. Formulas and other intricate work must be hand-set; then the whole brought together ("composed") in its true order, made into pages and forms. The results must be checked by proof reading at each stage. Then comes the "make-ready" and press-run and finally the binding into volumes.

All of these processes, except that of binding into cloth or leather covers, are carried on under our roof.

The motto of the Waverly Press is *Sans Tache.* Our ideal is to manufacture books *"without blemish"*—worthy books, worthily printed, with worthy typography—books to which we shall be proud to attach our imprint, made by craftsmen who are willing to accept open responsibility for their work, and who are entitled to credit for creditable performance.

The printing craftsman of today is quite as much a craftsman as his predecessor. There is quite as much discrimination between poor work and good. We are of the opinion that the individuality of the worker should not be wholly lost. The members of our staff who have contributed their skill of hand and brain to this volume are:

Keyboards: Mildred Lambert, Katharine Kocent, Laurel Tourtelotte, Vera Taylor.

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