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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

December 1967 United States Employment Service Technical Report S-403

S-403



# Development of USES Aptitude Test Battery for Vending-Machine Repairman

(bus. ser.; coin mach.) 639.381



U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION

Technical Report on Development of USES Aptitude Test Battery

For . . .

Vending-Machine Repairman (bus. ser.; coin mach.) 639.381

S-403

(Developed in Cooperation with the
California State Employment Service)

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December 1967

## FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Charles E. Odell, Director
U.S. Employment Service

GATB Study #2671

# Development of USES Aptitude Test Battery

For

Vending-Machine Repairman
(bus. ser.; coin mach.) 639.381-014

S-403

This report describes research undertaken for the purpose of determining General Aptitude Test Battery (GATB) norms for the occupation of Vending-Machine Repairman (bus. ser.; coin mach.) 639.381-014. The following norms were established:

| GATB Aptitudes | Minimum Acceptable GATB Scores |
|---|---|
| P - Form Perception | 85 |
| Q - Clerical Perception | 85 |
| M - Manual Dexterity | 90 |

## RESEARCH SUMMARY

Sample:

49 male workers employed as Vending-Machine Repairmen in various companies in the Los Angeles area.

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .32 $(P/2 < .025)$

Effectiveness of Norms:

Only 71% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-403 norms, 81% would have been good workers. 29% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-403 norms, only 19% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

| | Without Tests | With Tests |
|---|---|---|
| Good Workers | 71% | 81% |
| Poor Workers | 29% | 19% |

SAMPLE DESCRIPTION

Size:

N = 49

Occupational Status:

Employed workers

Work Setting:

Workers were employed by various employers in the Los Angeles area.

Employer Selection Requirements:

Education: Must be able to speak, read, and write English. High school courses relating to electro-mechanical theory are helpful.

Previous Experience: None - employers prefer applicants with backgrounds indicative of mechanical aptitude.

Tests: None

Principal Activities:

The job duties for each worker in the sample are comparable to those shown in the job description in the Appendix.

Minimum Experience:

No experience is required as on-the-job training is given on all aspects of the job including some electro-mechanical theory. A minimum of one year training is necessary to attain job proficiency.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

| | Mean | SD | Range | r |
|---|---|---|---|---|
| Age (year) | 36.3 | 9.5 | 23-57 | - .103 |
| Education (year) | 11.6 | 1.3 | 8-14 | .125 |
| Experience (months) | 68.3 | 52.5 | 3-254 | .125 |

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered in the period from April, 1964 through May, 1967.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as test data were collected. Two sets of ratings were made by each worker's immediate supervisor with a two-week interval between ratings.

Rating Scale:

The USES Form SP-21, "Descriptive Rating Scale", was used. The scale (see Appendix) consisted of nine items covering different aspects of job performance. Each item had five alternatives corresponding to different degrees of job proficiency.

Reliability:

A reliability coefficient of .91 was obtained between the two ratings. Therefore, the final criterion consists of the combined scores of the two ratings.

Criterion Score Distribution:

| | |
|---|---|
| Possible Range: | 18-90 |
| Actual Range: | 35-83 |
| Mean: | 64.0 |
| Standard Deviation: | 10.9 |

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 29% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers". The criterion critical score is 57.

## APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes G, P, Q, and M which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated that they were important for the job duties; the sample had relatively high mean scores for G, S, P, and M and a relatively low standard deviation for S, P, and Q. With employed workers, a relatively low standard deviation indicates that some sample pre-selection may have taken place and this restricted range of scores (low standard deviation) will depress the correlation between the aptitudes and the criterion. A relatively high mean score with employed workers may also indicate some sample pre-selection. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

| Aptitude | Rationale |
|---|---|
| G - General Learning Ability | Necessary to learn electro-mechanical theories for practical application to vending operations. Necessary to interpret and apply schematics and wiring diagrams. Necessary to exercise independent judgment. |
| P - Form Perception | Necessary for visual inspections to determine malfunctions by noting positions and relationships of various parts of the machine. |
| Q - Clerical Perception | Required to correctly read and post sales from meter readings. Necessary to maintain records of repairs and adjustments made. |

M - Manual Dexterity — Necessary in dismantling and reassembling of machine and replacement units. Necessary in working with hand tools used to dismantle and assemble vending machines.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 49.

| Aptitude | Mean | SD | Range | r |
|---|---|---|---|---|
| G - General Learning Ability | 100.8 | 15.2 | 67-151 | - .028 |
| V - Verbal Aptitude | 97.8 | 13.4 | 70-141 | - .054 |
| N - Numerical Aptitude | 95.5 | 17.5 | 43-139 | - .018 |
| S - Spatial Aptitude | 110.6 | 14.7 | 74-140 | - .137 |
| P - Form Perception | 100.4 | 14.5 | 57-138 | .131 |
| Q - Clerical Perception | 99.6 | 13.0 | 67-126 | .255 |
| K - Motor Coordination | 98.4 | 17.9 | 60-136 | .064 |
| F - Finger Dexterity | 96.7 | 18.9 | 47-149 | .227 |
| M - Manual Dexterity | 110.6 | 20.6 | 55-166 | .176 |

TABLE 5

Summary of Qualitative and Quantitative Data

| Type of Evidence | Aptitudes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | G | V | N | S | P | Q | K | F | M |
| Job Analysis Data | | | | | | | | | |
| Important | x | | | | x | x | | | x |
| Irrelevant | | | | | | | | | |
| Relatively High Mean | x | | | x | x | | | | x |
| Relatively Low Standard Dev. | | x | | x | x | x | | | |
| Significant Correlation with Criterion | | | | | | | | | |
| Aptitudes to be Considered for Trial Norms | G | | | S | P | Q | | | M |

## DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G, S, P, Q and M at trial cutting scores were able to differentiate between the 71% of the sample considered good workers and the 29% of the sample considered poor workers. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. The optimum differentiation for the occupation of Vending-Machine Repairman 639.381-014 was provided by the norms of P-85, Q-85 and M-90. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .32 (statistically significant at the .025 level). Combinations including aptitudes G and S show comparative selectivity. Rejection of these combinations is based on the fact that while the qualitative analysis has determined aptitudes G and S should be considered, analysis of the job description does not disclose any tasks having content similar to the content of the parts of the GATB that measure these aptitudes.

TABLE 6

Concurrent Validity of Test Norms, P-85, Q-85 and M-90

| | Nonqualifying Test Scores | Qualifying Test Scores | Total |
|---|---|---|---|
| Good Workers | 5 | 30 | 35 |
| Poor Workers | 7 | 7 | 14 |
| Total | 12 | 37 | 49 |

Phi Coefficient ($\phi$) = .32 Chi Square ($X^2_y$) = 5.1
Significance Level = $P/2 < .025$

## DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAPs included in Section II of the Manual for the General Aptitude Test Battery. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.

A-P-P-E-N-D-I-X

SP-21
Rev. 2/61

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male ____ Female ____ Experience: Length of time on job_____
(In Months)

Company Job Title: _____

How often do you see this worker in a work situation?

☐ See him at work all the time.

☐ See him at work several times a day.

☐ See him at work several times a week.

☐ Seldom see him in work situation.

How long have you worked with him?

☐ Under one month.

☐ One to two months.

☐ Three to five months.

☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Performance is inferior and almost never meets minimum quality standards.

☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Performance is acceptable but usually not superior in quality.

☐ 4. Performance is usually superior in quality.

☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Makes very many mistakes. Work needs constant checking.

☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Makes few mistakes. Work seldom needs checking.

☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. Cannot perform different operations adequately.

☐ 2. Can perform a limited number of different operations efficiently.

☐ 3. Can perform several different operations with reasonable efficiency.

☐ 4. Can perform many different operations efficiently.

☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and <u>only</u> these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Would be better off without him. Performance usually not acceptable.

☐ 2. Of limited value to the organization. Performance somewhat inferior.

☐ 3. A fairly proficient worker. Performance generally acceptable.

☐ 4. A valuable worker. Performance usually superior.

☐ 5. An unusually competent worker. Performance almost always top notch.

FACT SHEET

Job Title: Vending Machine Repairman (bus. ser.; coin mach.) 639.381-014

Job Summary: Installs and repairs coin-operated hot or cold beverage, cigarette, candy, sandwich, soup, and other merchandise, vending machine; adjusting, repairing, and replacing malfunctioning components in electrical, mechanical, refrigeration, heating, and plumbing systems.

Work Performed: Performs following tasks when installing machines at new site: Inspects site to insure that electrical outlet is of required type, three-pronged, and installation conforms with Building Code regulations.

Connects machine to water supply: Measures with tape or rule amount of copper tubing needed to connect machine to water outlet. Cuts off necessary amount of tubing with tubing cutter, and flares ends of tubing to accommodate threaded fittings. Connects fittings to tubing and water pipe, and tightens with wrench. Opens water valve and adjusts water pressure regulator inside machine to lower or raise water pressure, as needed. Adjusts leveling legs with wrench to level machine.

Performs following tasks on installations and when serving established sites: Examines machine exterior: Checks to see if machine door closes tightly. Inspects lights and light housings, beverage selector dial, painted surfaces, and metal surfaces for defects and damage. Posts written comments on coffee machine check list to indicate need for repair or replacement and action taken. Inspects machine for clues of malfunction, such as notes requesting refunds, plugged coin slots, out of order signs, unused cups, and spilled liquid on front or at base of machine. Follows up clues, when necessary.

Examines machine interior: Removes, tests, and replaces burnt out indicator light bulbs on machine door. Checks lubrication and adjusts, when necessary, cam-operated selector dial switches, using hand tools. Drops coins through coin rejector into changer to insure that units are operative and issuing correct change. Cleans rejector and changer, when necessary, to prevent clogging and jamming. Makes minute adjustments with hand tools to insure that mechanism will accept only coins of standard size, thickness, and weight. Inspects single-action pneumatic cylinder and piston that operate service door; cleans, lubricates, rebuilds, or replaces cylinder and piston, as necessary. Adjusts linkage between service door and piston to insure that door opens and closes in synchronization with rotation of turntable allowing free passage of filled cups. Depresses test switch to observe cup-drop mechanism through vending cycle to insure proper functioning. Checks cup-turret mechanism to insure proper automatic refilling of stacked cups in operating position. Runs machine through vending cycle repeatedly to diagnose cause of electro-mechanical malfunction, and makes adjustments accordingly, using fingers and small hand tools. Replaces or rebuilds worn parts, as needed. Checks dispensing time of hot water and adjusts timers, when amounts dispersed are insufficient or excessive. Starts vending cycle to insure that turntable indexes at correct rate of speed in order to receive empty cups from turret. Observes operation of brake which prevents turntable from coasting past specified degrees of rotation. Positions tray beneath turntable to catch spillage for draining into dump tank. Makes fine adjustments with hand tools, when turntable is not properly synchronized. Uses continuity testers and meters, and reads wiring diagrams and schematics to trace and repair defective wiring. Checks

spout shutter operation to see that air or electrically operated shutter retracts from beneath spout during delivery of beverage to cup and returns to prevent drippings. Checks for electrical or mechanical defects, such as faulty anti-siphon valve, defective wiring, residual magnetism in the solenoid, and leaking pneumatic cylinder and hoses. Examines hot water tank and bottom of machine cabinet for signs of water leaks from tank or fittings. Replaces tank or fittings, as needed. Checks water pressure gage to insure that pressure can be set and regulated properly. Inspects water filter and cleans or replaces, as needed. Examines refrigeration system, and raises or lowers temperature, as needed, by adjusting temperature control screw. Checks inside refrigerator cabinet for signs of malfunction, such as uneven frost patterns. Passes butane flame along refrigeration tubing to detect gas leaks by change in color of flame. Solders detected leaks with silver. Reads refrigeration system pressure on gage attached to compressor, and opens bleeder valve with wrench to relieve over-charged systems. Couples tank of pressurized refrigeration gas to compressor charging port with wrench to replenish undercharged systems. Visually inspects compressor unit and listens to unit turn on and off to insure that unit cycles satisfactorily. Inspects refrigeration screens and cleans with cloth or brush, if necessary.

Inspects coffee brewing and storage systems: Obtains number of sales and percs from readings on meters. Checks figures with last recorded readings to determine whether correct amount of unused coffee containers remain in perc drum. Records and reports shortages or evidence of tampering with cash receipts. Checks rubber pressure arm gasket for cracks or leaks, and replaces, when needed. Checks pressure arm control switches, and adjusts timing with hand tools, when necessary. Checks brew and serving temperatures with thermometer, and adjusts thermostats, accordingly. Records adjusted temperatures on service card. Checks water pressure on gage of regulator and opens or closes valve to adjust water pressure, as needed. Test-vends tank through its 16-cup cycle to taste beverage, check beverage level in cup, and makes adjustments, if needed. Checks reheating time of hot water tank. Examines all dispensing and dumping hoses, and replaces defective hoses. Records repairs and adjustments made on service card.

Checks miscellaneous systems: Measures cubic centimeters of cream, liquid sugar, extra sugar, and extra cream dispensed and adjusts air governor with screw driver to regulate pressure dispensing sugar and cream. Checks all timers for correct cam settings and to insure that switches ride cams properly. Records repairs, adjustments, and number of cups of beverage vended during tests on service card.

Effectiveness of Norms: Only 71% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-403 norms, 81% would have been good workers. 29% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-403 norms only 19% would have been poor workers.

Applicability of S-403 Norms: The aptitude test battery is applicable to jobs which include a majority of the duties described above.



GPO 941-062

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