# The Validity Behind YouScience

Helping People Make Effective Career Choices

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## Overview

The YouScience profile system provides a novel approach to career guidance. It begins with an assessment of 15 dimensions to identify important characteristics that students possess, and also assesses a student's interests. It then uses data on students' aptitudes and interests to identify promising career areas based on their assessment profile.

This document describes some of the critical components of the YouScience assessment. In particular, the document means to show how these components combine to establish the *validity* of YouScience. To say that the YouScience assessment has validity is to say that the decisions we make on the basis of the assessment and the inferences we draw from it are appropriate. This means, for example, that the individual characteristics we have selected to measure are useful for identifying promising career choices. It also means that the measures we use to determine an individual's standing on those characteristics do indeed assess the characteristics they purport to assess.

To this end, this document presents (a) our rationale for assessing the characteristics we do, using the career information we do, and employing the person-job matching process we do, along with (b) a discussion of how these components work together to provide promising recommendations for career choices that offer substantial promise in terms of job performance and job satisfaction in the years to come. The claims that underlie the YouScience assessment for which we will produce evidence are the following:

- Aptitudes are critical to career success.
- The YouScience assessment measures aptitudes important for career success.
- Interests are important in determining career choice and satisfaction.
- The YouScience assessment measures interests important for career choice and satisfaction.
- The career data underlying YouScience are robust and accurate.
- YouScience produces high-quality career recommendations.

We address each claim in turn.

## Aptitudes Are Critical to Career Success

Since the late 1800s, scientists worked to understand the nature of human aptitudes.[1] You can think of aptitudes as natural abilities that make it easier (or harder) for you to learn (and be good at) various types of work. One might imagine that people can have a really wide range of

aptitudes. Scientists, however, have conducted studies that have allowed them to identify major types of aptitudes. In 1940, a psychologist named Louis Thurstone conducted a study that involved administering a large number of ability tests (56 of them!) to a large group of students.[2] Upon analyzing the students' scores on these tests, Thurstone found that subsets of those tests produced similar results and reflected what he called *primary mental abilities*. Since Thurstone's work, many psychologists have conducted similar types of research and have come to similar conclusions: Human mental abilities can be summarized by a limited number of key types, and those types keep showing up across studies.[3] Similar findings have accrued with regard to physical abilities.[4,5]

Over the years, scientists in the field of industrial-organizational psychology have measured people on these primary mental abilities and explored the degree to which standing on those various abilities relates to other key outcomes. One of the most robust findings has been the relation between primary mental abilities and job performance. For example, higher levels of cognitive ability lead to higher levels of job performance across all types of jobs,[6-11] whether routine or complex (although it is higher for complex jobs).[12] In addition, it is clear that certain jobs require higher levels of certain abilities than others, such as physical strength for many construction jobs and perceptual speed and accuracy for jobs high on visual processing, such as air traffic controller. In short, the aptitudes one possesses relate to the types of work one will perform well, which in turn means that people with certain aptitudes but not others are likely to have greater success in some careers and lesser success in others.

### Key Points

- Researchers have identified the major types of human mental and physical aptitudes.
- These aptitudes are important for performing jobs well.
- Different jobs require different patterns of aptitudes.

## The YouScience Assessment Measures Aptitudes Important for Career Success

The types of aptitudes assessed within YouScience are consistent with those found by Thurstone, yet they offer more refined perspectives on a student's abilities which, in turn, can help us better pinpoint the careers in which a student may perform well.[13] YouScience measures a student's aptitudes with an augmented version of the computer-administered Ball Aptitude Battery (BAB). The BAB was created "to understand how one's talent and abilities can align or 'fit' with different performance environments".[14] It is one of the more well-known and well-researched multi-aptitude tests available today and has a longstanding research history demonstrating its utility for predicting such outcomes as school grades, success in training, job performance, and occupational fit.[15-20] Its reliability (mean estimate for computerized BAB of .87, median of .89 – estimates include internal consistency, test-retest, and split-half) and validity (construct validity via confirmatory factor analysis and measurement invariance analyses for gender and racial/ethnic groups; convergent validity via the Employee Aptitude Survey) are well-documented (cf. also the previous references).[21-23] For these reasons, the BAB serves as an ideal foundation for the YouScience ability measure. To ensure that the research history will generalize to the YouScience application, YouScience uses the BAB in a way that mirrors its development and intent, thus providing an ideal environment for the validity of the BAB to transport readily to its present use.

The original BAB comprises 12 tests, all of which are used in the YouScience system (some with slightly different names): Visual Comparison Speed, Vocabulary, Numerical Computation, Numerical Reasoning, Spatial Visualization, Inductive Reasoning, Sequential Reasoning, Idea Generation, Hand-Eye Coordination, Associative Memory, Visual Memory, Work Approach). The YouScience variation on the BAB involves the addition of two new cognitive tests: Timeframe Orientation and Pattern Memory. These tests assess one's capacity to generate multiple objects that could be represented by a given stimulus image and the ability to remember and reproduce linear patterns, respectively. These tests assess well-researched cognitive traits of ideational fluency and memorization/visual memory. They provide additional dimensionality to the abilities we consider when identifying the careers we think might suit students well.

To ensure that scores were meaningful for the YouScience system and to establish an appropriate inferential base for the two new tests, YouScience worked with HumRRO to conduct a norming study and subsequent measurement invariance analyses to establish the meaning of scores on the YouScience assessment for students who constitute YouScience's target population and to determine if the same latent structure of abilities could be said to underlie scores across applicant groups (gender, race/ethnicity). Doing so was necessary for establishing that all the previous research could be safely "generalized" to the BAB. That is, by establishing the comparability, we could safely conclude that the YouScience assessment has all of the qualities of the BAB that make it so valuable for use in career counseling.

The norming study involved a scientifically rigorous sampling strategy to ensure that its results would convey to all future users. Analyses of data from the norming study indicate that the augmented BAB that undergirds YouScience performs the same as the original BAB (e.g., patterns of relations among the tests are similar; mean test scores are similar, although a bit higher in the YouScience sample). Further, measurement invariance analyses conducted on data from the norming study employing a seven-factor model (Fluency, Math, Memory, Psychomotor/Speed, Reasoning, Spatial, Verbal) demonstrate measurement invariance across gender and partial measurement invariance across race/ethnicity. Thus, a single latent structure can be viewed to account for the relations among tests across major demographic groups. This, in turn, means the YouScience assessment can be viewed as a trusted means of assessing individual standing on abilities demonstrated to be important for identifying promising career choices.

### Key Points

- YouScience measures well-researched aptitudes important for performing jobs well.
- The YouScience assessment subsumes a multi-aptitude battery with a long research history that demonstrates its reliability, validity, and relations with important outcomes, including job success and career suitability.
- Current norms have been established to ensure meaningful score inferences for the population of students for which YouScience has been designed.
- The similar patterns of correlations among BAB tests and means on those tests, paired with the results of the measurement invariance analysis which establish the suitability of a single latent structure of abilities for the BAB tests, suggest that the

YouScience assessment performs similarly to the original BAB, thus supporting the imparting of BAB validity results to the YouScience assessment.

## Interests Are Important in Determining Career Choice and Satisfaction

Psychologists began to study people's work-related interests early in the 20th century.[24-26] Of course, people hold a variety of interests. But similar to what was found for abilities, psychologists have found over the years that when you ask people about the types of activities they like and then analyze the responses, you find they can be grouped into six types: Realistic – Investigative – Artistic – Social – Enterprising – Conventional (RIASEC).[27] Similarly, the types of activities people perform at work can also be described quite well in terms of these six types. Together, these types constitute what psychologists call the *RIASEC model of vocational interests*, which has become the dominant model of interests used by vocational counselors and researchers alike. Numerous research studies conducted over the past several decades indicate that the degree to which a person's interests match up with the types of activities performed on the job can predict a number of important outcomes, including (a) which careers people choose,[28,29] (b) whether people are satisfied with their jobs,[30,31] (c) whether they stay in or leave a job,[32] and (d) how well they perform on the job.[33,34]

### Key Points

- Researchers have identified six primary vocational interests: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional.
- Different jobs tend to attract individuals with different interest profiles.
- Matching one's interests to the types of work in a given occupation is important for many important outcomes, including job performance, retention, and satisfaction.

## The YouScience Assessment Measures Interests Important for Career Choice and Satisfaction

The approach YouScience uses to measure your interests is based on the RIASEC model. Specifically, the YouScience assessment incorporates the short form of the Interest Profiler.[35-37] Developed by the O*NET Center, this measure comprises 60 items (10 items per RIASEC dimension). This measure takes relatively little time to complete and possesses solid psychometric characteristics, including (a) appreciable internal consistency and test-retest reliability, (b) convergent and discriminant validity, and (c) expected patterns of covariation among the six interest scales.[38] Despite being a relatively brief measure of the RIASEC dimensions, the scales have demonstrated respectable internal consistency reliability (mean values of .81, .84, and .86 across three samples) and test-retest reliability (ranging from .78 to .86 across scales, with a mean test-retest reliability estimate of .82). In addition, it has demonstrated evidence of convergent and discriminant validity in terms of its relations with RIASEC scales from the Department of Defense's Interest Finder[39], with convergent estimates of .74 to .82 and discriminant estimates of .12 to .48.[40]

### Key Points

- YouScience measures well-researched interests important for performing jobs well.

- The YouScience assessment subsumes a RIASEC measure with demonstrated reliability (both internal consistency and test-retest) and validity (construct validity demonstrated through convergent and discriminant validity estimates).
- The interest profile is an excellent starting point for helping decide among the types of careers a student should explore.

## The Career Data Underlying YouScience Are Robust and Accurate

As noted in the sections above, having accurate measures of a student's aptitudes and interests provides a critical step in finding careers a student will perform well and find satisfying. However, such individual data absent robust and accurate data on potential careers are insufficient for facilitating career guidance. For this reason, data on potential careers play a central role in the YouScience system. Career data serve two critical purposes within YouScience. One purpose is simply informational. That is, YouScience uses career data to describe various features and trends regarding specific careers that are of potential interest to students, parents, and counselors when weighing career choices. The other purpose is to facilitate the process of recommending careers to students based on "fit" with their YouScience assessment scores. Specifically, just as one can describe a student's aptitudes and interests, so too can any given career be described in terms of (a) the aptitudes critical to performing it well, and (b) the types of interests it supports and does not support.

***So where do career data in YouScience come from, and how can you be confident they are accurate?*** The career data underlying YouScience are drawn from well-established and highly reputable career data sources maintained by the U.S. Department of Labor including the following:

- *The Occupational Information Network (O*NET)* is the United States' primary source of information on occupations in the U.S. The O*NET was developed by (and continues to be maintained via funding from) the U.S. Department of Labor's Employment and Training Administration.[41,42] Built by research teams led by some of the foremost occupational analysis experts in the world, the O*NET provides data describing more than 900 occupations on hundreds of standardized and occupation-specific descriptors. Since the foundational work in the early 1990s, the O*NET has been continually researched, evaluated, refined, and expanded.[43,44] It is also widely used in both human resource and career counseling applications across a wide range of industries.[45]

- *The Bureau of Labor Statistics' Employment Projections Program* focuses on maintaining data for forecasting the U.S.'s labor market 10 years into the future.[46] The employment projections offered by BLS are periodically evaluated for their quality, and past evaluations are available via in several past issues of the *Monthly Labor Review.*[47]

### Key Points

- Accurate career data are critical to the process of identifying which careers best fit a person,

- YouScience draws data on careers from the repository of occupational information provided by the U.S. Department of Labor (the Occupational Information Network -- O*NET).
- Data about trending careers come from the Bureau of Labor Statistics' Employment Projections Program – the nation's official source of such data.
- O*NET and BLS Employment Projections data have been extensively researched and evaluated over the past few decades and continue to be refined to ensure accuracy and currency.

## YouScience Produces High-Quality Career Recommendations

The sections above systematically laid out evidence for foundational data elements underlying the YouScience profile system, namely that (a) the YouScience assessment measures aptitudes that are important for career success, (b) the YouScience assessment measures interests that are important for career choice and satisfaction, and (c) that the career data underlying YouScience are robust and accurate.

What is missing from the string of evidence above is how all of this comes together. Specifically, how confident can you be that the career recommendations produced by YouScience are of high quality?

To provide the final piece in our evidentiary puzzle, we return to O*NET. As noted above, the Department of Labor's O*NET system provides a robust, comprehensive source of data on careers. Among the types of data maintained within O*NET are detailed ratings of (a) the level of aptitude required, and how important different aptitudes are to successful performance for more than 900 careers; and (b) the degree to which each RIASEC interest dimension characterizes those careers.

The process for matching individuals up to careers based on their YouScience assessment scores was designed by a highly experienced team of Ph.D. level industrial-organizational (I-O) psychologists (including three Fellows of the American Psychological Association and of the Society for Industrial and Organizational Psychology) specializing in individual differences measurement, occupational analysis, and person-job fit.[48] The rigorous process involved the following steps:

(1) *Determining which O*NET "descriptors" of aptitude and interest "mapped" onto the YouScience assessment dimensions.* This particular exercise required substantial subject matter expertise to execute, as most YouScience tests could be and were mapped to multiple O*NET dimensions...

(2) *Determining how different types of O*NET aptitude ratings (i.e., level of a given aptitude that is required for effective performance in a career, and importance of a given aptitude for effective performance in a career) could enhance the quality of YouScience career recommendations.*

(3) *Determining how to put O*NET aptitude/interest ratings for various careers on a "measurement scale" comparable to the YouScience assessment's measurement scale.* This scaling makes it possible to directly compare a student's YouScience assessment scores to O*NET career data to evaluate match.

(4) *Determining how to compare a career's aptitude/interest profile to a student's profile of YouScience assessment scores for similarity (i.e., the matching algorithms).* Psychologists have been studying methods for evaluating similarity of profiles for over a half century, and there is a substantial, complex scientific literature on indices for quantifying similarity.[49-53]
(5) *Fine tuning and evaluating the YouScience matching algorithms.* At this stage, steps were taken to refine and evaluate the matching algorithm. Our approach involved simulating profiles for thousands of users and vetting the quality of the resulting recommendations.

Although we would generally view the steps above as critical to the development of any career matching algorithm, what really distinguishes the YouScience algorithm is *how* and *by whom* the steps were carried out, and the degree to which it reflects knowledge gleaned from nearly a century of scientific research. It is these factors that really help ensure the YouScience career recommendations are of the highest quality. Specifically,

- The steps above were grounded in over a half-century of scientific research on individual differences and occupational differences that have been tied to career success and satisfaction.
- The steps above were carried out by a dedicated team of highly experienced, well-published, Ph.D-level I-O psychologists with specializations in individual differences measurement, occupational analyses, person-job matching, and the O*NET system.[54]
- Throughout the development process, key decisions were based on independent judgments from multiple I-O psychologists with expertise in the areas noted above.
- Methods for evaluating career match were grounded in the scientific literature that has emerged regarding person-environment fit over the past half-century.
- Simulations were expertly employed to ensure meaningful results emerged for a highly diverse array of simulated users of the system.

Taken together, the steps outlined above and the manner in which they were carried out helps ensure that the recommendations offered by the YouScience make the most of the student and career data at hand, and are of exceptional quality.

### Key Points

- The YouScience career matching process uses dimensions that describe both people and careers.
- The YouScience career matching process is rooted in the scientific literature on person-job matching.
- The development and evaluation of the YouScience career matching algorithms were the result of a rigorous process and were designed and executed by highly experienced Ph.D.-level I-O psychologists.

## Summary

YouScience provides career recommendations rooted in valid, well-researched measures of individual characteristics, as well as the most current information on jobs and state-of-the-art

algorithms for matching individuals to jobs. We learn about students by drawing upon reliable, valid assessments of individual characteristics critical for identifying the types of work they will do well and enjoy doing. We take this information and compare it to the most current career data available, comparing the similarity of students characteristics and the features that define each job. We then evaluate this information using scientifically robust statistical algorithms to provide students with a set of career recommendations they can explore with confidence.

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Dr. McCloy is a Principal Staff Scientist at the Human Resources Research Organization (HumRRO) in Louisville, KY, serving as an in-house technical expert and a mentor to junior staff. Dr. McCloy has nearly 25 years of experience conducting and directing personnel research. He is well-versed in several multivariate analytical techniques (e.g., structural equation modeling, event history analysis, hierarchical linear modeling) and has applied them to numerous research questions, particularly those involving personnel selection, job performance measurement and modeling, and attrition/turnover. His assessment and testing experience spans both cognitive and non-cognitive domains and has involved several large-scale assessment programs (Armed Services Vocational Aptitude Battery, National Assessment of Educational Progress, General Aptitude Test Battery). His recent research has involved development of (a) the first known computerized adaptive test of cognitive ability for use as a selection screen in unsupervised online settings, (b) a career exploration tool to help interested individuals identify government occupations that suit them best (including high-priority occupations such as cybersecurity), and (c) customized tools for performing human capital analytics. He has served as adjunct faculty at both The George Washington University and George Mason University and is currently on the advisory board for the industrial-organizational psychology program at Northern Kentucky University. He is a Fellow of the American Psychological Association (APA), the Society for Industrial and Organizational Psychology (SIOP), and the Society for Military Psychology. He received his B.S. in Psychology from Duke University and his Ph.D. in Industrial-Organizational Psychology from the University of Minnesota.

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Dr. Putka is a Principal Staff Scientist at the Human Resources Research Organization (HumRRO) in Alexandria, VA. He has over 13 years of experience helping public and private sector organizations design, develop, and evaluate assessments to (a) enhance their hiring and promotion processes, (b) guide prospective applicants to career and job opportunities that fit them well, and (c) enhance their understanding of, and ability to positively impact individuals' attitudes, performance, and tenure. In addition to his client centered work, Dr. Putka has maintained an active presence in the industrial-organizational (I-O) psychology scientific community, as evidenced by (a) over 40 presentations and invited workshops at national conferences, (b) over 17 published book chapters and articles in peer-reviewed journals, and (c) service as a reviewer and member of the editorial board of four scientific journals. Dr. Putka has presented and published on myriad topics to include, methods for evaluating the measurement of individual and job characteristics, vocational interests, person-environment fit, and high-fidelity psychological assessments. Dr. Putka has testified before a Congressional appropriations committee on behalf of the American Psychological Association (APA), and has also represented the Society of Industrial and Organizational Psychology (SIOP) in a Congressional briefing. He is a past-president of the Personnel Testing Council of Metropolitan Washington, and has been recognized with Fellow status in three different divisions of the APA in light of his national contributions in the areas of psychometrics, I-O psychology, and military psychology. Dr. Putka received his Ph.D. in I-O Psychology with a specialization in quantitative methods from Ohio University.