Report of the Research Department

Johnson O’Connor Research Foundation, Inc.
Human Engineering Laboratory, Inc.
Johnson O’Connor Research Support Corporation

2016
Goals of the Research Department

1. The isolation of aptitudes and the study of their role in various occupations.
2. The development of accurate measures of aptitudes.
3. The investigation of the role of aptitudes in education.
5. The study of the processes involved in the acquisition of knowledge.
6. The development of accurate measures of knowledge.
7. The communication of research findings to the public.

Dr. Linda S. Houser-Marko, Russell E. Burke, Dr. David H. Schroeder in our Chicago research conference room.
Letter from the Research Director

In a 2015 paper in the online journal *Frontiers in Psychology*, Rex Jung and his associates reported on a study using the Johnson O'Connor test of Foresight, Wks. 307 AQ, as a measure of divergent thinking to test Dean Keith Simonton’s “equal-odds rule”: that is, because the odds of any given idea or production being creative or not are equal, greater production of ideas should result in a greater number of creative ideas, or more simply, quantity yields quality. (See our 2015 report for details of this study.)

In comments on the paper, it was suggested that, because raters had seen the quantity of responses by each subject when making their creativity ratings, they might have been unconsciously biased toward giving higher ratings to those with more responses. In order to prevent this, it was suggested, it might be useful to enter all responses by all subjects into a spreadsheet, and have raters then assign creativity ratings to each response: each subject’s responses could then be scored based on these ratings.

Rusty Burke, Research Director, and Kelsey Bakas, an Aptitude Consultant in the Washington, D.C. laboratory, initiated a project to act on those suggestions. In the first phase of this project, Bakas created an Excel spreadsheet to record all examinee responses on each item of the Foresight test. Dr. Jung and his associate, Ranee Flores, provided scans of the response sheets for all subjects in their study, and Bakas, along with Nick Newell (Atlanta), Lauren Cuningham, Emily Mitchell, and Cindy Rosner (Boston), Will Eells, Hannah Waldman, and Roger Rindge (Los Angeles), and Doug Hastings (Seattle), entered all the responses into the spreadsheet. Bakas then created lists of all unique responses (that is, those given only once among all subjects), and non-unique responses (those given more than once among all subjects), and created for each non-unique response a “frequency score” based on how often it had been given among all subjects. These values were then used to calculate mean frequency scores for each subject, both for each test item and for the full test.

The 336 subjects in the study generated a total of 16,950 legible responses across all six items. When duplicate responses were combined, there were 6,283 distinct responses. Of those, 4,554 (72.5%) were given only once. We were somewhat surprised how few responses were given very frequently: only 56 responses were given by 10% or more of the subjects.

For the full test, the correlation between the number of responses given by a subject and the number of unique responses given by the subject was .67, and the correlation between the total number of responses and the mean frequency score for the subject was -0.59. These correlations were significant at the .001 level. Thus there does appear to be a fairly strong correlation between fluency (giving more responses on the test) and frequency (giving less frequent, or more “original” responses). Subjects who give more responses tend to give more uncommon ones.

Future work on this project will involve creating creativity scores, and correlating frequency and creativity scores with a measure of creative achievement.

A special tribute is in order for the most senior member of our foundation, Director of Research Emeritus Robert Kyle, who had served the vision and memory of our founder some two score and eight years. His advice and sage counsel had been greatly appreciated.

Bob passed away during the night of July 14-15, 2016. He possessed a sharp wit; he was a raconteur of Eleanor & Johnson stories when inspired; he was a guardian of the best values of the foundation to perform research following the model of our founder. He devoted his life to Johnson O’Connor for almost a half century.

We shall miss him and his trenchant observations even though he had been retired since 2009 and had been less frequently engaged with us since then. His career at the Foundation started in 1962. He served as Director of the Chicago office from 1964 to 1982. He was Vice President from 1981 and Director of Research from 1982 until retirement.

Robert F. Kyle

March 31, 2017
Observations & Announcements

Yesterday, Today, looking forward to Tomorrow

In one fashion or another, I have opined in this report each year since 2003 when I became President. I want to allow myself some reflection on how we all have progressed. In 2004 the professional researchers wrapped up the new bargraph computer program and published two journal articles with Dr. Timothy Salthouse concerning aging with aptitudes, among other efforts. Aging in aptitudes continues — see page 6 for work by Dr. Linda House-Marko. We switched from audio-visual tests depending on slide projectors to then modern eMac computer presentation. In 2005 Dr. David Schroeder and Dr. Christopher Condon developed new presentation materials to enliven their research projects to help our summarizers. A research advisory committee consisting of several key directors participated in the planning and discussion for future research. By 2006-07 we enlarged the scope of O’Connor research with funding from our support corporation to sponsor projects by outside scholars using techniques not possible for us. First Dr. Richard Haier and Dr. Cheuk Tang and others completed and analyzed brain scans related to performance on aptitude tests. Intriguing results, although not ready yet for individual client application, came in waves with each succeeding scanning project. Some board members remember the Brain Institute at University of New Mexico where Dr. Rex Jung showed us the facility where further work continues with scanning.

By 2008 we knew we had to continue repairs and office design already underway in the Chicago testing space with an even more heroic effort to rebuild the research space. Over the next year under the guidance of tenant architect Michael Pado we completed a new suite of rooms which still serves us well. (Putting on a new roof and fixing the parapets and brick outer wall later helped.) The advisory committee was supplanted by appointing Rusty Burke as Research Director to provide guidance and support for the professional researchers. Diagrams and charts from their research were incorporated in our new book, Understanding Your Aptitudes, to help validate what we tell our clients.

For magnetoencephalography (MEG) imaging we had the fun of designing variants of two key aptitude tests — Inductive Reasoning and Paper Folding — to suit the constraints in movement for the examinee. Our recent annual reports cover the results of this and other scanning projects. Blending the new techniques with time-honored research to understand the genetic component of individual differences in ability led us to participate in funding twin studies to augment our own research comparing identical with fraternal twins.

By 2013 & 2014, yesterday was not so far away. Updating norms, improving test items, continuing to examine heritability and aging, measuring long-term test stability, along with auditory and theater validation led the way. Client satisfaction returned after a long hiatus, with reassuringly positive results.

In last year’s report, there was much new and exciting talk about Foresight. Creativity joined long-term possibility imagining. Grasping again for a distant yesterday, I remember speculating about the august emperor Charles V, who abdicated great power to seek spiritual peace and aptitude fulfillment. Foresight now propels us beyond yesterday. Read p. 1 for the latest on the test. Read the following pages for other recent research.

And now, it is all about tomorrow. Possibilities abound. My time absorbing these research articles for the annual report, to include the typesetting and page layout, is finished with this issue. As of this spring, a new president will preside over the changes and future plans for Johnson O’Connor.

It is a great honor to introduce the President Presumptive, Anne Steiner, for this century the director of our Seattle testing center. She began life in Fairbanks, Alaska and continued on at the prestigious Williams College of Williamstown, Massachusetts. Well educated, high vocabulary (as we insist on), she is a well-informed generalist who will bring the perspective of literate, liberal education to inspire and broaden our research efforts going forward. We heartily welcome her promotion!

As I step down, I want to make the case for continuing to fund outside research by taking advantage of our support corporation to discover new aspects of aptitudes. Exciting things would come from funding graduate students or gaining professional guidance from consultants. I know there is also discussion of a re-designed bargraph program, integrating timing and scoring to the testing process, while keeping the value of individual attention and personal interaction in the interpretation of scores. New tests, new insights, new spirit; let’s toast to the future! Oh, old aptituders never die, they just fade away…

David Ransom, President 2003-2017
Test Scores Across Time

In 2016, David Schroeder, Research Manager, continued to investigate trends in performance on our tests across time. Because we have been giving our standard battery for a number of years, we are well-positioned to identify broad trends in the aptitudes of the examinees whom we test.

Performance on tests across time has attracted particular attention in the scholarly community because of a finding referred to as the Flynn effect, which is the sharp rise in scores on IQ tests and other broad measures of ability over the past 100 years or so. In our data, Schroeder has found that, if one examines overall scores—that is, scores for a general statistical factor—for our cognitive aptitude tests, then those scores do tend to increase slowly until about 2000, at which point they appear to level off. Importantly, however, the pattern for the general factor obscures the fact that the trends for individual aptitudes vary widely, with Foresight and Memory for Design showing relatively large gains over time and Number Memory and Analytical Reasoning showing modest changes similar to the general factor in recent years (see the accompanying figure). So, this is an area that illustrates the value of our approach of emphasizing individual aptitudes rather than overall scores.

Schroeder made a presentation on our data at the annual meeting of the Association for Psychological Science (APS) in 2016, and he will elaborate on the relationship between the general-factor findings and the individual-test findings at the APS meeting in 2017.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Standardized Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>-0.5</td>
</tr>
<tr>
<td>2000</td>
<td>0.5</td>
</tr>
<tr>
<td>2011</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note. Values are not shown for years in which the current versions of the tests were not given.

Neuroimaging Study of Artistic Judgment

Also in 2016, we published an article on some findings from our neuroimaging research in the journal Psychology & Neuroscience. The article was written by Nikolau Bezruczko, a former consultant to the Foundation who worked on our artistic judgment project (see, e.g., Technical Report 1998-1); Etienne Manderscheid, a recent Ph.D. in Neuroscience from the University of Chicago; and David Schroeder. In this article, we reported results for the Visual Designs test from the structural magnetic resonance imaging (sMRI) study that we conducted with Richard Haier a few years ago (see our annual reports for 2007-2011). Previously, we published several articles in scholarly journals on our findings from that study, but Bezruczko wanted to publish a report specifically on the data for our artistic judgment test, Visual Designs. In our sMRI study, we recruited 40 alumni of our testing program to undergo sMRI imaging, which enables one to assess the densities of gray matter in various areas of the brain. Haier and his team correlated scores on our tests with these regional brain densities.

In terms of results, the accompanying figure shows the brain areas for which gray-matter density correlated with our Visual Designs I scale, which presents examinees with randomly- constructed designs and measures whether the examinees prefer simpler versus more-complex designs in this context. There were
a total of 21 brain clusters that correlated with our scale, and they are spread out across the brain, but they tend to be in the parietal lobe and in the right hemisphere. We were interested to discover that several of the areas, specifically areas associated with visual processing (visual cortex) and emotional response (insula), corresponded to areas identified in previous studies that used functional MRI to examine brain activation during the viewing of visual art.

For the Visual Designs II scale, which contrasts less-uniform and more-uniform designs with artists preferring the less-uniform designs, there were fewer brain areas that showed correlations. Again, however, it was interesting that two of the brain clusters, the precuneus and the insula (as with Visual Designs I), had been highlighted in the functional MRI studies.

The article by Bezruczko, Manderscheid, and Schroeder appeared in the September 2016 issue of Psychology & Neuroscience. Bezruczko and Schroeder will also report our findings at the 2017 meeting of the American Association for the Advancement of Science, and Schroeder expects to review the research again in a 2017 Statistical Bulletin.

**Number Memory**

In another 2016 study, David Schroeder performed an internal analysis of our Number Memory (NM) test. Although we have performed internal studies of most of our tests, we have largely overlooked NM until this time.

In 2015 we collected NM answer sheets for 603 examinees and created a data file of their responses. Schroeder found that examinees are able to memorize some of the numbers on the test much better than other numbers (see the accompanying figure).

For the number (starts with 8) that has a pattern with just two different digits, with the second one repeating three times (e.g. like 939333), performance on the first trial of the test is about three points better (on a 0 to 6 scale) than performance on a number (starts with 4) using five different digits, with a middle pair (like 520039). As one moves to the other three trials, performance on both numbers improves, but the former continues to be substantially easier than the latter. Repeating digits may well simplify the memorization, bringing a simple rhythmic pattern to bear.

In terms of item-total correlations, all eight of the numbers seem to perform reasonably well, with correlations ranging from .38 to .50.

With respect to reliability, one can use the scores for the eight numbers to estimate the internal reliability for Number Memory (see the accompanying figure). Specifically, when one calculates split-half reliabilities by correlating scores for four numbers with scores for the other four numbers, one finds values that tend to be in the .75-.77 range. When one employs the commonly-used alpha coefficient, the value is .752.

![Internal Reliability Coefficients for Number Memory](image)

In general, the Foundation wants its tests to show reliabilities that are greater than .80, and so it appears that Number Memory is below our usual standard. Because Number Memory has an alternate form that is very comparable to the standard form, we plan to conduct an alternate-form reliability study and see if we find about the same level of reliability.

Schroeder reported his findings in Statistical Bulletin 2016-7, *Internal Analysis of Number Memory*. 
The follow-up studies of clients who had tested at the Foundation ten years ago continued through the work of Linda Houser-Marko, Researcher. The plan for these studies was to contact examinee-clients who had learned about their aptitudes several years ago and were further along in their occupational pursuits. By following up with our past clients, we can learn more about the connection between aptitudes and job choices. Further, we can learn more about how different jobs fit with different aptitudes and people, and then how an individual’s sense of person-job fit is related to their job satisfaction.

Follow-up survey invitations were sent by e-mail to clients who tested at the Foundation in 2006. We were able to send them by e-mail this time, because for this year we had more e-mail addresses for clients. The e-mail invitation made it easier for former clients to respond to the online survey. We received 190 responses from this invitation to the ten-year survey, a 12% response rate for “delivered” invitations.

We also sent a survey invitation to clients for a five-year follow-up study. We had a great response for this request, and received 528 survey responses as of the end of the year, or a 15% response rate for “delivered” invitations.

With these surveys, we wanted to develop an understanding of how former examinees think about their aptitudes in general. For example, we wanted to know if aptitude testing had an influence on their choices and the direction of their occupation. Ideally, after a person learns about their aptitudes, they would be able to make informed choices and decisions about what direction they would want for their career, and would be able to find a position in which they could put their aptitude strengths to use.

When they were tested, 30% of the respondents for these surveys were high school age, 14% were college age, 24% were early career age, 19% were mid-career age, and 13% were later career. Some respondents of the five-year survey were currently students, with 10% being college age. The average age for respondents of the ten-year survey was 38 years old and for the five-year survey was 33 years old.

Most of the respondents said that they personally wanted to come in and have their aptitudes tested. The majority (66%) of respondents said that they tested “Because I wanted to, or for my own reasons.” At the same time, 47% of respondents also said that they tested “Because someone else thought I should.” They could choose as many options as they thought applied to them. As might be expected, the examinees who were teenagers at the time of testing were more likely to say that they tested because someone else thought they should.

We were curious to find out whether aptitudes were part of the respondents’ daily lives. We asked “To what extent do you think about, or talk about, aptitudes in your daily life?” and the mean response was 2.86, on a scale of “Not very much” (1) to “Very much” (5), with the most frequently chosen options being “Somewhat” and “Quite a bit.” There was not a difference between the ratings for people who tested five versus ten years ago.

About one-third (31%) of respondents said they can find ways to use their aptitudes in their work or hobbies. Some said that they “struggled” to find ways to use their aptitudes (11%), 5% said that they “rarely use” their aptitudes, 11% said that they were not sure how to use their aptitudes, and 5% said that they did not know (or remember) what their aptitudes were. While about a third of the group said that they find ways to use their aptitudes, a much smaller group said that they did not feel connected to their aptitudes.

We asked “To what extent do you think your college major fit(s) with your aptitudes or abilities?” on a scale of 1 to 5. The examinees who were not in college at the time of testing rated the fit of their college major with their aptitudes the highest, whereas examinees who were likely to be in college at the time of testing rated the fit a bit lower, and examinees who were 22 and older at the time of testing rated the fit as generally lower than the others. Notably, the youngest examinees learned about their aptitudes before they went to college, and so might have been able to choose a major that was a good fit for them.

In order to get a better understanding of respondents’ thoughts about how their aptitudes fit with their occupations, or “person-job fit,” we asked more questions about their employment. For example, we asked if they thought their current job fit with their aptitudes and abilities.

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**Self-ratings of how college major fit with their aptitudes**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Age at time of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.25</td>
<td>14 to 16</td>
</tr>
<tr>
<td>4.00</td>
<td>17 to 18</td>
</tr>
<tr>
<td>3.75</td>
<td>19 to 21</td>
</tr>
<tr>
<td>3.50</td>
<td>22 to 24</td>
</tr>
<tr>
<td>3.25</td>
<td>25 to 30</td>
</tr>
<tr>
<td>3.00</td>
<td>31 to 45</td>
</tr>
<tr>
<td>2.75</td>
<td>46 &amp; +</td>
</tr>
</tbody>
</table>

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Many thought their current job fit with their aptitudes: 18% said they thought their job fit "very much" with their aptitudes, 34% said they thought it fit "quite a bit," and 28% said they thought it fit "somewhat."

Most people were satisfied with the tasks of their current job and 23% said the tasks and activities were "very satisfying," 36% said they were "satisfying," and 29% said they were "somewhat satisfying." 9% said they were "somewhat dissatisfying," and 3% said their job tasks were dissatisfying.

There was a survey year effect such that people tested ten years ago gave higher ratings of their job fitting with their aptitudes and overall job satisfaction, compared to those tested 5 years ago. Perhaps a person has to "grow into" their aptitudes, and finding the right occupation that fits with their aptitudes is more likely with time.

Then to look at these differences further, we looked at age when tested and the respondent's current age. We found that there is a tendency for people who tested when they were younger, and are older now, to say that their occupation fits with their aptitudes more.

To consider all of these factors together, we created a statistical model with all of the factors that seemed related, in this study, to general job satisfaction. General job satisfaction was related to age when a person tested, their satisfaction with job tasks, not thinking their job was boring, and their sense that their job fit with their aptitudes. Even when strong factors like satisfaction with job tasks and not thinking their job was boring were included in the model, their sense that their aptitudes fit with their job was still a significant and important predictor of job satisfaction.

Houser-Marko plans to continue these follow-up surveys as part of a larger program of longitudinal research on clients of the Foundation.

Updated Test Norms

We continue to periodically update norms for the tests in the Foundation battery. New norms were constructed this year for the tests of Analytical Reasoning and Number Facility by Linda Houser-Marko and David Schroeder.

The age curve for the Analytical Reasoning test is shown in the figure below. Compared to some of our other tests, the curve is a gentle slope. The peak of Analytical Reasoning scores is around the ages of 21 to 25, and then from there, scores gradually decline.

The figure below shows the age curve for the Number Facility test. There appears to be a plateau from age 16 to age 25, another plateau from 26 to 45, and then a gradual decline.
A study called “Spatial Ability and the STEM Majors: Where do Females with High Spatial Ability Go?” was presented by Linda Houser-Marko at the 28th annual meeting of the Association for Psychological Science (APS) in May 2016. The following is a portion of a press release that described the study of the STEM majors and Structural Visualization/spatial ability:

In a recent study, the Johnson O'Connor Research Foundation, Inc., (JOCRF), has found that spatial ability was high for all STEM majors, with the highest levels for physical science, engineering and math majors, and computer science majors scoring above average.

However, of all the students in the study who had high spatial ability, only 20% of the females and 34% of the males were majoring in the STEM fields. Females with high spatial ability majored in physical science, engineering, and computer science at lower than expected rates commensurate with their abilities. According to Linda Houser-Marko, a Foundation researcher who conducted the study, "More students in general have the abilities to major in the STEM fields. There is a larger pool of both female and male students who have high spatial ability who have the potential to go into the STEM fields.”

The study was conducted on a sample of 11,502 young adult (18 to 24 years old) JOCRF clients, of whom 16% had chosen to major in one of the STEM fields. The most were in the biological sciences (5.7%), with engineering (5.5%) also being a popular major in this sample.

According to Dr. Houser-Marko, "Being aware of one's strengths and weaknesses can help a person make better decisions, particularly for college and career directions. Knowing the important role of spatial ability in the STEM fields might help to increase interest in those fields, because not all students with high spatial ability are majoring in the STEM fields.”

**Research Department Staff**

**Russell E. Burke**, Director of Research, has also served as Director in Washington, D.C. He is our senior summarizer and writer interpreting research information to the staff. An autodidact by inclination following a degree in Religious Studies at the University of Tennessee, he joined the Foundation in 1983 in New Orleans and served as Director in Houston before moving to the nation's capital, living on Capitol Hill.

**David H. Schroeder**, Research Manager, joined the Research Department in August 1984. He has a B.S. from the University of Illinois and an M.S. from Colorado State University, as well as an M.A. and a Ph.D. in personality psychology from The Johns Hopkins University.

**Linda S. Houser-Marko**, Researcher, joined the Research Department in October 2010. She has a B.A. from Gustavus Adolphus College in Minnesota and a Ph.D. in social and personality psychology from the University of Missouri. She has published research on the self, identity, and motivation.
Surveying Our Recently Tested Clients

Beginning in the spring of 2016, the Research Department began collecting information from clients in the form of an exit survey based on a version first designed and implemented by Amanda Summers, director of the Chicago office, and Lisa Cook, director of the Denver office. In the pilot stage of development, use of the survey was optional, and participation varied from lab to lab. That was the case until April, when administration of the survey was handed over to Alison White, Research Assistant, and all labs were asked to participate. Designed specifically for clients who have recently completed the testing program, this survey serves not only to provide the Foundation with valuable information about the client and their experience with us, it is also the first step in our post-testing relationship with our clients.

Relationship development

The exit survey is the first in a series of planned interactions with former clients in the years to come. An invitation is sent by the lab where the client was tested soon after they sit down for their final appointment to go over their results with an Aptitude Consultant. Additionally, we have surveys for the five year and ten year mark, and a one year survey is currently in preparation. It is our hope that by checking in with clients every so often we can let them know we care about their success after testing, remind them of the services we provide, and gather longitudinal data pertaining to the way they use their aptitudes and choices they make over time.

The exit survey asks clients to rate different aspects of their testing experience, and gives them an opportunity to provide us with feedback. While the overwhelming majority of the responses we’ve received have been positive, this survey also allows clients who may have left the lab hoping for more to let us know what they felt was missing. If clients need further assistance, they are invited to leave contact information, and advised that someone will reach out to them soon. This gives us a chance to follow up with those clients who thought of questions after leaving their final appointment and provide them with additional support, while reminding them to take advantage of their free follow up appointment once they’ve gone through their materials and completed some research on their own.

Who takes the survey and why?

Of the 621 responses gathered between April and December of 2016, most surveys were taken by the clients themselves. However, there were instances where a parent, grandparent, or even a spouse chose to give feedback on behalf of the client. While clients of all ages participate, the largest group of respondents is between 14 and 23 years of age, a reflection of the fact that many of our clients are students in that age group.

In fact, a majority of clients come to us because they are trying to decide on a college major, or a focus for a higher degree. Other clients find themselves at a career crossroads, where they must make an important choice about the trajectory of their career. Some are unhappy with their current occupation, while others simply want to think beyond the options they’ve already considered. Clients of all ages and backgrounds indicate that they came out of curiosity; to gain a little bit of insight into themselves and to find out what their innate abilities are.

Why did you decide to come in for testing?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just curious/self-knowledge</td>
<td>300</td>
</tr>
<tr>
<td>Choose college major/focus for higher degree</td>
<td>250</td>
</tr>
<tr>
<td>Curious about new career options</td>
<td>220</td>
</tr>
<tr>
<td>Career crossroads</td>
<td>180</td>
</tr>
<tr>
<td>Good experience of friend/relative</td>
<td>150</td>
</tr>
<tr>
<td>Unhappy with current occupation</td>
<td>120</td>
</tr>
<tr>
<td>Decide on a school (tech, liberal arts, etc.)</td>
<td>90</td>
</tr>
<tr>
<td>Returning to career after absence</td>
<td>60</td>
</tr>
<tr>
<td>Retirement planning</td>
<td>30</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
</tbody>
</table>

Number of respondents
How did you hear about the Foundation?

According to our survey where clients could choose all that apply, over three quarters of our clients walk through our doors thanks to the recommendation of others. This includes family member or friends who have tested, acquaintances, employers, therapists, and even some people who haven't personally been tested but who know of someone else who had a positive experience with the Foundation.

The majority of the remainder of our clients say they found out about us through a publication such as O Magazine, a podcast, a radio interview, or even blogs of past clients who decided to tell their followers about their experience. A small portion of clients come to us thanks to our accounts on social media, or because they discovered the Foundation while conducting an internet search. We hope to use information gathered through the survey to help us expand our reach in this final category. Providing quality services and valuable information to each client ensures that they will be likely to recommend us to others in the future, no matter how they first heard about us.

What's next for our clients?

Clients tell us that they hope to use their aptitudes in a variety of ways. Many clients plan on using their aptitudes in enriching hobbies or volunteer work, in informing day to day decisions, and even in improving the quality of their relationships with other people. We can expect to see that our clients apply their results most in their work, and in the education needed prior to entering the field of their choice.

As clients participate in the one, five, and ten year surveys, we will be able to see just how much they are able to engage their aptitudes for success and satisfaction in the workplace. We anticipate that the information we gather at each of these intervals will provide us with a snapshot as clients progress through various stages in their careers and apply their aptitudes in new ways. In turn, this will better inform the way we talk about the benefits of using certain aptitudes in various jobs, spawning a new generation of research and test development.

Alison White
Research Assistant - Surveys
(recent test administrator Atlanta, Chicago, test trips)

How likely are clients to recommend us?

Based on the number of clients who come to us on a recommendation, it is perhaps not surprising that most clients indicate that they will in turn recommend us to others. Nearly 73% of surveyed clients would "Absolutely!" recommend us and over 20% say they “Probably” would. Of the remaining responses, a commonly reported concern is that the cost may be prohibitive to some people. Efforts to improve and expand scholarship testing and relationships with local sponsors may alleviate some of those concerns and further increase the percentage of clients who would readily recommend us.

Would you recommend our service?
Dissemination of Research Findings

In recent years we have made it a practice to present findings from our research in scholarly outlets such as professional conferences and journals. In 2016 we made two presentations at the annual meeting of the Association for Psychological Science, which was held in Chicago. Dr. Linda Houser-Marko presented “Spatial Ability and the STEM Majors: Where Do Females With High Spatial Ability Go?” In this presentation, she compared the rates of examinees in the STEM majors with the rates who have STEM-compatible aptitude patterns. Dr. David Schroeder presented “The Flynn Effect: Is It Continuing in the United States?” in which he addressed trends in mean scores over the last several decades. After the conference, Houser-Marko and Schroeder submitted their presentations to the Open Science Framework’s database, where they can be retrieved by other researchers. In addition, Houser-Marko [and associates at the Foundation] prepared a press release on her findings. See page 7.

Also in 2016, Drs. Nikolaus Bezruczko, Etienne Manderscheid, and Schroeder published an article in the journal Psychology & Neuroscience, which is published by the American Psychological Association. In this article, they reported on neuroimaging findings regarding brain areas related to our Visual Designs test.

Dr. Rex Jung and his research team, who have collaborated with us on research on aptitudes and neuroimaging, published a couple of journal articles in 2016 on studies that used our tests. One of the articles, “Fronto-Parietal Gray Matter and White Matter Efficiency Differentially Predict Intelligence in Males and Females”, appeared in the journal Human Brain Mapping. In this article, they looked at the relationships for gray-matter volume and white-matter efficiency with a general ability factor and used our vocabulary test in a small battery to identify the general factor. The other article, “Cognitive Specialization for Verbal vs. Spatial Ability in Men and Women: Neural and Behavioral Correlates”, by Ronald Yeo and others, appeared in Personality and Individual Differences, and it focused on a comparison of the relationships of brain structure with spatial and verbal ability, respectively. Our Paper Folding and Vocabulary tests were among the spatial and verbal measures that they used. Previous articles by Dr. Jung and his associates on research that we sponsored have continued to receive attention in scholarly circles in 2016. The Jung et al. article in Frontiers in Psychology in 2015 has now been viewed 6,152 times and cited in 7 other scholarly articles. The 2014 PLoS ONE article by Dr. Jung and his team has been viewed by 3,016 persons and cited 9 times.

Other scholarly work sponsored by us continued to have impact in 2016. Our 2010 article with Dr. Richard Haier and his associates in BMC Research Notes has now been viewed by 12,275 persons and cited 18 times in other articles, while our 2012 BMC article by Dr. David Schroeder and others has been viewed by 1,653 persons and cited 3 times. In addition, our 2009 article with Haier and others in Intelligence has been cited 69 times, and our our 2010 article with Dr. Cheuk Tang and others in Intelligence has been cited 46 times.

With regard to earlier publications, Schroeder’s 2004 article with Drs. Timothy Salthouse and Emilio Ferrer in Developmental Psychology has now been cited in 113 scholarly publications, and his article with Salthouse in Personality and Individual Differences has been cited 64 times. Our 2001 Intelligence article by Dr. Scott Acton, a former research assistant in the Research Department, and Schroeder has been cited 58 times.

In 2017 Drs. Bezruczko and Schroeder will present “Artistic-Judgment Aptitude Factors Correlate Significantly With Increased Gray Matter” at the annual convention of the American Association for the Advancement of Science. Later in the year, Drs. Houser-Marko and Schroeder will make presentations titled “A Longitudinal Study of Abilities and Interests in STEM and People-Oriented Fields” and “Secular Trends in Specific Abilities: Understanding the Flynn Effect” at the annual meeting of the Association for Psychological Science.

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Recent Statistical Bulletins

2016-1 Preliminary Results for the Cognitive Ability Scales From the Revelle/Condon Project  
Collaboration  
**Linda Houser-Marko**

2016-2 Frequency and Creativity Scores for Foresight, Wks. 307 AQ  
**Rusty Burke, Kelsey Bakas**

2016-3 Age Curve for the Analytical Reasoning Test  
**David Schroeder, Linda Houser-Marko**

2016-4 Age Curve for the Number Facility Test  
**David Schroeder, Linda Houser-Marko**

2016-5 Results from the Decade Study of Examinees from 2005  
**Linda Houser-Marko**

2016-6 Poster Presentation for Association for Psychological Science Convention  
**Linda Houser-Marko**

2016-7 Internal Analysis of Number Memory  
**David Schroeder**

2016-8 Analysis of Experimental Inductive Reasoning Items, Wks. 164 X10 (2014)  
**David Schroeder**

2016-9 Theatre Artists’ Aptitudes Study: Results for WA and an Online Survey of Theatre Artists  
**Scott Barsotti**

2016-10 Scores on Writing Speed Across Time  
**David Schroeder**

2016-11 Analysis of Experimental Inductive Reasoning Items, Wks. 164 X11 (2014-15)  
**David Schroeder**

2016-12 1-4 Versus 0-6 Scoring for Inductive Reasoning  
**David Schroeder**

2016-13 Theatre Artists’ Aptitudes Study: Aptitudes Of Theatre Professionals  
**Linda Houser-Marko, Scott Barsotti**

2016-14 Analysis of Experimental Inductive Reasoning Items, Wks. 164 X12 (2015)  
**David Schroeder**

2016-15 Inter-Trial Improvement of Scores on Silograms  
**Rusty Burke**

2016-16 Sex Differences in Variability for Non-Cognitive Foundation Tests and SDS Scales  
**David Schroeder**

2016-17 Mean Sex Differences for Foundation Tests and SDS Scales  
**David Schroeder**

2016-18 Analysis of Standard Inductive Reasoning Items, Wks. 164 OA  
**David Schroeder**

2016-19 Analysis of Latest Set of Experimental Inductive Reasoning Items, Wks. 164 X* (2013-14)  
**David Schroeder**

2016-20 Heritability/Familiality Studies of the Foundation’s Aptitude Tests  
**David Schroeder, Mikako Nakajima**

2016-21 Mean Percentiles for Individual Test by Lab and Test Administrator  
**Linda Houser-Marko**

2016-22 Sensory Discrimination in Relation to a General Factor of Cognitive Ability  
**David Schroeder, G. Scott Acton**

2016-23 Poster Presentation at Behavioral-Genetics Conference  
**David Schroeder**

2016-24 Long-Term Stability for English Vocabulary  
**David Schroeder**

2016-25 Analysis of Experimental Inductive Reasoning Items, Wks. 164 X9 (2014)  
**David Schroeder**

2016-26 Number of Aptitudes Per Examinee  
**David Schroeder**

2016-27 The Distributions of Times for Color Discrimination  
**David Schroeder**

Recent Publications


**Recent Presentations**


Spatial ability and the STEM majors: Where do females with high spatial ability go?

Poster session presented at the annual meeting of the Association for Psychological Science, Chicago, May 2016.

Dr. Linda Houser-Marko’s poster. See page 7 for coverage about this presentation.

Spatial ability and the STEM majors:
Where do females with high spatial ability go?

Linda S. Houser-Marko, PhD
Johnson O’Connor Research Foundation
Poster presented to the Association for Psychological Science 28th Annual Convention in Chicago, May 26–29, 2016

Introduction
Spatial ability appears to be an important aspect of working in and studying the science, technology, engineering, and math fields. Each field of STEM has a slightly different profile pattern of numerical, verbal, and spatial abilities.

Specific STEM majors have different profiles of numerical, verbal, and spatial abilities. Spatial ability was high for all STEM majors, with the highest levels for engineering and math majors. Females with high spatial ability go into physical science, engineering, and computer science at lower than expected rates, relative to their abilities.

Method

Sample
- The sample was 11,502 18 to 24 year olds who had tested with the Johnson O’Connor Research Foundation for the purpose of vocational guidance. From our database, we also selected those who reported their college major. There were 54% males and 46% females. The mean and median of age was 21 years old.
- Of the overall sample, 16% indicated that they had chosen a STEM major. There were 5.7% in biological sciences, 1.7% in computer science, 5.5% in engineering, and 1.1% in math. Of the STEM majors, 31% were female.

Measures
Numerical ability: A combined score of two numerical tests (number series and number facility). Test reliabilities were .87 and .86.
Spatial ability: a combined score of two spatial tests (paper folding and wiggly block). Test reliabilities were .82 and .77.
Verbal ability: a test of vocabulary knowledge. Test reliability was .96.

Our first analytical approach started with the majors, and determined the profile patterns from those, assuming that the aptitudes of the students, on average, “fit” with the major that they had chosen.

What are the aptitude patterns, specifically numerical, verbal, and spatial ability, for STEM majors?

We found that for biological, physical, and computer sciences, numerical and verbal abilities were “symmetrical,” or in other words, about equally high within the person. Engineering showed asymmetry in which numerical aptitude was higher than verbal aptitude.

Spatial ability had a unique pattern, in which math majors had the highest levels, followed by physical science and engineering, followed by biology and computer science.

Comparing Males and Females

We looked at males and females specifically, to see if there were differences in the strengths of students in the STEM majors.

For engineering and math majors specifically, females showed the asymmetry of numerical aptitude being higher than verbal abilities, while male math majors had symmetrical (and high) numerical and verbal aptitudes. The levels of spatial ability for male and female engineering students were about the same.

Though the computer science students might look somewhat average on their numerical and verbal abilities, their spatial abilities were above average.

Conclusion
Being aware of one’s strengths and weaknesses can help a person make better decisions. Knowing the important role of spatial ability in the STEM fields might help to increase interest in those fields.
Future projects will look in more depth into the major choices of students who tested before they entered college to see if learning about spatial ability influenced them to choose STEM majors more often.
This research suggests that early exposure to STEM programs might positively impact students by introducing them to fields that they have the aptitudes for but might not otherwise have sought out.
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