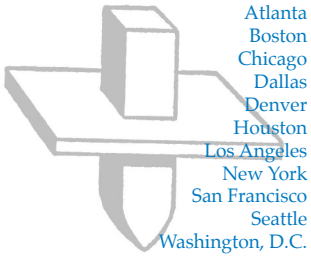
Report of the Research Department

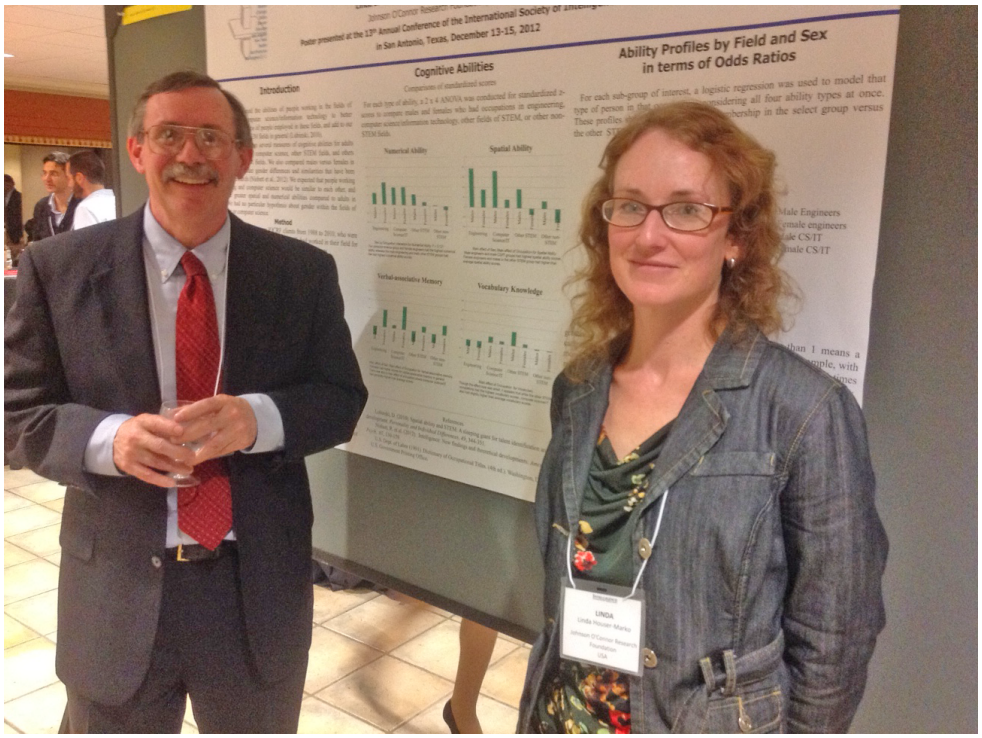
Johnson O'Connor Research Foundation, Inc.
Human Engineering Laboratory, Inc.
Johnson O'Connor Research Support Corporation



2012

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.
4. The evaluation of age and sex differences and the effect of practice on test performance.
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. David H. Schroeder and Dr. Linda S. Houser-Marko at Linda's ISIR poster presentation

"What of brain processes? Are there mental characteristics? If so, can they be measured, and thus become of scientific consequence? Do they follow physical laws? The question unfolds a fascinating field of future research."

Johnson O'Connor, **Born That Way,** 1928

Letter from the Research Chairman

Throughout its 90-year history, the Human Engineering Laboratory/Johnson O'Connor Research Foundation has sought to isolate and measure the mental characteristics we refer to as "aptitudes" through the development and refinement of a battery of tests in which individuals perform a variety of activities, from placing pins in holes to memorizing numbers to reassembling blocks. While we take, I think, justifiable pride in the accuracy and usefulness of our tests, which have helped many thousands of individuals to discover their strengths and apply that knowledge to choosing satisfying careers, such tests are at best *indirect* methods of measuring mental traits. With the emergence over the past two decades of new technologies for brain imaging, it is becoming ever more likely that we may someday be able to isolate and measure mental characteristics *directly*.

Since a meeting in late 2006 between Foundation president David Ransom and noted neuropsychological researcher Dr. Richard J. Haier, we have been working in collaboration with Haier and others on neuroimaging studies, hoping that what are now small steps will lead to an ever more accurate understanding of individual differences in cognitive abilities. The first of these studies, in which 40 Foundation examinees underwent both structural and functional MRI scanning in New York in 2007, resulted in a number of scholarly publications and presentations. A final report from this study, on the relationships between regional gray-matter densities and scores on an interest test, was published by the online journal *BMC Research Notes* in 2012, as detailed on page 3.

In 2012, two new imaging projects got underway, and plans were made for a third. The principal investigator for the two new studies is Haier's long-time friend and collaborator Dr. Rex Jung, of the University of New Mexico, with consulting assistance from both Haier and Dr. Michael Weisend (also of UNM). In the first of these, which was mentioned briefly in our 2011 report, 32 individuals were selected, after taking a battery of tests including Johnson O'Connor aptitude measures, for imaging with an exciting new technology called magnetoencephalography (MEG), in which sensors pick up minute magnetic fluctuations around neurons in the brain as they fire on and off. The MEG device records these fluctuations millisecond by millisecond, and when the data are analyzed it can produce an animation showing the sequence of activation across brain regions as subjects perform a given task. For this study, we are interested in the performance of people who score high on a test (for instance, Paper Folding) compared with those who score lower, when they are attempting to solve these types of problems. Preliminary indications are that there are, indeed, very substantial differences in the ways they process information. These 32 subjects were also scanned with structural MRI, which can provide information about brain structures, and Diffusion Tensor Imaging (DTI), which provides data about white-matter connectivity within the brain. As discussed on page 2, in December Jung, his research associate Joseph Frantz, and Haier presented some of the data from this study at the International Society for Intelligence Research (ISIR) annual meeting in San Antonio, and more presentations and papers will be forthcoming.

Concurrently with this MEG study, the Johnson O'Connor Research Support Corporation also provided funding for Jung and his colleagues for preliminary work toward a larger study he is conducting on "The Neuroscience of Scientific Creativity," with funding from the John Templeton Foundation. For the preliminary phase, 100 subjects between the ages of 16 and 24 were given the battery of cognitive tests (which includes, in addition to several JOCRF measures, an IQ measure, non-JOCRF tests of creativity and spatial ability, a creative achievement questionnaire, and others). Those with high scores in areas of interest (such as math ability, spatial ability, and so on) were selected for MRI imaging. The larger study will ultimately involve the testing of 500 students and professionals in STEM fields (science, technology, engineering, and math), and should be a significant contribution to understanding the brain structures and interactions which underlie creative achievement in these fields.

Late in 2012 we also laid the groundwork with Jung for a study of twins. We plan to recruit twin pairs who have taken the Johnson O'Connor tests, as well as giving our battery of tests to other twin pairs who will be recruited by Jung and his staff, and have the twins undergo MRI scans in New Mexico. This promises to be an ambitious study, and should generate a great deal of interest. Work will get underway early in 2013.

I believe that Johnson O'Connor, an avid adopter of technological advances which promised to help further his work, would have been delighted with these new methods of providing images of and information about the brain at work, which will allow us, possibly, to actually observe directly the mental processes that underlie individual differences: a "fascinating field of future research" indeed!

Rusty Burke

April 11, 2013

Aptitudes and Brain Imaging

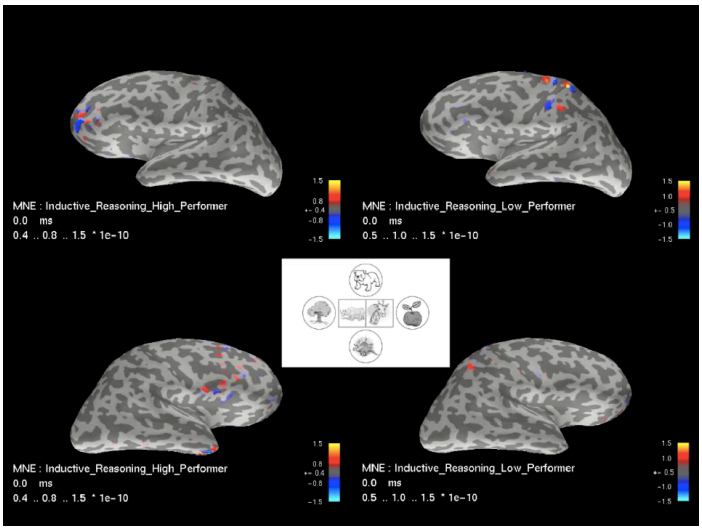
Since 2007, we have collaborated with outside researchers on studies linking the traits that we measure to various regions in the brain, with funding from the Johnson O'Connor Research Support Corporation. In 2012, two new studies were initiated, with Rex Jung of the University of New Mexico as Principal Investigator for both, along with Richard J. Haier (University of California-Irvine) and Michael Weisend (UNM). In the first of these studies, 32 subjects were selected on the basis of test scores for scanning with magnetoencephalography (MEG) while they performed three specially modified versions of JOCRF tests (Paper Folding, Inductive Reasoning, and Vocabulary -- see the 2011 annual report, page 8, for a description of these tests). All the subjects took a full battery of cognitive tests, including the standard JOCRF measures for the three experimental tests, and were also imaged using structural MRI (to look at brain structures) and Diffusion Tensor Imaging (DTI, to look at white-matter connectivity).

Dr. Richard Haier

In December, Jung and Haier, as well as Jung's research associate Joseph Frantz, presented the first data from this study at the annual meeting of the International Society for Intelligence Research (ISIR) in San Antonio, Texas. Jung's presentation was on "Differentiation of Intelligence, Creativity, and Aptitude via Brain-Behavior Imaging." From the testing battery, they were able to identify six factors, three of which he discussed in his talk: a general factor (*g*), of which Vocabulary is a component; a "creativity" factor, to which Foresight contributes; and a "written fluency" factor, which includes Ideaphoria. These three factors were associated with specific brain networks: of particular interest to us, the "creativity" factor was associated primarily with frontal regions, and the "written fluency" factor with orbitofrontal and posterior (e.g., motor) regions. The data thus far seem to lend support to findings from earlier studies, in that creativity seems to be associated with less cortical thickness and with lower fractional anisotropy (a measure of white-matter integrity) in certain regions.

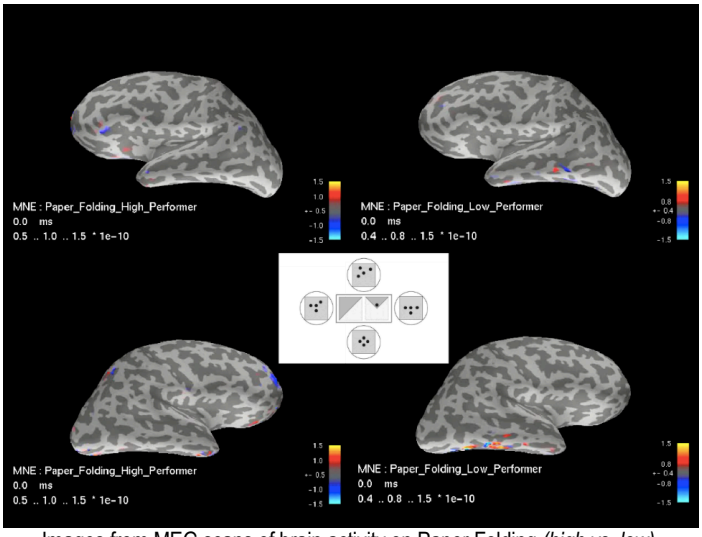
Dr. Rex Jung

Jung's research assistant, Joseph Frantz, presented a poster on "Subcortical Correlates of Aptitude," based on the same subjects as the Jung paper but focusing on mid-brain structures, which are less studied than cortical structures. This study found a positive relationship between Paper Folding and volume in the corpus callosum, which plays a vital role in communication between the brain's hemispheres and is associated with better cognitive function and higher intelligence. A positive relationship was also found between Word Association scores and volume in the right putamen, which plays a role in transmitting signals to and from the frontal lobes, while a negative relationship was found between Ideaphoria scores and volume in the left nucleus accumbens. These results are in line with other findings that indicate lower functioning of the frontal lobes is associated with creativity.



Images from MEG scans of brain activity on Inductive Reasoning *(high vs. low)*.

In a third ISIR presentation, Haier gave a talk on "Sequence and Speed of Information Flow Among Brain Areas During Problem Solving in High and Average Intelligence Individuals," a general overview of the MEG study that did not get into specific findings, because the data was so preliminary. As with the earlier MRI study, we expect many more papers and presentations to emerge from this study.



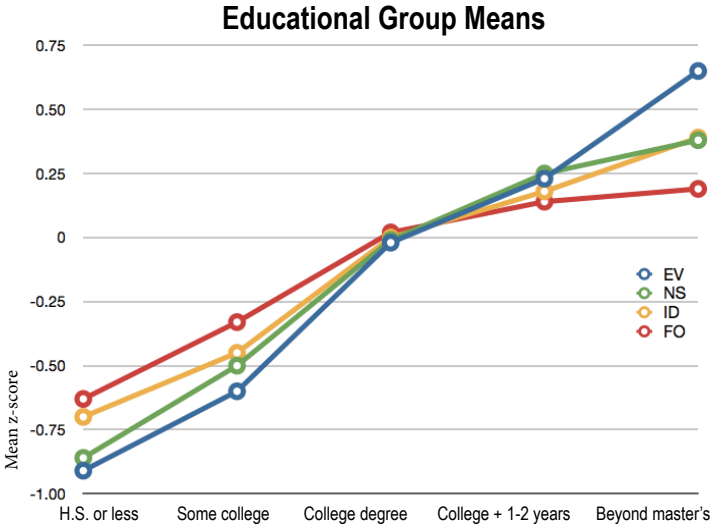
Images from MEG scans of brain activity on Paper Folding *(high vs. low)*.

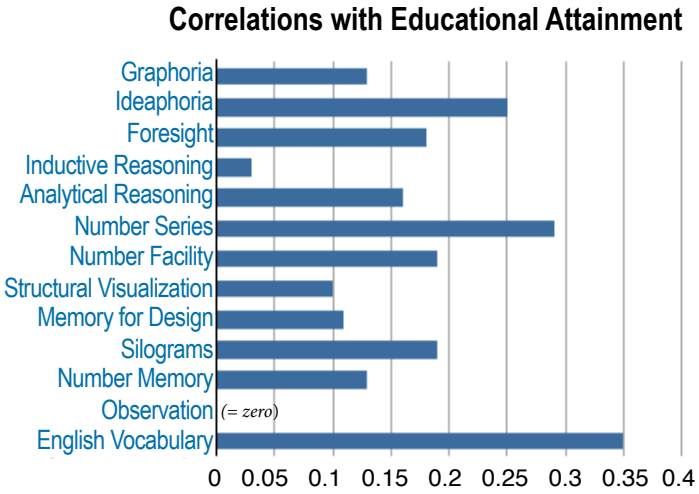
Jung has also embarked upon an ambitious study of "The Neuroscience of Scientific Creativity," with funding from the John Templeton Foundation. Ultimately, he will administer a battery of cognitive tests to 500 students and 70 professionals in STEM fields (Science, Technology, Engineering, and Mathematics), with 175 of the students and all the professionals to have MRI and DTI scans. The Johnson O'Connor Research Support Corporation provided funding for a preliminary study of 100 of the student subjects, which allowed Jung to assess the various measures making up the test battery (which includes several JOCRF tests) before beginning on the Templeton study itself, and gave us an opportunity to look at the correlations between our tests and a number of others.

Also in 2012, we published an article by Dr. David Schroeder, our Research Manager, Haier, and Dr. Cheuk Tang (another brain-imaging collaborator, from Mt. Sinai Medical Center) titled "Regional Gray Matter Correlates of Vocational Interests" in the journal *BMC Research Notes*. In this article, Schroeder et al. reported their analysis of the relationships between regional brain densities and scores on the Self-Directed Search (SDS), finding that two of the six SDS scales showed substantial relationships with brain densities: the Realistic scale, which measures interest in outdoor, blue-collar hands-on activities, along with some areas of engineering, and the Investigative scale, which measures interest in science and related activities.

Aptitudes and Educational Attainment

In 2012 David Schroeder completed a study of the relationships between the tests in the Foundation's battery and the educational attainment of our examinees. The strongest relationship was for English Vocabulary, with a correlation (r) of .35 with years of education. Examinees who scored in the top 10% on vocabulary averaged 2.3 more years of education than examinees in the bottom 10%. Number Series also showed a substantial relationship with years of education (r = .30), as did Ideaphoria (.25), Number Facility (.20), Silograms (.19), Foresight (.18), and Analytical Reasoning (.17). When the effect of English Vocabulary was statistically controlled, the other tests still showed significant (but smaller) relationships. Schroeder's report on the study was published as Technical Report 2012-1, *Aptitudes, Vocabulary, and Educational Attainment*.





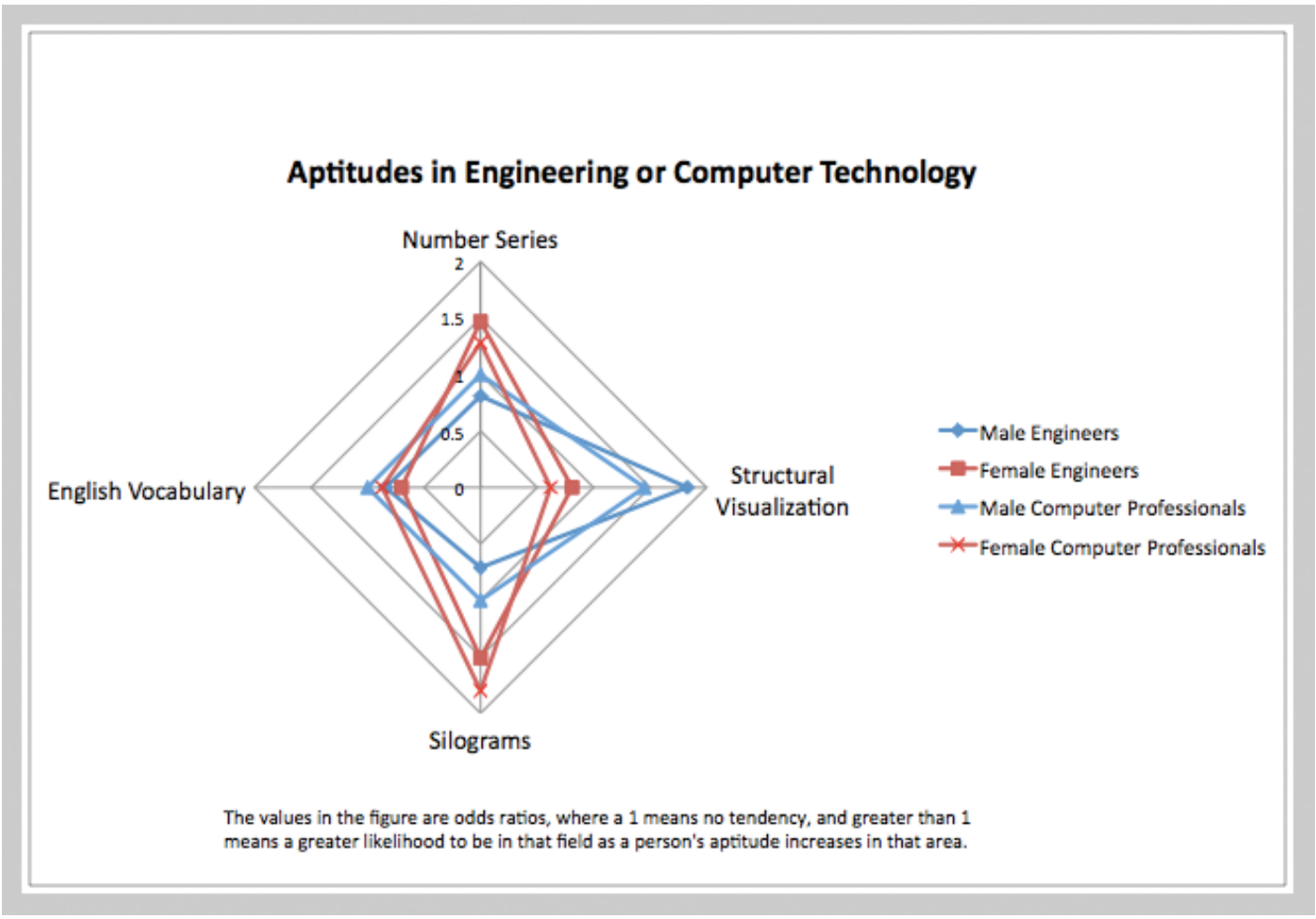
Aptitudes in STEM Fields

Enhancing education in the Science, Technology, Engineering, and Mathematics (STEM) fields in general, and for women and minorities, has been a current topic of interest for educators nationwide. We were curious to learn more about aptitudes for our clients who have reported that they work in a STEM field.

Dr. Linda Houser-Marko, Researcher in the Research Department, did a study that examined the aptitudes of former clients who were working in the fields of engineering and computer science/information technology to better understand characteristics of this aspect of the STEM fields. For this sample, the number of clients working in the sciences and mathematics was too low to make fair comparisons for those fields. We compared scores on several measures of cognitive aptitudes for adults working in engineering and computer science versus other employed adults, and for males versus females in these fields. As expected, we found that people working in engineering and computer science were similar to each other, and had higher Number Series and Structural Visualization scores compared to adults in general. Specifically, computer professionals (both male and female) and female engineers had the highest Number Series scores compared to the other groups. Male engineers had the next-highest Number Series scores. These results are shown in the form of odds ratios in the accompanying figure.

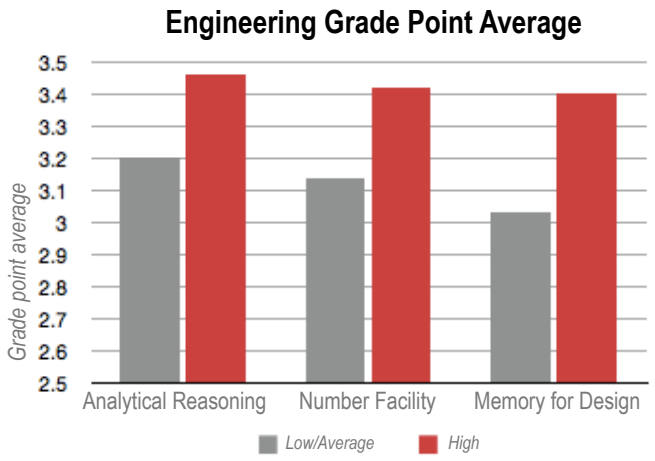
Further, males in computer science and engineering had the highest Structural Visualization scores. Female engineers also had higher-than-average Structural Visualization scores. High scores on Silograms (verbal-associative memory) for females in computer science and engineering stand out as a key difference compared to the men in those fields.

In sum, males and females who work in the same fields are similar in some ways and different in other ways. The importance of verbal-associative memory for females in computer technology and engineering could be explored more in the future. Houser-Marko reported these findings at the 2012 annual meetings of the Association for Psychological Science and the International Society for Intelligence Research.



Engineering Students

In 2012, Dr. Chris Condon, a former Research Department researcher who is now a consultant for the Foundation, and David Schroeder completed our study of engineering students at the University of Texas's College of Engineering. In this study, we tested the aptitudes of 256 freshmen in the engineering school and then followed them through their undergraduate experience. The students who successfully completed the UT program scored higher than the students who did not complete the program on a number of Foundation tests–namely, Analytical Reasoning, Number Series, Number Facility, Incomplete Open Cubes (a test of spatial ability), and both English and Mathematics Vocabulary. In addition, the students' grade point averages were correlated significantly with scores on Foresight, Number Facility, and Memory for Design, along with our two vocabulary tests, as illustrated in the accompanying figure.



Self-Directed Search

In 2012 David Schroeder continued to work on a series of studies of the Self-Directed Search (SDS), the vocational-interest test that the Foundation administers in conjunction with our standard aptitude battery. At the end of the year, he completed a technical report in which he recounted the studies: Technical Report 2012-3, *Four Studies of the Self-Directed Search*.

Previously, Schroeder examined the correlational structure of the six SDS summary scales and the relationships between the summary scales and the Foundation's aptitude tests. In addition, he and Richard Haier and Cheuk Tang, two of our collaborators on neuroimaging research, investigated regional brain densities and the SDS (see page 3). In 2012 Schroeder expanded this research in two directions. First, he looked at the relationships between the SDS scales and three demographic variables: sex, age, and the city where an examinee was tested. There are large sex differences on several of the scales, with males scoring 1.08 of a standard deviation higher than females on the Realistic scale. The age and city differences are relatively small.

In the other new direction in 2012, Schroeder analyzed the relationships between the Foundation's aptitude tests and the five components of the SDS scales—namely, (a) interest in various activities, (b) self-reported competencies, (c) interest in occupations, and (d) and (e) self-estimated abilities related to the given areas. In general, the correlations for the component scores showed similar results to the correlations for the summary scores. For example, for the Realistic area, the summary score correlated .36 with Structural Visualization, and the corresponding correlations for the components are .31 (Activities), .34 (Competencies), .23 (Occupations), .36 (Self-Estimate 1—Mechanical Ability), and .22 (Self-Estimate 2—Manual Skills). In contrast, the five components for the Artistic area correlate only .02, .06, .02, .04, and .08 with Structural Visualization.

Overall, the correlations between the SDS scales and our aptitude tests were fairly low, which is consistent with the distinctness of aptitudes and interests, and when there were substantial correlations, they usually involved interest in areas that make use of the given aptitude, such as such as Realistic interest and Structural Visualization or Conventional interest and Graphoria.

Sex Differences in Variability

In the past, we have often studied mean sex differences in areas such as structural visualization and graphoria. In recent years, outside scholars have discussed sex differences in variability (that is, in the spread of scores) and suggested that this may account for the high proportion of males at high levels of fields such as science and mathematics. If males have greater variability on, say, numerical tests, then one would expect to see a greater percentage of males in the high end of the score distributions, even if there is not a mean sex difference.

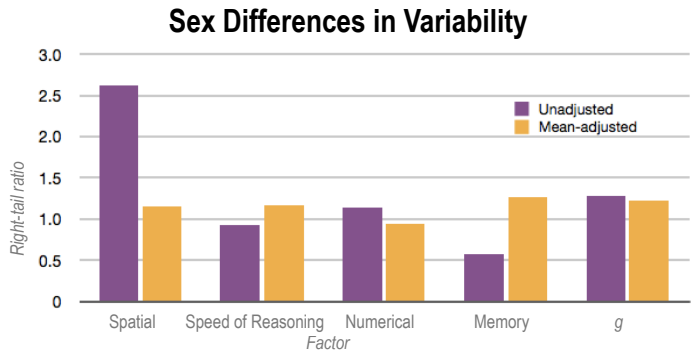
In 2012 David Schroeder conducted a series of studies on sex differences in variability and made presentations on this research at the annual meetings of the Association for Psychological Science and the International Society for Intelligence Research. In 2013 he expects to write up these studies in a technical report.

For Foundation examinees tested in 2008-2010, Schroeder found mean sex differences similar to those we have observed before on scales such as Structural Visualization and Silograms (verbal-associative memory). However, there were only modest differences in variability. For scores in the top 5% (the "right tail" of

the distribution), he found that the ratio of males to females was 2.6 for the Spatial factor in the Foundation battery and 0.6 for the Memory factor (see the accompanying figure).

When mean sex differences were statistically controlled, though, there were only small differences in the right-tail proportions, with ratios of 0.9 to 1.2. The results were similar for examinees tested in 1998-2000 and 1988-1990.

Thus, it appears that there are more males in the right tail of aptitude in some areas and more females in some areas, but this effect is largely attributable to the mean differences and not to differences in variability.



Inductive Reasoning

For several years the Foundation has conducted research on our standard Inductive Reasoning test and on new experimental items constructed by David Ransom, Steve Greene, and Tim Fitzgerald, directors of the New York and Boston offices. In addition, in 2009 Russell Burke, Research Chairman, administered a survey to Foundation test administrators requesting perceptions of items on the standard test that might be problematical. In 2012 the Foundation inserted ten of our more-promising experimental items into the standard test in place of some of the weaker or more-problematical items.

David Ransom and Tim Fitzgerald prepared the new test sheets, and Foundation staff began using the new form in November 2012. David Schroeder modified the existing test norms to accommodate the expected higher scores on the new items. In addition, Ransom modified previous items and designed new items to form a new set of 20 experimental items which were also administered beginning in November. Five are modified versions of the 10 rejects from the standard test, and 15 are new or revisions of earlier experimental items. Russell Burke and David Schroeder reported on the revisions to the standard test in Statistical Bulletin 2012-13, *Changes in Inductive Reasoning, Form 164 MB, Leading to Form 164 NA.*

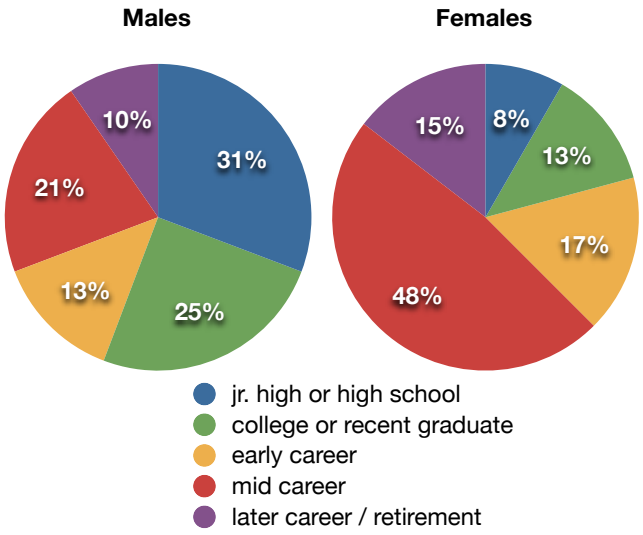
Alumni Study

Linda Houser-Marko reported the results of a study of former examinees who are currently over 65 years of age. Alumni participants were recruited through the Foundation's 2012 *Bulletin*, and more than 200 individuals responded either through an Internet survey or through the mail.

In general, the respondents were very satisfied with their testing and thought that the results were accurate. Three quarters of the respondents were under age 75. The average age of these clients when tested was 29 years old for men and 38 years old for women, a tendency noted by the Foundation in the past.

The mean rating for their own perception of how well their past job(s) fit with their aptitudes was 4.2 on a 5 point scale, and this was similar to and correlated well with their job satisfaction (r = .44). In other words, alumni perception that their work corresponded nicely with their aptitudes is related in some way to their job satisfaction, at least later in life. This notion could be tested more in the future.

These findings were reported in Statistical Bulletin 2012-16, *Results From a Study of Alumni Who Are Currently Sixty-Five Years Old or Older.*



In this study of older alumni, as mentioned above, females historically tended to be older when tested. Over half of males were tested in high school or college (or just after) compared to 21% of females. More than twice as many females came to us in mid career.

Earliest tested: male client, age 94, tested in 1936, architect. Oldest respondent: male client, age 100, tested in 1986 at age 74, owned insurance agency, retired in 1994.

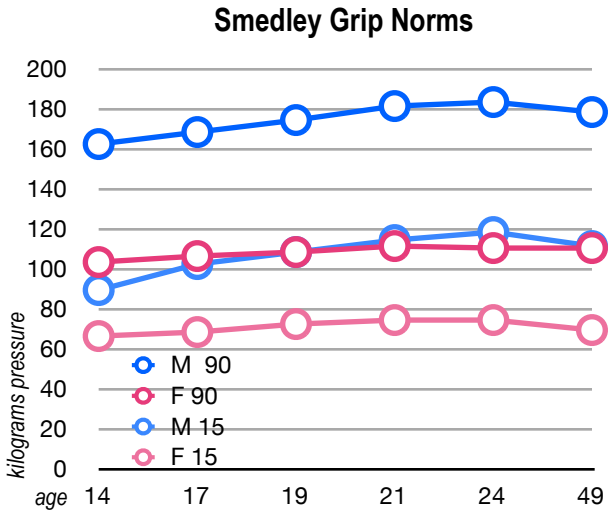
Additional Projects

Foundation staff made progress on a number of additional projects in 2012, and several of these are highlighted in this section.

Linda Houser-Marko and David Schroeder reported on various **demographic features of our testing population** in Statistical Bulletin 2012-12, *Demographic Information for 2008-2010 Examinees*. Examinees at the Foundation vary widely in age, with about half between the ages of 14 and 20, about one-quarter between 21 and 29, and the remaining quarter 30 and older. There are just a few more males than females. The majority of our examinees are highly educated—baccalaureate degree or higher—or plan to pursue higher education. Slightly over three-quarters of our clients report that their fathers had obtained a college degree or higher, and the majority of clients' mothers had as well. About twenty percent of clients who were working said they were dissatisfied with their most recent job, which might indicate that not all clients come in for testing due to job dissatisfaction. When clients noted a referral source, they cited a family member a little more than 50% of the time. A referral by a friend was another frequently mentioned source, 25% of the time. Indeed, the younger family members of clients who have tested with us previously seem to currently be a big part of our clientele.

David Schroeder analyzed data on the **long-term stability of the Foresight test**. Overall, the stability was moderately high, with an uncorrected coefficient of .64, which is comparable to the stabilities of other Foundation tests. He reported these results in Statistical Bulletin 2012-15, *Long-Term Stability for Foresight*.

For the **Grip test**, the Foundation began using digital Smedley dynamometers in place of the Jamar dynamometers that we had been using. New norms were produced and they are similar to the earlier norms. They reaffirm the dramatic spread in scoring between males and females, with females at the 90th-percentile scoring essentially equal to males at the 15th-percentile.



Amanda Summers, the assistant director for the Chicago testing office, and Linda Houser-Marko analyzed results for a **validation questionnaire** that was given in relation to our Foresight test. The questionnaire was developed based on discussions about what our summarizers often say about the Foresight aptitude. The questionnaire was administered to a sample of clients in the Chicago lab. One concept that stood out in the results was "seeing possibilities." The clients who endorsed items related to seeing possibilities were also somewhat likely—with a correlation of about $r = .17$—to have higher scores for the Foresight test. This concept, as part of the Foundation's notion of Foresight, appears to be supported at this point.

The results suggest that further examination of Foresight as "seeing possibilities" and other not-yet-tested concepts is warranted. The relationship of the test to long- and short-term goals may be a secondary, rather than a primary, effect. In any event, more about Foresight could be examined in the future. Summers and Houser-Marko reported their findings in Statistical Bulletin 2012-3, *Foresight Validation Study*.

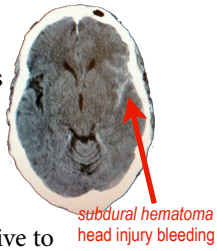
Scott Barsotti, from the Chicago testing office, and other staff members continued to collect data for a study of **theater artists**. By the end of 2012, 130 theater professionals had taken the entire Foundation battery, and 38 more had taken Word Association and the theater-artist validation questionnaire.

Barsotti, Russell Burke, and Linda Houser-Marko also conducted a study in which they examined the effect of **the feedback that examinees receive on their incorrect answers during the Inductive Reasoning test**. Specifically, they compared the response times for examinees who received feedback after each sheet versus examinees who did not receive feedback until the end of the test, and there was little difference in the times. Burke and Houser-Marko reported the results of the study in Statistical Bulletin 2012-17, *The Effect of Immediate Feedback About Errors on Examinee Response Times for the Inductive Reasoning Test*.

Scott Barsotti and Amanda Summers

Observations & Announcements

David Ransom - *President* - JOCRF - HEL - JOCRSC



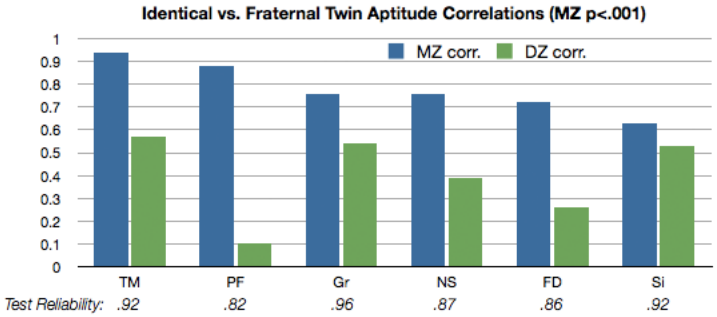
Ever since a June 2010 bicycle fall when I emulated Humpty Dumpty by getting a cracked noggin with blood flowing sideways in my brain, visions of brain images as part of JOCRF testing have danced in double in my head. Indeed, sometimes I see three. Testing twins and comparing aptitude test scores with other siblings was always attractive to Johnson O'Connor and those of us in his footsteps.

The Bouchard twin studies (see Google) dramatized to the general public how testing for individual differences finds such exciting exception when comparing identical twin test results. Individuals they may be, but their often virtually identical scores serve as markers for the heritability component of abilities.

Our study of familial resemblance by Dave Schroeder presented in 1995 at the APA addressed the inheritance component of the aptitudes we measure. As JOC wrote his first book with the title ***Born That Way***, he was persuaded that isolating aptitudes was a primitive path to isolating genetic characteristics. Mendel inspired him but the discovery of DNA, decoding the genome, finding physical evidence of the locations of brain activity in relation to performance on tests was all in the future beyond his time. We think our past work with twins and our supply of twins in our database can prove especially useful now.

When we look at twins in the future to see similarities of brain activity and relative density or other measures, we have some targets to aim for.

The chart below shows the difference in test correlations for identical (monozygotic) and fraternal (dizygotic) twins from 1995 (sample size of c. 25 per test). Just the twin correlations at the highest standard of probability are shown here; this selection of tests also evinces strong (split-half) reliabilities. Lower reliabilities would limit the possibility for matching test results. The pattern of higher correlations for twins with matching DNA over close familial resemblance fits the *Born That Way* vision. We will carry on studying aptitudes, now with the mind-brain integration of modern science.



I mentioned seeing triple visions on occasion. Some time ago our foundation had the rare opportunity to test a set of identical triplets. On the tests shown above, each had the identical 62/88 right on Tonal Memory, 85-75-85 percentile on Paper Folding, 5-20-15 on Graphoria, 40-20-30 on Finger Dexterity, and 25-30-60 on Silograms, the latter a somewhat anomalous result. Intriguingly, though, almost as tight a match as TM was Writing Speed at 149-140-147 raw score, so low as to guarantee below average Ideaphoria; they each had 5th percentile scores. Looking for the heritability of aptitudes is as urgent now in the face of so many blandishments to improve your brain by exercising and puzzle-taking as in the days of denial of genetics in nature vs. nurture debates.

To date the brain studies we have funded have used averaged results rather than focusing on individual differences. When we finally are able to advise our examinees using information from brain scanning and the like, we will need to know the individual's indicated potential to determine the proper interpretation, guided and directed as now by the particulars of personal background and questions and interests. Test scores for us are not the end result, just the starting point for providing useful interpretation to each unique individual in front of us. Well before the brain research JOCRSC is funding is able to tie into our standard testing program, we want to continue to share our wealth of data and test information with outside researchers who are making such exciting progress. That President Obama has recently announced major government funding for this type of brain research validates our last several years of smaller efforts in the same vein. Here is a flyer to recruit examinees for Rex Jung's twin project we will help fund. Let's get started!

Dissemination of Research Findings

As part of the Research Department's mission, in 2012 we continued our practice of presenting findings in scholarly outlets such as professional conferences and journals.

In December, the Foundation had a considerable presence at the annual meeting of the International Society for Intelligence Research (ISIR). David Schroeder presented a paper on "Gender Differences in Variability in Ability Factors Over Time." In this presentation, he examined the relatively modest contribution of male-female differences in variability to differences in scores at the high end of our tests.

Linda Houser-Marko and Schroeder also made a presentation on "Cognitive Abilities of Engineers and Computer Scientists," in which they addressed the aptitude patterns of people in those professions.

In addition, Rex Jung, one of our collaborators on brain imaging research with funding from the Johnson O'Connor Research Support Corporation, was responsible for several presentations, in conjunction with his research team at the University of New Mexico. In "Differentiation of Intelligence, Creativity, and Aptitude via Brain-Behavior Imaging," he presented data relating regional brain densities to Foundation test scores along with outside measures of intelligence and creativity. In "Subcortical Correlates of Aptitude," he and his associates examined the relationships between Foundation tests and regional densities of brain areas below the cortex, which have received little attention in brain imaging studies.

Finally, Richard Haier, another collaborator of ours on brain research, and Jung presented a paper on "Sequence and Speed of Information Flow Among Brain Areas During Problem Solving in High and Average Intelligence Individuals." In this paper, they presented second-to-second MEG data collected in 2012 of the brain areas activated while examinees take English Vocabulary, Inductive Reasoning, and Paper Folding test items.

Haier also received the ISIR's Distinguished Contributor award for his many accomplishments. In addition, Haier chaired two symposia on brain imaging and presented a paper on improving intelligence (from a skeptical point of view).

In other 2012 presentations, Houser-Marko and Schroeder made a presentation at the annual meeting of the Association for Psychological Science (APS) on their research on scores of examinees in science and technology fields. Schroeder also made a presentation at the APS meeting on his work on sex differences in variability.

In terms of scholarly articles, Schroeder, Haier, and Tang published an article on the relationships between regional brain densities and scores on the Self-Directed Search, the vocational interest test that the Foundation administers to its testing clients, in the journal *BMC Research Notes*. So far, this article has been viewed by 532 persons.

Our previous scholarly work continued to receive attention in 2012. Our 2010 article with Haier and associates in *BMC Research Notes* has now been viewed by 8,634 persons and is the seventeenth-most-read article in the journal's history. According to Google Scholar, our 2009 article in *Intelligence* with Haier and others has been cited in 29 scholarly journal articles and books. In addition, our 2010 article in *Intelligence* with Tang and others has been cited 11 times.

In terms of earlier publications, our 2004 article with Drs. Timothy Salthouse and Emilio Ferrer in *Developmental Psychology* has now been cited in 63 scholarly journal articles and books, and our article with Salthouse in *Personality and Individual Differences* has been cited 35 times. Our 2001 *Intelligence* article by Dr. Scott Acton, former research assistant in the Research Department, and David Schroeder has been cited 34 times.

Finally, in the 2012 volume of the widely read *Annual Review of Psychology* series, our 2004 article with Salthouse was cited in the chapter on cognitive aging, and our 2009 article with Haier and colleagues was cited in the chapter on intelligence.

Research Department Staff

Russell E. Burke, Research Chairman, also serves as Director in Washington, D.C. and is our senior summarizer and writer interpreting research information to the staff. An autodidact by inclination following a degree in Religious Studies at 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 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 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 University of Missouri. She has published research on the self, identity, and motivation.

Recent Technical Reports

2012-1	Aptitudes, Vocabulary, and Educational Attainment	*D. Schroeder*
2012-2	The Aptitudes of Engineering Students	*C. Condon, D. Schroeder*
2012-3	Four Studies of the Self-Directed Search	*D. Schroeder*
2008-1	Is the Flynn Effect Primarily a Rise in Structural Visualization?	*C. Condon, D. Schroeder*
2008-2	Memory for Design: Internal Characteristics and Validation Data	*D. Schroeder, C. Condon*
2007-1	Analyses of Fixed-Piece and Standard Administrations and Alternative Scoring Methods on the Wiggly Block Test	*D. Schroeder, C. Condon*
2005-1	The Aptitudes of Attorneys	*S. Goldman, D. Schroeder, K. M. Jang*
2003-1	The Aptitudes of Software Engineers	*R. Burke, T. Fitzgerald*

Recent Statistical Bulletins

2012-1	Research Proposal: Niceness of Perception	*Kurt Conover, Atlanta staff*
2012-2	Development of Norms for Grip, Wks. 185/186 FA	*Linda Houser-Marko, David Schroeder*
2012-3	Foresight Validation Study	*Amanda Summers, Linda Houser-Marko*
2012-4	Aptitudes of Ballet Dancers	*Holly Wilhelm*
2012-5	English Vocabulary, Foresight, and Years of Education	*David Schroeder*
2012-6	Research Proposal: Physical Therapists' Aptitude Study Phase I: Paper Folding, Memory for Design, Ideaphoria, and Word Association	*Christine McSchneider, Megan Terrazas*
2012-7	Equating Scores on Ideaphoria	*David Schroeder*
2012-8	Standard Errors of Measurement for the Foundation's Standard Battery of Tests	*David Schroeder*
2012-9	Construction of a 25-Item Vocabulary Test, Wks. 764*	*Rusty Burke, David Schroeder*
2012-10	Study Eliminating the Clipboard From the Wiggly Block Administration	*Kurt Conover, Rusty Burke*
2012-11	Study of *O: The Oprah Magazine*	*Dessie Berry, Casa Wilson, Hannah Waldman*
2012-12	Demographic Information for 2008-2010 Examinees	*Linda Houser-Marko, David Schroeder*
2012-13	Changes in Inductive Reasoning, Form 164 MB, Leading to Form 164 NA	*Rusty Burke, David Schroeder*
2012-14	The "Cold" Item on Inductive Reasoning, Worksample 164	*Rusty Burke*
2012-15	Long-Term Stability for Foresight	*David Schroeder*
2012-16	Results From a Study of Alumni Who Are Currently Sixty-Five Years Old or Older	*Linda Houser-Marko*
2012-17	The Effect of Immediate Feedback About Errors on Examinee Response Times for the Inductive Reasoning Test	*Rusty Burke, Linda Houser-Marko*

Recent Publications

Schroeder, D. H., Haier, R. J., & Tang, C. Y. (2012). Regional gray matter correlates of vocational interests. ***BMC Research Notes***, 5(1), 242. doi: 10.1186/1756-0500-5-242

Haier, R. J., Schroeder, D. H., Tang, C. Y., Head, K., & Colom, R. (2010). Gray matter correlates of cognitive ability tests used for vocational guidance. ***BMC Research Notes***, 3(1), 206. doi: 10.1186/1756-0500-3-206

Tang, C. Y., Eaves, E. L., Ng, J. C., Carpenter, D. M., Kanellopoulou, I., Mai, X., Schroeder, D. H., Condon, C. A., Colom, R., & Haier, R. J. (2010). Brain networks for working memory and factors of intelligence assessed in males and females with fMRI and DTI. ***Intelligence***, 38, 293-303.

Haier, R. J., Colom, R., Schroeder, D. H., Condon, C. A., Tang, C. Y., Eaves, E., & Head, K. (2009). Gray matter and intelligence factors: Is there a neuro-g? ***Intelligence***, 37, 136-144.

Schroeder, D. H., & Salthouse, T. A. (2004). Age-related effects on cognition between 20 and 50 years of age. ***Personality and Individual Differences***, 36, 393-404.

Salthouse, T. A., Schroeder, D. H., & Ferrer, E. (2004). Estimating retest effects in longitudinal assessments of cognitive functioning in adults between 18 and 60 years of age. ***Developmental Psychology***, 40, 813-822.

Recent Presentations

Houser-Marko, L. S., & Schroeder, D. H. (2012, December). *Cognitive abilities of engineers and computer scientists*. Poster session presented at the annual meeting of the International Society for Intelligence Research, San Antonio.

Jung, R. E., Frantz, J., Ryman, S., Carrasco, J., Shamiloglu, S., Vakhtin, A., Burke, R. E., Schroeder, D. H., & Haier, R. J. (2012, December). *Subcortical correlates of aptitude*. Poster session presented at the annual meeting of the International Society for Intelligence Research, San Antonio.

Jung, R. E., Ryman, S., Frantz, J., Carrasco, J., Shamiloglu, S., Vakhtin, A., Burke, R. E., Schroeder, D. H., & Haier, R. J. (2012, December). *Differentiation of intelligence, creativity, and aptitude via brain-behavior imaging*. Paper presented at the annual meeting of the International Society for Intelligence Research, San Antonio.

Schroeder, D. H. (2012, December). *Gender differences in variability in ability factors over time*. Paper presented at the annual meeting of the International Society for Intelligence Research, San Antonio.

Haier, R. J., Jung, R. E., Ryman, S. G., Frantz, J. A., Carrasco, J., Burke, R. E., & Weisend, M. (2012, December). *Sequence and speed of information flow among brain areas during problem solving in high and average intelligence individuals*. Paper presented at the annual meeting of the International Society for Intelligence Research, San Antonio.

Houser-Marko, L. S., & Schroeder, D. H. (2012, May). *Cognitive abilities of males and females who work in STEM fields*. Poster session presented at the annual meeting of the Association for Psychological Science, Chicago, Illinois.

Schroeder, D. H. (2012, May). *Gender differences in variability of specific cognitive abilities*. Poster session presented at the annual meeting of the Association for Psychological Science, Chicago, Illinois.

Houser-Marko, L. S., & Schroeder, D. H. (2011, June). *The association between objectively-measured and self-perceived abilities and educational achievement in adults*. Paper presented at the biannual meeting of the Association for Research in Personality, Riverside, CA.

Schroeder, D. H., Haier, R. J., & Tang, C. Y. (2010, December). *A comparison of the gray-matter correlates of vocational-interest and cognitive-ability scales*. Paper presented at the annual meeting of the International Society for Intelligence Research, Alexandria, VA.

Schroeder, D. H., Tang, C. Y., Eaves, E. L., Ng, J. C., Carpenter, D. M., Kanellopoulou, I., Mai, X., Condon, C. A., Colom, R., & Haier, R. J. (2009, December). *Brain networks for factors of intelligence assessed in males and females with fMRI and DTI*. Paper presented at the annual meeting of the International Society for Intelligence Research, Madrid.

Tang, C. Y., Carpenter, D., Eaves, E., Ng, J., Condon, C. A., Schroeder, D. H., Colom, R., & Haier, R. J. (2009, April). *Resting state networks and human intelligence: An fMRI study*. Paper presented at the annual meeting of the International Society for Magnetic Resonance in Medicine, Honolulu, Hawaii.

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