2007

Interest in physical science or social science as a function of intelligence

Adam Larson
San Jose State University

INTEREST IN PHYSICAL SCIENCE OR SOCIAL SCIENCE AS A FUNCTION OF INTELLIGENCE

A Thesis

Presented to

The Faculty of the Department of Psychology

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Adam Larson

August 2007

APPROVED FOR THE DEPARTMENT OF PSYCHOLOGY

Dr. Gregory Feist

Dr. Mildred Alvarez

Dr. Kevin Jordan

APPROVED FOR THE UNIVERSITY

ABSTACT

INTEREST IN PHYSICAL SCIENCE OR SOCIAL SCIENCE AS A FUNCTION OF INTELLIGENCE

By Adam Larson

This study examined the question of whether an interest in different domains of science could be explained by distinct domains of intellectual aptitude: physical intelligence ("thing orientation") or social-emotional intelligence ("people orientation"). An undergraduate sample of 67 students at San Jose State University (n = 67) was used. Physical intelligence was assessed by using the Autism Spectrum Quotient (AQ) with the Differential Aptitude Test (DAT) being used for mechanical reasoning. Social-emotional intelligence was assessed via the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT). Scientific interest was assessed by major (social versus physical science) and the Test of Scientific Related Attitudes (TOSRA). Results showed the physical science majors differ significantly on the AQ score, but MSCEIT and DAT scores did not differ significantly. In addition the number of physical science courses was significantly correlated to the DAT score for mechanical reasoning.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

What makes a person choose to study science as a career? There are many ways to approach this topic. People have examined scientists and scientific thought along with behavior from a historical perspective, drawing inferences about the time period when scientific thought first emerged. The nature of science along with scientific knowledge has been examined by philosophers who debate ideas about the correctness of logic in science. However, not until relatively recently have social scientists started investigating the psychological characteristics of scientists. With science being only one of many epistemologies that one could follow, are there psychological differences between people who choose science and those who do not? In particular, this study focused on two things: first, whether psychological traits of scientists are related to different domains of intelligence, and second, whether those differences in traits predict what kind of science someone may study (i.e., the social versus physical sciences).

This study is also meant to address another research question brought forth by Feist and Gorman (1998). After an exhaustive review of the psychology of science literature, these authors indicate that the one remaining question is whether the traits associated with scientists are inherent to a particular person or a byproduct of the person's career choice. This study attempts to answer this question via methodology that uses participants who are at the beginning of their scientific careers (i.e., undergraduate students).

Psychology of Science

Congruent with the field of the psychology of science, principles of psychology (in this case, intelligence, interest, development, and evolutionary psychology) are used to explain aspects of thoughts and behaviors of persons interested in the practice of science. In particular, this research examines a small portion of the psychology of science literature, specifically intelligence and career choice.

Feist (1993) first looked at personality traits that influence scientific eminence. The author was able to show that certain personality characteristics (i.e., hostile personality, arrogant working style, and extrinsic motivation) emerge as strong predictors of scientific eminence. The question raised in Feist's work concerns the nature and origins of personality traits. If it can be said that certain traits are inherent to persons who study science, then are these traits just a by-product of choosing science or a key factor that propels someone to study science?

To address this question, Feist (2006a) investigated the origins of the scientific mind in his study of Westinghouse Science Talent Search finalists and members of the National Academy of Science. Feist was able to show the Westinghouse finalists completed higher level degrees and achieved more honors in their respective fields than standard predictive averages. The importance of this research highlights the developmental aspect of choosing a career in science and allows us to ask the question whether certain traits predict a person's pursuit of a scientific career, and more importantly, what path in science that person may take.

Somewhat similar studies have been done to determine the characteristics that can predict an interest in science. Ware, Steckler, and Leslerman (1985) examined an incoming class of freshman regarding the difference in men's and women's decisions in choosing science. The authors looked at parental education, math SAT scores, measure of commitment to the choice, science affiliation, and need for power. This study is pertinent to the research at hand because it showed that sex differences affect choices in science, but even more importantly, because it was an initial study that started to look at predictors of science using psychological constructs such as need for affiliation and need for power.

Personality characteristics in general clearly play a role in career choice, including science. Bachtold (1976) designed a study to discriminate between personality characteristics of eminent female scientists and other professional women. The author studied the personality characteristics drawn from a 16-point scale that measured features such as warmth and intelligence and showed personality variables (i.e. sociability, conscientiousness, self-control, and tough mindedness) could predict membership in groups with a career interest. The importance of this study is that it marks the trend in the psychology of science to discover which personality traits are inherent to a group of scientists as compared to other professionals.

Although it is important to see that distinct personality characteristics exist among scientists, this study explores aspects of intelligence that may also be helpful in understanding scientists. Barton, Modgil, and Cattell (1973) researched the hypothesis that personality variables can predict interest in science. The assessments given were meant to examine 14 dimensions of personality. Much like the assessment used by Bachtold (1976), respondents were classified by polarized responses (i.e., reserved or detached versus warm headed and outgoing) (p. 6). The author found three of the given personality factors were related to scientific interest: "Self-sufficiency," "Ego-Strength," and "Intelligence." This is an important introduction of the idea of intelligence as a predictor of scientific interest. However, the study's definition of intelligence only minimally addressed the different aspects of intelligence, with the examination being done using a 14-item personality assessment scale that simply measured self-reports of perceived intelligence, while exact clarification of intelligence is needed to determine whether it plays a role in predicting scientific interest.

One domain of intelligence that is a point of interest for this research is social intelligence, as having ability in social-emotional intelligence should be related to developing an interest in a social science (e.g., psychology, sociology, or anthropology). One recent study examined emotional intelligence as related to undergraduate major (Seaman et al., 2007). In their study of archival data at the University of Nevada Las Vegas, the researchers compared mean scores from the Mayor-Salvoy-Cursuso Emotional Intelligence Test (MSCEIT) with groups they had segregated by major as to liberal arts or science. However, they were not able to show that students classified as to their respective majors differed significantly in scores obtained on the MSCEIT. Although this study did not reveal any difference in emotional intelligence by major, the problem may lie in an unclear definition of *science*. Thus this study has chosen to examine only those majors that heuristically are very distinct rather than look at the overly general liberal arts and science majors by more specifically comparing physical science to social science majors

Domains of Intelligence

One of the important aspects of this study is the assumption that intelligence exists within a cluster of distinct abilities rather than an aggregated total score. Two opposing schools of thought are used to explain intelligence. Wechsler (1944) defined it as "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" (p. 3). This conceptualization of intelligence which was first discussed by Spearman (1904) and later Binet (1905) served as the basis for the g-factor conceptualization of intelligence. Within this framework, the abilities of a person (e.g., music, math, creativity) are aggregated into one domain: global functioning. Even under Wechsler's definition, this idea encompasses phenomena such as behavior and thinking and interprets them as the ability to be utilized in an environment.

However, the opponents to this singular theory or g-factor define intelligence as not one singular domain, but a collection of individual domains. Gardner (1983) in his "Frames of Mind" describes seven working domains of intelligence: Visual/Spatial, Musical, Verbal/Linguistic, Logical/Mathematical, Interpersonal, Intrapersonal, and Bodily/Kinesthetic Intelligence. In line with Gardner's theory, a person is born with all seven intelligences; however a person may be stronger in one domain than another. For example, an athlete may excel due to a greater body awareness, but may lack spatial abilities because of an overdependence on visual acuity. This more dynamic view of intelligence attempts to encompass all the abilities at person may possess, and unlike singular intelligence, considers each ability that is useful in a given environment.

Similarly, Feist (2006b) argues for seven folk domains of mind or intelligence: psychology, physics, linguistics, mathematics, biology, art, and music. The two most relevant to the current study are folk or implicit physics and psychology. Implicit physics "concerns the inanimate world of physical objects (including tools); their movement, positioning, and causal relations in space; and their inner workings (machines)" (Feist, p. 165). Implicit psychology or social intelligence is the "ability to recognize and infer our mental and emotional state as well as those of others, even when their beliefs and emotions differ from our own" (p. 162).

Feist (2006b) argues that we all possess implicit stories about how the world works, with these stories being used to explain all seven domains of intelligence. His basic idea relevant to the current study is that folk physics and psychology are the foundation for more advanced and systematic interest and ability in the physical and social sciences respectively. According to Feist, a person interested in physical science should have a cognitive disposition that uses spatial intelligence to solve problems, whereas social (psychological) intelligence should be associated with persons who possess a social cognitive disposition. The field of science a person chooses should then be congruent with how that person solves problems inherently.

Sternberg (2002) elaborates on an even more complex view of intelligence that looks at it not as a single domain or multiple domains in general, but as domains of successful intelligence. Sternberg highlights his studies of the inherent intelligence of

Kenyan children that is useful for their success, finding that traditional intelligence tests do not reflect an applied intelligence while traditional intelligence testing does not transfer to real-world or applied intelligence.

Sternberg (2002) then defines four domains of successful intelligence. The first is a definition of intelligence for a person in a given culture. Sternberg's argument is that although there is much environmental influence, a person inherently possesses the ability to choose a successful intelligence. The second domain is the type of intelligence he defines as analytical, creative, and practical. The third domain is an applied ability that is an intelligence to adapt to the environment. Finally, Sternberg argues for a domain that encompasses the ability to execute applied intelligence, which he defines in three aspects as capitalization on strengths, correction of weaknesses, and compensation for weakness.

Sternberg's arguments are mainly based on research that looked at cross-cultural studies finding that persons in a group were able to use one kind of intelligence (in many cases mathematics) if it were inherent to their survival; however, when faced with the same mathematical problems in a more abstract form, the person was unable to understand them. Sternberg introduces a fresh and more complex view that defines intelligence by the practical ability to apply a skill, with the function of intelligence as being success.

In integrating current views of intelligence for the purpose of this study, there are two major categories, *physical* and *social* intelligence. Physical intelligence or "thing orientation" is the embodiment of spatial and mathematic intelligence, with both characteristics being meant to get at the core of what may explain a person's choice of a physical science. This factor involves applied tasks such as being able to imagine three-dimensional chemical structures or the amount of material needed for a construction project.

In comparison, social intelligence and its applied factor of "people orientation" is meant to encompass the kind of intelligence one would expect to find in a person who studies human thought and action. The hypothesis is that a person would need to possess applied abilities of basic understanding of human emotion to choose a career in this field. As this understanding is drawn from intra- and interpersonal intelligence, the researcher would expect to see that someone who chooses social science has a better affinity to recognize and properly react to emotions elicited from another.

Tests for Assessing Various Domains of Intelligence

The Mayer-Salovey-Caruso Emotion Intelligence Test (MSCEIT) is used to assess a person's overall emotional understanding. The MSCEIT asks participants questions that involve recognition of faces with emotional affect. As the test is also meant to assess emotional integration, participants are asked to choose emotions that are similar or dissimilar to a given emotion. In addition, the MSCEIT assesses emotional understanding and management. For the purpose of the research question, the MSCEIT is meant to represent intra- and interpersonal intelligence. The researcher expects to see that people who choose a career field in the social sciences possess higher levels of emotional intelligence and therefore stronger interpersonal skills than those in the physical sciences.

In contrast to emotional understanding, to assess physical intelligence, this study uses the DAT-Mechanical and the Autism Spectrum Quotient (AQ). In the DAT-Mechanical, a participant views a pictogram of gears, weights, and pulleys while being asked different questions about the direction of travel interactions with other cog systems (i.e., which is heavier or more difficult to pull). The researcher for this study expects to see that people majoring in physical science possess stronger abilities to see and solve mechanical reasoning problems with the difference being significant when compared to those in the social sciences. For example, an engineering major should be better at seeing an open space and being able to imagine a solution to that space using materials.

Tests for Autistic-Like Traits as Related to Physical Intelligence

Based on the idea of intelligence as being domain specific and consisting of multiple components, as an index of physical intelligence this study also incorporated the degree to which a person may or may not possess autistic-like traits such as Aspergers syndrome. This is meant to examine inter- and intrapersonal intelligence and relate it to scientific interest. In this study, the readily available Autism Spectrum Quotient or AQ (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) was chosen. This scale is not meant to be a clinical diagnostic tool but rather a way to measure the range of a person's autistic-like tendencies from severe to mild. Autism is defined as deficits in social and communication development accompanied with repetitive behaviors and limited imagination (Baron-Cohen et al.). According to Baron-Cohen et al., these traits exist along a continuum and can range from severely impaired to high functioning. Aspergers is a disorder based on the autism spectrum that can be defined as autism with no evidence of a language problem. In particular, the interest for this study is in the non-clinical and milder forms of higher functioning autism known as Asperger syndrome.

Baron-Cohen et al. (2001) set out to normalize the AQ scale and examine whether these autistic traits may be found in varying levels among professional scientists. They looked at scores of professionals including scientists and liberal arts professionals. The first group consisted of more traditional science-oriented persons, such as those pursuing careers in physical science, biological science, mathematics, computer engineering, engineering, or medicine. Baron-Cohen et al. compared these results with the second group, which consisted of professionals in the humanities (i.e., classics, law, languages, philosophy, or English). In addition, they included a sample from the social sciences (sociology, psychology, anthropology, land economy, and management). They found that the highest mean scores were attributed to the physical science participants while social science and humanities did not differ from each other. This work evidences that having Aspergers or being "thing-oriented" may well be a hallmark of physical scientists.

Recently Austin, Evans, Goldwater, and Potter (2005) conducted a factor analysis to determine whether one's particular undergraduate major (physical science, social science, or classics) related to AQ scores. Their study consisted of 201 participants drawn from an undergraduate pool. Researchers classified the participants by type of major, then administered the AQ. Austin et al. found that the analysis did hold up for Austin's three-dimensional model, as differences in scores existed between the groups with physical science majors being the highest.

Tests for Scientific Interest

In addition to the categorical determination of an individual's major, a more continuous measure of scientific interest can be gauged by measuring a person's attitudes toward science. Given science is the focus of this research; attitude may play a role in the choice of career. The researcher expected to see that persons who choose science have attitudes that reflect values congruent with science such as recognizing the value of replication and avoiding falsafiability. Furthermore, the researcher was interested in seeing if a particular orientation as to "people" or "thing" holds these values more for one than the other. To examine these phenomena, the researcher used an objective measure of attitude toward science, the Test of Scientific Related Attitudes (TOSRA) developed by Fraser (1981). Although it is a seven-scale inventory, the hypothesis at hand is relevant to only four scales relating to the kind of science in which a person may be interested: Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. As scaled down, this measure allows this research to assess each person's attitude toward science in general and may be able to confirm the hypotheses by comparing interest scores from both groups.

Hypotheses

The hypotheses are: (a) that social or physical science majors differ significantly on measures of domain intelligence, and (b) that a relationship exists between a person's major and domain of intelligence. In addition, the researcher hoped to draw inferences concerning whether domain intelligence applies to science career interest. In the sample, the researcher assumed that a declaration of a major is a strong indicator of scientific career interest. Therefore the factor or grouping variable will be a dichotomous variable, with the participant being declared either a physical or social science major. In this study, physical science majors are limited to engineering, chemistry, biology, and physics, while social science majors are limited to psychology, sociology, and anthropology. Finally, the researcher used the TOSRA to attempt to confirm the hypothesis by comparing each group's scores, expecting to see that both groups possess an equal and marked interest in science.

CHAPTER TWO: METHOD

Design

The non-experimental study at hand involves one independent variable, major (social or physical), and three dependent variables as measures of intelligence (AQ, MSCEIT, and DAT mechanical). This study's hypothesis is that each test is a measure of a domain of intelligence and that each domain is discrete and its own phenomenon. Therefore data will be analyzed separately with an individual one-way ANOVA and correlations.

Participants

Participants consisted of 65 college undergraduates from San Jose State University aged 18-35. Introductory Psychology students from San Jose State University were solicited from the psychology subjects' pool there via an open research announcement. Participants were asked to volunteer 90-120 minutes of their time at a designated classroom for the purpose of participating in a research study at the San Jose State campus in which they would complete four questionnaires. Sessions were held with an average of 6 students per session with the students being only those with declared majors in either social or physical science. There were a total of 28 men and 37 women in the study. Ethnicity was roughly representative of the SJSU undergraduate population, with 9% African American, 31% Asian, 11% Hispanic, 9% Pacific Islander, 6% Middle Eastern, and 23% European American. Student data were then placed in either a Physical or Social group depending on the declared major ($n = 28$ physical science; $n = 37$ social science). As participants were all from Introductory Psychology courses, they received compensation in the form of credit by their respective instructors for participating in the study. There were no more risks or discomforts expected with this study than may normally occur in daily life.

Procedures

Only on the consent form were names directly linked with ID numbers; on all other data collection forms, only IDs were used to identify participants. Raw data and consent forms were handled only by persons directly involved with this study, with data being kept in the office of Dr. Gregory Feist, Professor of Psychology at San Jose State University, Room 313, in a key-locked cabinet that can be accessed only by Dr. Feist.

Administration of the inventories took place in groups during scheduled times on campus. Students interested in participating were asked to sign up for a given administration time that lasted 90-120 minutes. Each session was proctored by one of two researchers from this study. During this time participants were asked to complete the Autism Spectrum Quotient (AQ), Test of Scientific Related Attitudes (TOSRA), and the Demographic Interest Questionnaire by hand and the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) and the Differential Aptitude Test (DAT)-Mechanical online.

Instruments

The battery of questionnaires consisted of: (a) one standard San Jose State University informed consent form (Appendix A); (b) one demographic and interest questionnaire and abilities survey (Appendix B); (c) the DAT, AQ, MSCEIT, and

TOSRA; and one questionnaire inquiring as to the person's declared major, GPA in major and overall GPA, academic club affiliations, and job expectations after college.

Autism Quotient Test (AQ)

The AQ is a 50-item paper-and-pencil survey designed to assess a whether a person possesses more or less autistic characteristics (Baron-Cohen et al., 2001). Sample questions for the AQ consist of "I prefer to do things with others rather than on my own," with participants then being to report a response on a 1-4 Likert scale as "definitely agree," "slightly agree," "slightly disagree," and "definitely agree." The AQ has shown strong reliability with moderate-to-high internal reliability. Cronbach's alpha within its five domains are communication = .65, social = .77, imagination = .65, local detail = .63, and attention switching = .67 (Baron-Cohen et al.).

Emotional Intelligence: Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)

The MSCEIT is an abilities test of emotional intelligence consisting of four subtests: Identifying Emotions, Facilitating Thought, Understanding Emotions, and Managing Emotions (Mayer, Salovey, & Caruso, 2002; Palmer, Gignac, Manocha, & Stough, 2005). Examples of items include asking the participant to view a photograph of a face and report the given emotion expressed on the face. In addition, participants are asked to pick from a list of appropriate emotional responses to a given scenario.

Scoring of responses is carried out in two ways: consensus and expert. Consensus scoring compares an individual's answers to a large group of people, so that if 80% of people coded a face as "happy," then that would be the best score. In expert scoring, individual responses are compared to those of emotion experts (currently 21 members of the International Society for Research on Emotions). The scoring for participant data in this study was coded online from a third party administrator with raw scores then being used in the analysis.

Differential Aptitudes Tests (DAT): Mechanical Reasoning

The Differential Aptitudes Test or DAT: Mechanical Reasoning (Bennett, Shore, & Wesman, 1974) was used as the measure of physical intelligence. This is a timed test in multiple-choice format. The DAT Mechanical Reasoning measures a person's understanding of mechanical apparatuses and principles. It consists of 45 pictorial problems and is timed at 20 minutes maximum. Each picture depicts a physical or mechanical situation and asks whether the outcome will be A, B, or C, with C being "either." The pictures most often depict gears, pulleys, or weights. For instance, the picture will show the direction of one gear (A) with an arrow with the question being "What direction will a different gear (B) move?" Other questions concern weights and pulleys and ask which is easier or harder to move, or show wheels on a car axle turning around a curve or different sizes of wheels and ask which will spin faster.

Scientific Interest and the Test of Scientific Related Attitudes (TOSRA)

The TOSRA is a 70-item inventory consisting of seven scales (Fraser, 1981); however for the present purposes, only four subscales were administered: (a) the Adoption of Scientific Attitudes, which measures the extent to which a participant places importance on scientific attitudes of open-mindedness and willingness to revise one's opinion; (b) the Enjoyment of Science Classes, which measures "enjoyment of science learning experiences"; (c) the Leisure Interest in Science, which measures the "development of interest in science and science-related activities"; and (d) the Career Interest in Science subscale, which measures "interest in pursuing a career in science." Each subscale consists of 10 items rated on a 5-point Likert scale ("strongly disagree," "disagree," "not sure," "agree," and "strongly agree"). For example, participants are asked if they would rather conduct a study or just have someone tell them the result. Cronbach's alpha for our sample was .94, which shows strong internal reliability for measuring interest in science for a sample.

CHAPTER THREE: RESULTS

The means were assessed from the physical and social science majors to determine differences in intelligence test scores. A total of 65 participants participated in this study, 57% of whom were declared social science majors while 43% were physical science majors. By chance, the ratio of men to women in each major was distributed unequally (χ (1) = 12.31, p <.01; see Table 1 below). The descriptive statistics on the key variables were broken down by physical and social science major (see Table 2 below). Data obtained on the various tests are presented in Table 3 below.

Analysis of Variance

The hypotheses were that physical science majors would have greater physical intelligence (DAT-Mechanical Reasoning and Autism Spectrum Quotient/AQ) than social science majors, and that social science majors would have higher emotional intelligence (MSCEIT-EQ) than physical science majors. To test these hypotheses, three one-way ANOVAs where conducted as well as correlations with the number of classes taken and the three outcome variables (DAT, EQ, and AQ).

For the ANOVAs, the grouping variable was the major while the outcome variables were DAT, EQ, and AQ. The results showed that physical and science majors differed significantly on the AQ $F(1,63) = 6.39, p < .01$, with physical science majors showing higher average scores on the AQ. This finding supports our main hypothesis that physical science majors are more inclined toward a "thing-orientation."

Table 1

*Gender * Major Cross Tabulation*

		Major		
		Physical Science	Social Science	Total
Gender	Male	19	9	28
	Female	9	28	37
Total		28	37	65

Table 2

Demographics by Major

		Gender		Total
		Male	Female	
Major	Physical Science	19	9	28
	Social Science	9	28	37
Total		28	37	65

The DAT-Mechanical result showed a trend that approached significance with $F(1,48) = 3.82$ $p = .056$. As hypothesized, the physical science majors tended to perform better on mechanical reasoning than did social science majors. The MSCEIT average scores showed no significant difference with $F(1,48) = .13$, p = n.s.; see Table 4 below.

In addition to ANOVAs on the dichotomous grouping variable of major, Pearson correlations were conducted on the continuous variables of number of classes taken in the physical and social sciences and the three outcomes of intelligence scores. The results showed one significant finding related to our research: the number of physical science classes taken was significantly related to the score on the DAT Mechanical with $r(49) = .41$, $p < .01$. To further examine the relationship between scientific interest and major, a point bi-serial correlation was calculated between major "physical" or "social" science and interest in science using the TOSRA. Results showed no significant relationship between major and total career in science interest, leisure interest in science, or attitude toward scientific interest; see Table 5 below.

Table 3

Descriptive Statistics Major by Predictors

		N	Mean	Std. Deviation
DAT Raw Score	Physical	23	31.48	6.54
	Social	27	27.56	7.49
	Total	50	29.36	7.27
Emotional Intelligence Standardized Total	Physical	23	99.09	19.57
	Social	27	97.22	16.80
	Total	50	98.08	17.96
AQ Total Score	Physical	28	18.54	4.94
	Social	37	15.38	5.02
	Total	65	16.74	5.19

Table 4

Correlations of Intelligence Test Scores and Number of Classes

	Physical Science Classes	Social Science Classes	DAT Score	EQ Score
Number of Physical Science Classes	--			
Number of Social Science Classes	0.68	--		
DAT Raw Score	0.41**	0.23	--	
Emotional Intelligence EQ	0.16	0.08	0.06	--
AQ Total Score	0.05	-0.19	-0.04	-0.06

** Correlation is significant at the 0.01 level (2-tailed).

Table 5

Correlations for Test of Scientific Interest

	Major	Career Science Interest	Leisure Interest in Science	Attitude to Scientific Inquiry
Major	--			
Career in Science Inter.	0.20	--		
Leisure Inter. in Science	0.10	0.66**	--	
Attit. to Scientific Inqu.	0.10	0.41**	0.40**	--

** Correlation is significant at the 0.01 level (2-tailed).

Discussion

Results gave partial support to the initial hypotheses and also allowed for recommendations to be made for future research. This study was able to show that incoming freshmen in physical or social science majors differ in scores on the autism spectrum. It was also found that persons who major in physical science have higher mean scores of autistic traits than social science majors, perhaps due to the domain of intelligence needed to pursue a physical science career. It may be that the person who chooses physical science has an inherent aptitude for thing orientation, and therefore selects a profession that matches this intellectual orientation. In contrast, in the case of those with more social science or "people-oriented" abilities, the student goes on to choose a people-oriented major and profession.

The implication that persons who study physical science show higher levels of high functioning autistic traits over social science majors extends into the academic world and beyond. Teachers should recognize that some persons in physical science may learn better when dealing with mechanical rather than social topics. In addition, universities and businesses could recognize these results in their personnel recruitment and expectations of work results as it may be that for these persons, less interactiveness could lead to better results than working in a group environment.

Moreover, the results suggest that the more physical science classes students take, the better they are at solving mechanical reasoning problems. One of two arguments can be made for the finding that those who have taken more physical science classes are better at mechanical reasoning. The first is that education in physical science enhances a person's performance on mechanical reasoning. However, another explanation and the one supported by this study's author is that the number of classes produces attrition within its sample, and what is left is a more skewed sample of those who possess the intelligence qualities that would be expected in professionals within the physical sciences.

As the DAT-Mechanical results were close to significant, it is assumed that given an appropriate sample size and power, one might see that mechanical reasoning can discriminate between the science majors. If future research does show this, then researchers would be better able to define what kind of intelligences make up the physical scientist and then gear training for the disciplines toward more mechanical reasoning programs.

However, this author must point out that these results alone do not answer the question of the origins of scientific thought. It would be ideal to say that persons who choose physical science inherently possess spatial intelligence and autistic traits. Science can begin to build support for the origin of scientific interest by examining the level of career stage of our participants.

The MSCEIT findings on emotional intelligence showed no support for the hypothesis. However, there are two important points to make about this finding. First, it was not possible to gather what would be considered a sufficient sample size to rule out the possibility of there actually being a difference between the two sciences on emotional intelligence. The effect size was small, and even a larger sample may not have yielded any significant effect, but power was not ideal in this sample. Second, initially this study meant to address the emotional intelligence of professionals in science. It may be that emotional intelligence may be more of an effect than a cause of interest in social science with the difference being more pronounced later in the participants' careers. With the freshman sample used, the participants' major is not completely established so collecting these data from older students or professionals would be a cleaner test of the hypothesis. The main caveat concerning these results therefore lies in the sample of the study, as first-year students in an entry-level university psychology class may not fully represent the true population of social and physical scientists.

In addition, this study was unable to account for the confounding effect of gender and major. Gender was significantly confounded with major, with more women being in the social science group. One problem with gender and these two areas of science is that the population frequencies are inherently skewed. Only about 17% of the PhDs in engineering and 35% of the PhDs in the physical sciences are awarded to women, whereas nearly 50% of the PhDs in the biological and social sciences were awarded to women (Feist, 2006b; Long, 2001). In psychology, the percentage of female PhDs in 1995 was 73% (Feist, 2006b). Future research should control for this effect or limit generalization to gender populations.

The strength of this research is to allow for a broader and more varied definition of intelligence that incorporates an applied aspect from a certain field of science. The conflicting results in our emotional intelligence domain, significant AQ means, and non-significant MSCEIT helps define the construct of people orientation. If this study's findings are applied, one may see a difference in what it means to be knowledgeable of emotion as in the case of the MSCEIT, or having the ability or the motivation to apply that knowledge as measured in the AQ.

The next step in this line of research will be to use people more advanced in their majors or professional scientists as a better way to understand what intelligences are inherent to physical and social science. Controlling also for gender and field of science, new research will show a better understanding of domains of intelligence, evolution of scientific thought, and interest in science. However, by addressing these and other limitations, research on the psychological nature of interest in the distinct domains of science can tell us a lot about the psychology of science.

References

Austin, E., Evans, P., Goldwater, R., & Potter, V. (2005). A preliminary study of emotional intelligence, empathy and exam performance in first year medical students. *Personality and Individual Differences, 39*(8), 1395-1405.

Bachtold, L. (1976). Personality characteristics of women of distinction. *Psychology of Women Quarterly, 1*(1), 70-78.

Baron-Cohen, S., Wheelwright, S., Skinner, M., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (QA): Evidence from Asperger syndrome/high functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*(6), 603-603.

Barton, K., Modgil, S., & Cattell, R. (1973). Personality variables as predictors of attitudes toward science and religion. *Psychological Reports, 32*(1), 223-228.

Bennett, G., Shore, H., & Wesman, A. (1974) *Manual for the Differential Aptit*ude *Test.* New York: The Psychological Corporation.

Binet, A. (1916). *The development of intelligence in children.* Baltimore: Williams and Wilkins.

Feist, G. (1993). A structural model of scientific eminence. *Psychological Science, 4*(6), 366-371.

Feist, G. (2006a). The past and future of the psychology of science. *Review of General Psychology, 10*(2), 92-97.

Feist, G. (2006b). *The psychology of science and the origins of the scientific mind.* New Haven, CT: Yale University Press.

Feist, G. & Gorman, M.E. (1998). The psychology of science: Review and integration of a nascent discipline. *Review of General Psychology, 2*(1), 3-47.

Fraser, B.J. (1981*) Test of Science-Related Attitudes (TOSRA)* Melbourne: Australian Council for Educational Research.

Gardner, H. (1995). Reflections on multiple intelligences. *Phi Delta Kappa, 77*(3).

Long, J.S. (Ed.). (2001). *From scarcity to visibility: Gender differences in the careers of doctoral scientists and engineers.* Washington, DC: National Academy Press.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2002). *Mayer-Salovey-Caruso Emotional Intelligence Test: User's manual*. Toronto, Canada: Multi-Health Systems.

Palmer, B., Gignac, G., Manocha, R., & Stough, C. (2005). A psychometric evaluation of the Mayer-Salovey-Caruso Emotional Intelligence Test Version 2.0. *Intelligence, 33*(3), 285-305.

Seaman, K., Zhong, C., Beecher, S., Brehman, B., et al. (2007) Emotional intelligence: Comparing science and liberal art students. Poster session at the WPA, Vancouver Canada.

Spearman, C. (1904). 'General intelligence,' objectively determined and measured. *American Journal of Psychology, 15*(2), 201-293.

Sternberg, R. (2002). *Intelligence is not just inside the head: The theory of successful intelligence*. San Diego, CA: Academic Press.

Ware, N., Steckler, N., & Leserman, J. (1985). Undergraduate women: Who chooses a science major? *Journal of Higher Education, 56*(1), 73-84.

Wechsler, D. (1944). Wechsler Intelligence Scale for Adults. Baltimore: Williams and Wilkins.

Appendix A

Informed Consent Form for "Interest in Physical or Social Science as a Function of Intelligence"

Agreement to Participate in Research

Responsible Investigator(s): __Adam Larson___________________
Title of Protocol: Personality and Science

You have been asked to participate in a research study investigating predictive factors of scientific interest.

1. You will be asked to *complete four questionnaires that measure your interest in people and things and a demographic survey.*
2. *No risk or discomfort to you as the participant is expected during the completion of this study.*
3. No discernable direct benefit other than compensation may be expected to you the participant from completion of this study.
4. *Alternative procedures N/A.*
5. Although the results of this study may be published, no information that could identify you will be included.
6. *For you participation in this survey after completion you will be rewarded (one) $5 dollar gift certificate good for food purchases at San Jose State concessions.*
7. Questions about this research may be addressed to *Adam Larson (406) 531-4656 or Dr. Gregory J. Feist (408) 925-5617.* Complaints about the research may be presented to Dr. Sheila Bienenfeld Chair of Psychology Phone: 408-924-5600. Questions about a research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2480.
8. No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose to "not participate" in the study.
9. Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. You have the right to not answer questions you do not wish to answer. If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with San Jose State University or with any other participating institutions or agencies.
10. At the time that you sign this consent form, you will receive a copy of it for your records, signed and dated by the investigator. The signature of a subject on this document indicates agreement to participate in the study. The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.

Appendix B

Demographic Questionnaire for Participants in "Interest in Physical or Social Science as a Function of Intelligence"

ID Code ________

Predictive Factors of Science Interest

We are currently investigating the development of scientific interest. As a part of our study we would like you to answer the following questions about your academic experience. Your responses will be kept confidential and only persons directly involved in this study will have access to your responses. In order to maintain your confidentiality if this study is published your data will be coded by id number and your name will not be presented in any report of findings.

In the space below please provide the following information:

Gender________ Age_______ Major: ___________________________
How many courses in physical science (physics, chemistry, astronomy, geology, or engineering) have you taken at the University?__________
How many courses in social science (psychology, sociology, anthropology) have you taken at the University?______
Your birth-order (e.g., first, second, etc): ___________________
What is the age gap between you and your next older sibling (months)?____________
What is the age gap between you and your next youngest sibling (months)?____________
Ethnicity:_____________________________
Number of Generations Father's Family in US: ______________________
Number of Generations Mother's Family in US:_________________

Answer the appropriate question using the rating scale below. Answer each item by marking the number in the blank line that best corresponds to your reason.

1 = "completely false"
2 = "somewhat false"
3 = "neither true nor false"
4 = "somewhat true"
5 = "completely true"

What led to your decision to study science in college?
____ High degree of motivation in the topic
____ Satisfies my curiosity
____ Solves important problems
____ Science helps humanity
____ It matches my talents and skills
____ I am good at it
____ Aesthetically appealing and satisfying
____ I like the rigor and logical nature of the material
____ Financial support while in school (through loans or family)
____ High degree of intellectual interest in the topic
____ Encouraged by family, friends, or mentors
____ Financial security
____ Other________________________

In the space below please list any academic or professional organization that you are a member.

____

____

To the best of your knowledge what is your current GPA.

Overall GPA ______ In major GPA ______

What is your career expectation after you graduate?

____