

**The Missing Element: A Discussion of Autism Spectrum Disorders in  
Computer Science**

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## **Abstract**

Autism Spectrum Disorders (ASD), a neurodevelopmental disorder, is characterized by significant impairments in social communication and interaction. Encouraged by advocates who are unaware of industry changes, many young adults find themselves pursuing careers in computer science. Recent changes to the industry, many of which place a greater demand on social communication and interaction, have left individuals with ASD frustrated. Struggling to find what may have once been the “perfect” job, the workplace environment has become increasingly difficult for those with ASD to navigate. This study examined the possible prevalence of individuals with ASD in computer science courses.

## **Keywords**

Autism Spectrum Disorders, computer science, social skills, SCRUM, Extreme Programming

## **Introduction**

The birth of a child fosters renewed faith in humanity and hope for the future. Parents envision birthday parties, dances, graduations, weddings, and grandchildren as the traditions of the family pass through the generations. What happens to those hopes and dreams when that child receives a diagnosis of autism spectrum disorder (ASD)? With approximately 50,000 adolescents diagnosed with autism turning 18 years old on a yearly basis, parents desperately seeking answers find limited population-based evidence that sheds light on educational and vocational outcomes for these young adults.

According to the fifth edition Diagnostic and Statistical Manual, published by the American Psychiatric Association, Autism Spectrum Disorder is defined as a “neurodevelopmental disorder” with the following characteristics: “Severe and pervasive impairments in reciprocal social communication and social interaction (verbal and nonverbal); and restrictive, repetitive patterns of behavior, interests, and activities.” (DSM). Baron-Cohen <sup>1</sup>, of Cambridge University, has proposed that children and adults with ASD have distinctive deficits in what he refers to as “theory of mind (TOM).” Theory of Mind is described as “the ability to put oneself into someone else’s shoes, to imagine their thoughts and feelings <sup>1</sup>.” Finding the social and nonverbal cues of others frustrating and unpredictable, individuals with ASD struggle to internalize information readily available to their peers and are often referred to as having “mind-blindness. <sup>1</sup>” This mind-blindness presents as the inability to notice and respond to nonverbal cues such as facial expression and changes in voice inflections. The individual with ASD can experience problems with social interactions as simple as exchanging pleasantries and working collaboratively with other professionals can be challenging. It is easy to understand why frustrated parents of children diagnosed with ASD challenge the status quo and fight diligently to provide their children with the opportunities to learn life skills necessary for independence in adulthood.

Temple Grandin <sup>4</sup>, one of the more famous individuals with ASD and a strong vocal advocate for the rights of those living with autism, has written about employment opportunities within the autism population. When speaking to audiences, Grandin breaks down jobs into two categories: (1) positions that require strong visual/spatial learning skills or visual thinking, and (2) positions

that do not require strong visual thinking but rely heavily on skills such as mathematics, music, or fact memorization.<sup>8</sup> Individuals with ASD who demonstrate poor social skills and a strong desire for repetition or rituals, should be encouraged to sharpen their skills in specialized fields where social challenges go largely unnoticed in favor of talent that may be difficult to find in the general population. For example, when expertise in highly demanding fields such as engineering, science, and math are obvious, many employers are willing to overlook oddly inappropriate social skills or habits.<sup>4</sup> This push for students with ASD to enter professional and technical fields that can mesh with their particular challenges has been a long-standing practice, especially since the early 1990s.

## **Computer Science**

Computer Science is the art of teaching a computer what to do. It is the study of theory, experimentation, and engineering that form the basis for the design and use of computers. Unlike electrical and computer engineers, computer scientists deal with software and software systems, including their theory, design, development, and application. Computer scientists work largely with the code, or language, used by computers to execute tasks.

In its earliest times, particularly in the 1940s through the early 1960s, computer programming was considered a reasonable female career choice. The attitude was that hardware was for men, and unglamorous and low paid programming was for women.<sup>7</sup> Attending to the social trends, magazines such as *Cosmopolitan* urged their readers to consider employment in the field of computer programming. However, as the importance of programming rose, the salaries rose, and men started becoming programmers. The biggest reduction in the numbers of women in Computer Science (at least in the United States) occurred when the personal computer and computer games arose. Simple video games such as shooting and pong were marketed toward boys and men, and “computers are for boys” became a common assumption. The percentage of women in Computer Science was at a peak of about 37% in 1985, and by 2011 this had fallen to 17%. While society was supportive and encouraging, male programmers wanted to enhance their status and eventually professional organizations were formed that lobbied for the hiring of males rather than females. Many companies advertised the ideal programmer as “someone who displayed a disinterest in people” and disliked “activities involving close personal interaction,” thus birthing the stereotypical nerdy, anti-social geek.<sup>3</sup>

Stemming from the male movement into computer science, these employees tended to work in isolation, only meeting briefly with other employees to pass information or briefly consult on projects. Starting in the late 1990s, and gathering increased attention today, the traditional document heavy industry processes are being replaced with what is known as the “agile process.” Two well-known agile processes are Extreme Programming and Scrum.

Extreme Programming, commonly referred to as XP, gained significant interest in the software community between 1990 and 2000. The overall goal of XP is to reduce the cost of changes in requirements by having multiple short development cycles, rather than one long one. Putting computer scientists together to work as joint teams is believed to foster an environment where changes are a natural, inescapable and desirable aspect of software-development projects, and should be planned for, instead of attempting to define a stable set of requirements. Extreme

programming also introduces a number of basic values, principles and practices on top of the agile programming framework.

Designed to work best with three to nine-member teams, Scrum is the process in which computer scientists break their work into fixed duration cycles known as “sprints.” Each sprint is characterized by the formulation of a master plan with smaller short-term goals. These sprints are tracked through daily 15-minute “stand up meetings.”

Although knowing how to program is essential to the study of computer science, it is only one element of the field. Principal areas of study within Computer Science include artificial intelligence, computer systems and networks, security, database systems, human computer interaction, vision and graphics, numerical analysis, programming languages, software engineering, bioinformatics and theory of computing. Computer scientists design and analyze algorithms to solve programs and study the performance of computer hardware and software. The problems that computer scientists encounter range from the abstract-- determining what problems can be solved with computers and the complexity of the algorithms that solve them – to the tangible – designing applications that perform well on handheld devices, that are easy to use, and that uphold security measures.

Labor statistics from the U.S. Department of Labor in 2012 point to significant unemployment percentages for young people. With increased difficulty in gaining employment, adolescents and young adults with ASD find additional difficulty with sustaining employment<sup>10</sup> with most studies finding between 20% and 30% of the ASD population unemployed.

In 2014, Wei, Christiano, Yu, Blackorby, Shattuck and Newman<sup>9</sup> reviewed the largest and most comprehensive data set available to date. This data set, known as the National Longitudinal Transition Study-2, included information about high school and post-secondary experiences for more than 11,000 students. Approximately ten percent of these were identified as having a disability that required special education services under the Individuals with Disabilities Education Act. Of these, 660 individuals were identified with ASD. As part of this study, the research team reviewed the data and after conducting a descriptive analysis and a pairwise comparison between disability groups and chi-squared tests within the ASD group, they found that 34% of those with ASD were enrolled in a STEM related major. In addition, 12% of this group was enrolled in a computer science degree program. Seeking to compare these findings to the overall population, the research team found that individuals with ASD were more likely than their overall peer group to concentrate in science (12% v. 8%) and specifically, more likely to major in computer science than their overall peer group (16% v. 6%).

## **Methodology**

### **Participants**

Upon approval from the university, three sophomore and upper division summer computer science courses were identified as our recruitment pool. The overall sample was a selected based on convenience and easy access to the instructional time. Participants in this study were students of sophomore, junior, or senior status who had a declared major in computer science.

## Instrument

The Gilliam Autism Rating Scale: Third Edition is a psychometrically sound instrument that was initially developed in the first edition to meet the growing need for reliability and accuracy in the identification of individuals who could possibly be on the autism scale. After initial positive public attention in 1995, the scale was recommended for use by most state education agencies. However, despite praise, some questioned the use of a probability score. Such concerns were taken into consideration when the authors of the scale revised the GARS in 2006 to create the second edition.

The second edition of the Gilliam Autism Rating Scale required less time to administer and included the use of interview questions. In addition, the 2000 Census was utilized to update the assessment norms and new guidelines were established for interpreting scores. Despite minor criticisms, the GARS continued to be reviewed favorably.

In 2013, the GARS was once again updated to create the utilized GARS-3. The third edition is comprised of six subscales and 58 Likert-type questions. Subscales and questions were revised to reflect both the 2012 Autism Society of America's definition of ASD and the most current diagnostic criteria found in the Diagnostic and Statistical Manual- 5 ed.: SDM-5 American Psychiatric Association. <sup>1</sup> To accomplish this, sixteen original items were retained and 42 new items were added; subtest names were altered to reflect the DSM-5 headings, subscales were added, and new normative data was collected.

After undergoing four different independent studies, the correlation coefficients between the GARS-3 and four other ASD assessment instruments provide compelling evidence for the validity of the GARS-3 criterion-prediction. In order to subject the GARS-3 to additional scrutiny, a series of binary classification and receiver operating characteristics under the curve analyses were conducted. Results demonstrated the effectiveness of the GARS-3 in predicting ASD.

Designed to be completed either as a questionnaire or as a structured interview, each rater completes the instrument on the response form with a writing utensil. Raters are asked to respond to each of 58 observable and measurable behavior statements by circling a response from zero to three with zero indicating not at all like the individual, one being not much like the individual, two being somewhat like the individual, and three being very much like the individual.

## Procedure

Participants were selected based on their enrollment in junior and/or senior science course work that was taken during the summer months. The students were presented with an informed consent letter identifying the purpose of the study as an investigation of student learning characteristics. Completion of the survey constituted participant consent.

The GARS-3 protocols, consisting of 58 items, were folded open and stapled so that students could access only the Likert items being used for study. Students were instructed to read each statement and decide whether the item did not describe them, was not much like them, was somewhat like them, or if the statement was very much like them. Each protocol was assigned a

random number that was utilized to count the instruments and assure that all protocols were returned. Students were not asked to provide any identifying information.

Upon completion, protocols were collected and secured until scored. First a total raw score was tabulated for each of the six subscales. Using the appendix provided in the Examiner's Manual, these raw scores were then converted to scaled scores and percentile ranks. Percentile ranks indicate the percentage of the normative sample that is equal to or below the percentile obtained. Scaled scores for subscales were obtained by applying a direct linear transformation to a raw score to obtain the distribution with a mean of 10 and a standard deviation of 3.

Scaled scores for the subscales are totaled to calculate an overall composite score known as the Autism Index. Appendix B in the Examiner's Manual provides the examiner with the corresponding Autism Index and percentile rank. The Autism Index composite score yields a different type of standard score with a mean of 100 and a standard deviation of 15. The greater the Autism Index score, the more significant the behaviors and characteristics and the higher the probability that the participant is on the autism spectrum.

## **Results**

After removing incomplete protocols, there were a total of 60 responses: 19 scored in the very likely category (32%) and another 30 in the probable category (50%). This means that 82% scored either probable or very likely ASD.

## **Discussion**

According to the Centers for Disease Control (CDC), one in 68 individuals is now diagnosed with an Autism Spectrum Disorder. Living longer and aging out of public K-12 school, greater numbers of young adults with ASD are now enrolling in colleges and universities. While many individuals may choose to register with their institution of higher learning's office of disability services many do not. In instances when someone does register, university employees are struggling with what and how to provide support and accommodations to the ASD population on campus.

The initial interest in this study stemmed from the above described situation. Expressing frustration, multiple faculty members on a moderate sized university campus in the southern United States, began contacting disability services and administration. Anecdotally, they described students who paced, spoke out of turn, perseverated on topics and were unable to work collaboratively with classmates. In many stories they described young men who dominated classroom discussions with single unrelated statements or those that when assigned to complete group projects struggled with the fluidity of meeting schedules or group discussions. Frustrated by the inability to assist or guide these students to success, faculty flounder and students' frustrations increase.

In the article *It's Open Secret: Asperger's Syndrome has been part of IT for as long as IT has existed. So Why Aren't We Talking About It?*, author Tracy Mayor<sup>6</sup> interviewed multiple adults diagnosed with ASD. These adults described "Aspie's" as "bubbling along the bottom or doing very well at the top." Specifically, those interviewed discussed how individuals with ASD

often excel at data entry or execution of concrete skills only to fail when they are promoted to positions that require increased ability to navigate social settings.

Grappling to understand the potential concentration of individuals enrolled in computer science courses, this study utilized a reliable and valid ASD screening instrument to calculate the number of individuals who would meet the DSM criteria for ASD characteristics.

### Limitations

While this study has significant implications for providing a “real-time” glimpse into how prevalent ASD could be in a computer science program, this study is limited by the small sample size. The use of convenience sampling and the small sample size, limits the extent to which the researchers can generalize the results across the computer science student body.

### Conclusions

Despite the study’s limitations, the initial pilot data gives reason for additional research to be conducted. Similar to Wei, Christiano, Yu, Blackorby, Shattuck, and Newman’s<sup>9</sup> findings, this study also supports the commonly accepted assumption that individuals with ASD are very likely to major in Computer Science. Additional research should be conducted to determine the degree to which this is due to self-selection versus being encouraged toward this major by high school guidance counselors and parents who may not be aware of how the industry has been shifting toward more social and interactive programming teams. Further research is also needed to determine whether and, if so, the degree to which, the change in the industry toward social and interactive teams negatively affects individuals with ASD who have Computer Science degrees in acquiring and retaining employment. For such individuals with ASD who are successful in acquiring and retaining employment, further research would also be required to determine if they are relatively happy with their employment situations or, alternately, if their employment is a significant stressor in their lives relative to individuals in the same positions who do not have ASD. In addition to needing more data regarding the prevalence of ASD in Computer Science programs, additional research should be conducted regarding best practices and instructional strategies that could be utilized by college professors. Educating university faculty on instructional strategies and visual supports could enhance the educational experience of all participants in the classroom.

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## **Biographical Information**

### **Whitney Wayne Meade**

Dr. Meade completed her undergraduate studies at the University of Alabama. Completing the requirements to obtain dual certification in K-6 and 6-12 special education, she began her career as a special education teacher. With research interests in the area of autism spectrum disorders, she returned to UA to obtain her Master's degree in Innovative Leadership and later her Ph.D. in Autism Spectrum Disorders and Behavior with a minor in Criminology from Auburn University. She is currently employed as an Assistant Professor at the University of Alabama in Huntsville. Current research efforts include students with autism at the university level and adjudicated youth. She has presented at all levels and continues to provide ASD training to professionals.

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Dr. Letha Etzkorn is a Professor and Associate Chair in the Computer Science Department at The University of Alabama in Huntsville. She earned her master's degree and PhD in computer science from The University of Alabama in Huntsville, and bachelor's and master's degrees in electrical engineering from the Georgia Institute of Technology, Atlanta, Georgia. Dr. Etzkorn has published more than 100 peer-reviewed research papers and has received more than \$4.1 million in grants and contracts as a principal investigator or co-principal investigator from federal agencies including the NSA, the NSF, NASA, and the U.S. Army. Some of her major research areas are in software engineering, and cybersecurity.

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Dr. Huaming Zhang is an associate Professor in the Computer Science Department at The University of Alabama in Huntsville. He earned his master's degree and PhD in computer science and engineering from State University of New York at Buffalo. Dr. Zhang has published a dozen peer-reviewed journal articles and conference papers. He received two NSF grants. Some of his major research areas are in algorithm design and analysis, and deep learning. He has taught numerous courses at both the undergraduate and graduate level.