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Predictors of College Readiness for Students with Autism Spectrum Disorders

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Abstract: *More youth with Autism Spectrum Disorders are transitioning into a post-secondary environment than ever before. These individuals have been found to be unemployed and under enrolled in school at disproportionately high levels. This problem is compounded by the fact that even when students on the spectrum make it into college, their graduation rates are far lower than those of neurotypical students. In an attempt to better predict these students' likelihood of success in college, this study used multivariate regression analysis to compare current college readiness measures. Despite universal declines in the measure after transition, high school grade point average was found to be far more predictive than American College Test (ACT) scores and all demographic control variables. This finding challenges the efficacy of the current reliance on standardized test scores as a metric of preparedness in the post-secondary admissions process for students on the Autism Spectrum.*

Keywords: *Standardized Tests, Autism Spectrum Disorder, Higher Education Admissions, Multiple Regression Analysis, ACT Scores*

I. Introduction

Autism Spectrum Disorder (ASD) is a life-long developmental disorder characterized by "persistent impairment in reciprocal social communication and social interaction, and restricted, repetitive patterns of behaviors, interests, or activities" [1] A massive growth in diagnoses has been reported over the last twenty years as a result of rising public cognizance and diagnostic specification [2]. Recent broadening of definitions may be resulting in an increase in diagnosis; however, a total rise in the number of individuals on the spectrum cannot be ruled out entirely[3](CDC, 2014). The increase in diagnosis of ASD over the past two decades has resulted in an increased number of these young individuals transitioning into adulthood [4](Shattuck, et al., 2012). This demographic shift has catalyzed a plethora of troubling quantitative work examining this critical period. Of particular concern is recent data which indicates these students have significantly lower rates of employment and college participation post high school than students of the same age group with speech and language impairments, learning disabilities, and cognitive delays [4]. This finding coupled with the fact that young adults on the spectrum generally have a harder time than neuro-typical students holding paid employment and seeking post-secondary education [4], provides a robust justification for further study into their experiences transitioning into adulthood and potential barriers accessing opportunities.

In the fall of 2014 total enrollment in post-secondary educational institutions surpassed 17.7 million students representing a 48% increase from 1990 [5]. Despite this oversaturation, data has shown that a completed degree of any kind is highly beneficial for both the individual and society, on average yielding a full time worker 84% more earnings over a lifetime than a comparable individual with only a high school diploma [6]. Functionally, institutions of higher education prepare students for the world by developing their skill sets in two ways: content mastery and general abilities [7]. Unfortunately the indirect nature of labor force preparation at institutions of higher education makes it difficult for students on the spectrum to capitalize on the wage premium their degree would afford an individual without autism [2]. Even so, for individuals with ASD, participation in post secondary education is not as lucrative, but is still correlated with higher earnings, and yet, a low percentage of these individuals actually take advantage of this opportunity [8] Transition planning for a post-secondary education environment is particularly problematic for youth on the spectrum, who have been shown to have a greater than 50% likelihood of complete disengagement for two years post-graduation [4] More specifically, research has shown that young adults on the spectrum face robust difficulties gaining access to employment even when compared with cognitively disabled individuals of the same age[9] More troubling is the fact that students from a low socioeconomic background have an even further decreased likelihood of participation in post-secondary educational opportunities which mirrors the larger wealth disparity that affects all post-secondary education participation rates [4] Overwhelmingly, current research indicates the growing

post-secondary education complex that is otherwise providing wage premiums for a growing proportion of the populace is leaving behind students on the spectrum.

Each student on the spectrum has unique strengths and weaknesses [10] and like neuro-typical students, there exists a distribution of students ranging from gifted to severely challenged [3]. Despite this variance, an overwhelming majority of individuals with ASD display mild forms of the disorder, and yet, academic research tends to focus on severe iterations of ASD [2]. Currently very little is known about what practices best faciltiate academic success for these students [11] and this places a large burden on society in terms of unmaximized human capital [12]. How society progresses economically is largely dependent on our ability to prepare the next generation for leadership through higher education (Hiss & Franks, 2014). One specific area where students with ASD are over represented in the status quo is in Science, Technology, Engineering, and Mathematics (STEM) enrollment [13] giving these individuals a unique set of interests that are in demand in the 21st Century [11]. While ASD is considered a lifelong diagnosis with no cure [3] there is potential for improvement in ASD-related symptoms and behaviors [14] making it critical to identify factors that influence post-secondary educational attainment among these individuals.

It is clear that individuals with ASD are facing barriers gaining access to higher education, but simply attending college is only half the degree equation. As of 2012, the rate of graduation after six years for all individuals who began college seeking a bachelor's degree from a four year accredited institution in a full time capacity was 59%[15]. The cumulative negative impact of the students who failed to graduate is in the billions of dollars each year in lost personal income, tax liability, and government appropriations [16]. Various theories have emerged to identify factors impacting graduation rates including but not limited to level of integration, individual perceptions of the institutional setting, social life, bureaucratic polices, and emotional intelligence [17]. Such a large disparity in the number of students, who enter college, and those who complete it, suggests that the process by which institutions selects applicants is antiquated.

Since the turn of the 20th century college entrance exams have exploded in popularity with nearly three million high school seniors a year taking either the SAT or American College Test (ACT) [18] making them a primary tool in the college admissions process. Despite this growth, college entrance exams have been shown to be an inaccurate predictor of college readiness when compared to high school grade point average (HSGPA)[19]. The overwhelming popularity of college entrance exams as a predictor of college readiness may limit the availability of a degree for many individuals [19] diverting minority students away from academia [18]. In particular, highly selective institutions have an increasing number of applicants each year but maintain a finite number of seats. This has the twin effect of increasing the average test score needed for admittance and decreasing the number of minority students attending these institutions [18] .

In the context of ASD, many students on the spectrum learn and display content proficiency in very different ways [3] that a single test may fail to capture. Standardized tests can be uniquely problematic indicators of college readiness for these individuals because they have been shown to perform better in settings where they are familiar with the individuals assessing them [20]. This is problematic because familiarity is far more likely in a high school or college classroom than a standardized testing facility. In addition, students with ASD may experience inflexible adherence to routines and rigid thinking patterns as well as overly literal interpretations of content [1] all of which could contribute to poor scores on standardized tests. More specifically, research shows that for high school students with disabilities no significant correlation exists between critical thinking and practice college entrance exams, even though critical thinking is what is actually necessary for individuals to be productive members of society [21].

While many problems persist at post-secondary institutions for students on the spectrum, the growth in personal computing, information technologies, and social networking have empowered students on the spectrum with tools to support executive functioning and social interaction [22]. This may indicate that individuals with ASD can be successful in postsecondary institutions [2] despite deficiencies in standardized test scores. The limited literature suggests the status quo reliance on college entrance exams, as a primary predictor of college readiness for individuals on the spectrum may be problematic. The aim of the present study was to determine the efficacy of relying on standardized tests and HSGPA in admissions decisions for students on the spectrum.

II. Method

II.1 Participants

All data used in this study were collected from college students at the same mid-size regional public university who participated in a college support program for ASD (n=102). The support program generated a unique concentration of individuals attending the same university, reducing the effect of self-selection bias that would otherwise make it impossible for a simple cross sectional analysis to control for value added by any particular university [7]. All individuals in the study were diagnosed using guidelines articulated in the fourth edition of the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders.* The sample was fairly homogenous with an overwhelming number of men (87.3%) who entered college at an

average age of 19 years old. Data were collected on all years from 2008 to 2014 with a higher density representing the latter half of the range. Most majors available on campus were present in the sample with computer science being particularly well represented.

Descriptive statistics were calculated for all variables used in the study and in depth results are listed in Table 1. The average completion rate for the students in the sample with a terminal status (n=49) was 28.6%, far below the average of 59% calculated by the National Center for Education Statistics (2014) or the 42.43% graduation rate of the 2007 fall semester cohort at the sample university [23]. GPA differential was another troubling indicator with an average drop of .89 points out of 4 from high school to college for the whole **sample (n=102).**

Table 1				
Descriptive Statistics				
Variable	*Mean*	*Std. Dev.*	*95% CI*	
Completion	0.286	0.0652	0.1546	0.4168
ACT	22.46	0.5361	21.397	23.524
Pass	0.706	0.0293	0.6488	0.7652
CollegeGPA	2.18	0.1027	1.982	2.3896
HSGPA	3.08	0.0556	2.9697	3.1903
GPADiff	-0.894	0.0957	-1.0841	-0.704
InStateStatus	0.461	0.0496	0.3624	0.5592
Gender	0.127	0.0332	0.0616	0.1933
EntryAge	19.06	0.1197	18.821	19.296
Note. N = 102. CI = confidence interval				

II.2 Proxy Variables

College readiness has been defined tautologically as "An accumulation of knowledge and experiences that prepare students for college" [24]. Various measures have emerged to access this nebulous variable in the admissions process. This study tested the efficacy of two: ACT scores and HSGPA. The primary measure used to access the validity of college readiness exams in the status quo is the proximal indicator first year college grade point average [7](Stemler, 2012). However, for the present research the concept of readiness was operationalized into two distal dependent variables: college GPA and percentage of classes passed. The long-term nature of these dependent variables may better explain the terminal impact on graduation of relying on ACT scores and HSGPA in the admissions process. Completion status was not used because the initial sample included individuals who had dropped out, graduated, transferred, and remained in school at the university where data was collected. Completion status is the most valuable variable to predict because it represents the terminal impact of all academic activities in a college career. Unfortunately, completion status can only be utilized properly in a regression analysis if measured as a binary variable, which has the effect of reporting transfer and in progress students as false negatives. Thus to maximize the amount of observations available for analysis, college GPA and pass percentage were selected as proxies for completion. The graduation requirements for all university attendees in the sample included attainment of 120 hours and at least a "D" in non-major classes and a "C" in major classes. Since graduation was largely dependent upon cumulative success in individual classes, and that successes was largely captured by college GPA and pass percentage, it was hypothesized that completion would be highly correlated with the proxies. Dividing the number of hours passed by those attempted and remained a decimal throughout analysis derived pass percentage. The university's Office of Institutional Research provided data for all variables used in the study.

II.3 Independent Variables

Five different independent variables were used in various regression analyses with HSGPA and ACT scores representing the variables of interest and gender, in state status, and entry age as demographic controls. HSGPA was calculated as the un-weighted cumulative grade point average on a standard four point scale with an "A" counting as four points and an "F" counting as zero. The average HSGPA for the sample was 3.08 with a standard deviation of 0.562. ACT Score was the unadjusted ACT score for each participant. Scores ranged from 12-34 with 22 being the most frequent (11.8%) score. Some individuals (n=5) only had SAT scores and for these cases a web service was used for conversion with a 1030 on the SAT equating to a 22 on the ACT [25]. Gender was a binary dummy variable that was associated with the sex of the student. "One" was defined as female with "zero" defining a male. An overwhelming percentage of the sample was male (87.3%). In state status was a binary dummy variable that defined the geographic location of each guardian's primary residence. "Zero" was defined as living in the state where the test university was located and "one" was all other states. The sample size was fairly even on this measure with 53.9% living in the state. All individuals had domestic primary residences. Entry age was a derived value that was calculated by subtracting the year a student was born from the year they entered the university. Students in the study ranged from seventeen to twenty three years of age upon entry with eighteen (30.4%) and nineteen (42.2%) being the most common ages.

III. Results

III.1 Analysis of Proxy Validity

The sample used to test the validity of the proxies included only individuals who had achieved a terminal status (n=49). Isolating observations to those with a terminal status was necessary because students who are still attending college or have transferred (n= 53) are necessarily unable to provide data on completion status. Using the truncated sample, independent sample *t*-tests were used to compare the means of the proxies to completion status. As shown in Table 2, both proxies were shown to be positively correlated with completion status, and both were statistically significant at all confidence levels. Individuals who graduated were shown to have, on average, a 1.6-point higher college GPA and passed an average of 45% more credit hours. These stark differences in pass percentage and college GPA lent credence to the initial hypothesis that the proxies were a viable stand in for completion status.

TABLE 2

Summary of Independent sample t-Tests of Completion Status to College GPA and Pass percentage						
	Paired Differences					
	Mean	*Std. Dev.*	*Standard Error Mean*	*t*	*df*	*Sig. (2-tailed)*
College GPA to Completion	-1.5677	0.5997	0.1906	-8.227	46.967	<.001
Pass% to Completion	-0.4506	0.2147	-0.5685	-7.697	45.434	<.001
Note. N = 49.						

III.2 Analysis of College GPA Measures

In an attempt to determine the efficacy of HSGPA and ACT scores as predictors of college readiness multiple regressions were run using the entire data set (n=102). The initial pair of regressions used college GPA as the dependent variable with results shown in Table 3. When only using HSGPA and ACT scores as independent variables, HSGPA was found to be the only statistically significant variable at the 5% or 1% confidence level. HSGPA was significant at all confidence levels and had a large coefficient (0.72) in relation to the constant and the other variables. Additionally, ACT scores were shown to have an insignificant effect on college GPA in the first regression. Adding the demographic controls to the regression doubled the coefficient for ACT scores and had a minimal effect on the coefficient and significance of HSGPA. None of the additional independent variables used in the second regression were found to be statistically significant. Results using college GPA support the notion that HSGPA is a far more predictive variable than ACT scores.

TABLE 3

Predictors of College GPA				
	College GPA			
		Model 2		
Variable	*Model 1 B*	*B*		*95% CI*
Constant	-0.128	0.03		[-3.844, 3.904]
HSGPA	0.721**	0.719**		[0.363, 1.076]
ACTscore	0.004	0.008		[-0.029, 0.045]
Gender		0.273		[-0.307, 0.853]
InStateStatus		-0.283		[-0.672, 0.106]
EntryAge		-0.007		[-0.177, 0.162]
R^2	0.155		0.179	
F	9.079		4.176	
Δr^2			0.024	
$\Delta\Phi$			-4.903	
Note. N = 102. CI = confidence interval. **p < .01				

III.3 Analysis of Pass% Measures

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IV. Discussion

The current study examined the efficacy of two prolific predictors of college readiness used in the post-secondary admissions process: high school GPA and ACT scores. Results contextualize the limited literature's findings to ASD, and suggest that HSGPA is the most effective measure of likelihood of success in college.

This study began with the observation that standardized tests have proliferated rapidly, becoming one of the primary methods institutions use to craft their student body. Overwhelmingly, this study found that HSGPA was the only statistically significant predictor of readiness for individuals with autism, challenging the commonly held belief in the admissions process that standardized test scores are valuable predictive tools.

Largely unsurprising is the fact that HSGPA is a more predictive measure than standardized tests. At their core standardized tests represent effort over a three to four hour period versus HSGPA, which is the culmination of thousands of data points spanning a three to four year period. It cannot be ignored that studying plays a large part in success on a standardized test; however, this measure will always suffer from an incredibly small sample size when compared to the inputs for HSGPA which represents all activities ranging from a pop quiz freshman year, to a group project senior year and all the homework, tests, and participation points in between. The incredible diversity of assessments that factor into a grade point average provide a statistic that more closely represents the types of factors that lead to success at a post-secondary level. Results from this study suggest that long-term work ethic, as measured by HSGPA, will likely better predict the probability of success in college.

Despite these relatively conclusive findings, the average drop in GPA from high school to college was almost a full letter grade (-0.89). When comparing the means with a two-sample *t*-test ($p<0.001$) however it becomes evident that completion explains most of the variances in GPA. Those who dropped out ($n=35$) had an average differential of -1.7 points whereas those who graduated ($n=14$) saw a decrease of only .16 points. Even when the individuals who had a 0 college GPA ($n=5$) were removed as a sensitivity check, those who dropped out still lost a full point and a half. High school GPA is thus most predictive for individuals who are already most likely to succeed.

Previously in the literature it has been argued that the over reliance on standardized test in the admission process may artificially limit access to college for some individuals (Hiss & Franks, 2014). This notion is particularly troubling when coupled with this study's findings that these tests may not accurately capture probability of success for students with ASD. Students on the spectrum are being left behind in the increasingly competitive school admissions process [8], [4] despite recent research [2] this study included, which indicates that these individuals are not necessarily ill equipped for college. Relying on standardized tests has systematically decreased the probability that individuals with autism will be accepted to institutions of higher education. For students on the spectrum it is imperative that alternative measures of college readiness be evaluated.

IV. 1 Limitations and Future Research

Initially, this study attempted to remove self-selection bias by collecting data from the same institution. While minimized in this regard, this study still suffers from some self-selection bias in its sample population. All students in the sample sought out acceptance into a specialized college support program. The lack of significance for any demographic control was likely the result of a homogenous sample caused by similar individuals taking advantage of similar services. Whatever the cause of homogeneity, the generalizability of this study is severely limited by its lack of a representative sample. Working with a college support program provided a unique opportunity to generate data, unfortunately, in most college environments disclosure of developmental disabilities is not the norm. Additionally, community colleges have been shown to be an important part of the postsecondary career for students with ASD [11] and, the present study does not include data points from this important subsection of institutions.

In addition to the homogeneity issue, the study likely suffers from an endogeneity issue. While high school GPA was statistically the most predictive variable in all cases, the present studies analysis was unable to ascertain causality for specific factors that influence success in a post-secondary setting. High school GPA is likely capturing several omitted variables including IQ, work ethic, socioeconomics, race, language proficiency, and even rigor of high school curriculum, which all may better predict readiness. Unfortunately, the present study relied on data sources that were unable to be optimized for causal analysis on retention trends. Future work would benefit from data generation oversight that would facilitate more meaningful data collection and analysis.

One potentially significant omitted variable is executive functioning which is a broad cognitive construct that attempts to quantify goal directed behaviors and identify specific traits that are critical for performing non-habitual behaviors [26] Executive functioning skills are critical barometers used in an attempt to measure and explain symptoms of ASD [26]. Among students with ASD, the development of executive functioning skills is highly heterogeneous [27] meaning they may explain some of the variation in the data. Future research should include data on these skills to better improve the fit of the regression model.

V. Conclusion

This study mirrors much of the established work on the effectiveness of standardized test scores as predictors of college readiness and contextualizes it to students with autism. High school GPA was, by all measures, the only statistically significant predictor of college readiness despite trends, which show an increased reliance on standardized test scores in the admission process. Overwhelmingly, students on the spectrum are being left behind after high school; future work should focus on further identifying specific factors that impact success and enrollment.

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