6-14-2019

Impulsivity in Science: Students' Beliefs in Their Science Abilities with and without ADHD Symptomology

Deza'Rae M. Collins
Portland State University

Lisa Marriott
Portland State University

Impulsivity in Science: Students' beliefs in their science abilities with and without ADHD symptomology

Collins, D.M.[1], Mitchell, S.H.[2], Bouwma-Gearhart, J.[3], Nigg, J.[4], Marriott, L.K.[5]

[1] Departments of Psychology, Social Science and Urban Honors College, Portland State University, Portland, OR, United States of America

[2] Departments of Behavioral Neuroscience and Psychiatry, Oregon Health & Science University, Portland, OR, United States of America

[3] College of Education, Oregon State University, Corvallis, OR, United States of America

[4] Departments of Psychology, Psychiatry, Pediatrics, and Behavioral Neuroscience. Oregon Health & Science University, Portland, OR, United States of America

[5] OHSU-PSU School of Public Health, Oregon Health & Science University, Portland, OR, United States of America

Abstract

Impulsivity has been negatively associated with students' beliefs in their abilities in science (e.g., science self-efficacy). Impulsivity and risk tasking are known to be characteristics of Attention Deficit Hyperactivity Disorder (ADHD), but it is unknown whether science self-efficacy is altered in students exhibiting ADHD symptomology. STEM beliefs (i.e. science, technology, engineering, and math) were hypothesized to be more challenging for impulsive and risky students who exhibited symptoms of ADHD, since that the fields require the practice of repetitive tasks and coordinated attention to task performance. Impulsivity, ADHD symptomology, and risk taking behavior were assessed in a cross-sectional sample of 612 middle school students in grades six through eight. Results show that impulsivity and risk tasking affect a wide proportion of students, not limited to students with ADHD symptomology, though ADHD total scores and risk taking behavior were negatively associated with students' beliefs in their science abilities. The relationship between these factors across gender and underrepresented minority groups were explored.

Introduction

Students' self-beliefs about their performance in STEM (i.e. science, technology, engineering, and math) are directly related to their persistence in STEM fields (1,2), regardless of parents' education or family socioeconomic status (SES) (3). Middle and high school are both critical time periods for developing students' self-beliefs and interests in STEM (3, 4). Early interest in science is a key predictive factor for students later choosing a STEM-related career (5, 6), however it can be disregarded due to poor academic performance in math and science courses, therefore influencing a student's self-belief in their ability to succeed in science (3). These self-beliefs are thought to contribute to student retention in STEM fields (5, 7).

This study explored whether impulsivity may influence students' science beliefs in STEM, as Spinella et al. (8) previously reported impulsivity to be negatively associated with academic grades in college-aged students. Impulsivity is defined as a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these actions to the impulsive individuals or to others (9). There are two different behavioral characteristics that describe impulsivity: (1) an impairment of behavioral inhibition and (2) a pronounced discount of delayed outcomes (10, 11). Higher levels of impulsivity are associated with various psychopathologies including ADHD subtypes, substance use disorder, conduct disorder, and delinquency (12-16). In contrast, low impulsivity levels have been associated with compulsivity, obsessive compulsive disorder (OCD), and food-restricting eating disorders (17, 18).

Previous impulsivity research exploring academic performance has focused on contexts such as attention-deficit/hyperactivity disorder (ADHD) (19, 20), risky behaviors (21, 22), and early childhood self-control (23, 24). However, the role of impulsivity as an underlying behavioral trait that influences student academic performance has been largely unexplored (8, 25), especially in the context of STEM. Impulsive students can have increased difficulty staying on task which may influence the perception of STEM learning as more challenging than other subjects, which may not require the practice of repetitive cognitive tasks to achieve mastery. Consequently, impulsivity has the potential to influence student motivation, more specifically the lack of, which may translate to poor STEM academic performance by postponing homework or studying. Therefore, as we have previously discovered, impulsivity negatively influences the relationship between students' self-beliefs in STEM developed during secondary school (3).

The learning outcomes of children diagnosed with ADHD are negatively impacted due to the trouble in school with sustained attention, hyperactivity, and impulsivity (26). Accordingly, students with ADHD perform at lower academic levels than their peers (27), an effect also present in children who are severely inattentive, hyperactive, and impulsive, but lack a formal diagnosis of the disorder (20, 28, 29). In the United States alone, the prevalence of these disorders among children and adolescents range from 5.9%-7.1% for ADHD (30), 5-6% for learning disabilities (31), and 0.6-2.2% for autism spectrum disorder (32). However, our prior work shows that sub-clinical levels of impulsivity also affects the science beliefs of students with or without a formal learning disability (3).

Risk tasking is an additional behavioral characteristic similar to and often clustered with impulsivity to describe irrational decision making exhibited in impulsive individuals (73). Whiteside & Lynham have examined this personality trait using a five factor model to create a revised personality inventory that assesses positive urgency, negative urgency, sensation seeking, lack of premeditation, and lack of perseverance. Previous research studies have frequently administered the Urgency, Premeditation, Perseverance, and Sensation Seeking (UPPS) instrument in the context of substance abuse treatments for both adults and adolescents. However literature in the context of academic performance is lacking. Tomko et al. reports that both subscales negative and positive urgency as well as lack of perseverance were positively related to problematic substance abuse, suggesting that goal oriented behaviors may protect against substance use (70). For the purpose of this study, the UPPS survey was administered to middle school students to examine the relationship between impulsivity and risk taking on science beliefs, in the presence and absence of ADHD symptomology.

Carol Dweck's mindset theory (33,34), which emphasizes growth of intelligence through effort and hard work, has been previously shown to positively influence science beliefs of adolescents regardless of impulsivity levels (3).   Mindset was measured in conjunction with self-determination theory, which posits that individuals feel greater motivation when their universal basic psychological needs are satisfied (3). Deci et al. investigated this model to predict motivation and behavior adjustments in many settings, finding that when an individual has competence (i.e., beliefs in their skills in an area), autonomy (i.e., ability to make choices), and relatedness (i.e., have people around who are supportive of the behavior), they have increased motivation and well-being to succeed in that task (69). Unlike previous research, this study evaluated self-determination theory in the context of science to determine the degree to which science self-determination influences student's self-beliefs in their science abilities. It is hypothesized that students will have a greater motivation for science if they identify a sense of relatedness amongst their peers and others in science (i.e., teachers, family), have the autonomy to make their own choices about their science work, and feel the competence (i.e., belief in their skills) to do the required science tasks.

This study assessed impulsivity and risk tasking in a large cross-sectional sample of secondary students to understand whether subclinical levels of impulsivity may affect a wide spectrum of students, in the presence or absence of ADHD symptomology. This study also explored whether, like mindset, self-determination theory was related to students' beliefs in their science abilities. This study was not designed to be causal nor to identify learning disabilities among students, but rather to explore whether students' impulsivity levels were associated with measures of STEM persistence including STEM interest, science self-efficacy, science self-determination, and mindset.

Method

Participants and Setting

This project was overseen by Oregon Health & Science University's (OHSU) Institutional Review Board (IRB, protocol #3694) who approved the study. One middle school was recruited to participate in the current study based on a prior academic relationship with the investigator (L.K.M.) and school sociodemographics. The survey site was a suburban school located in the state of Washington. The site permitted use of their facilities, managed interaction with students, and oversaw parental opt-out forms that maintained student anonymity to study staff. The study's IRB protocol permitted the school to select an opt-in or opt-out procedure for parental notification, with the school selecting an opt-out procedure in this study. The school managed parental permissions to maintain student anonymity to OHSU study staff. The school selected which classes would administer surveys to support maximal participation by all interested students. Selected teachers received an informational packet about the study, which included a teacher informational letter, student information sheets, student surveys, a data intake form, and a prepared paragraph to read to their students describing study goals, survey length, and voluntary participation in the anonymous research. Students were then given an information sheet about the study with time to ask questions. Students provided verbal assent to their teacher to participate and surveys included a printed introduction at the top of each survey reiterating procedures being voluntary and anonymous. One paper-based survey, roughly 30-40 minutes in length, was administered to students. Completed surveys were returned to the teacher and immediately sealed in a manila envelope. Completed survey packets were returned to the main office to be mailed to the study team (postage pre-paid).

Survey Instruments

A series of instruments were combined into a single survey, presented in the following order to enhance complete data from impulsive students who may not be interested in completing the entire instrument: ADHD, impulsivity (BIS), Sources of Science Self-Efficacy (SSSE), mindset, STEM pursuits, Science Self-Determination Theory (SSDT), and risk taking (UPPS).

ADHD Self-Report Scale (ASRS). The ASRS is a screener survey for identifying Attention Deficit/Hyperactivity Disorder (ADHD) in adults over the age of 18 (71). The instrument comprised 18 items over two parts: Part A, which describes common symptoms of the disorder and Part B, additional cues to assist in provider diagnostics (71). On Part A, a score of four or more responses greater than a frequency of 'sometimes' indicates symptoms highly consistent with ADHD. Previous test-reliability produced Cronbach's alpha coefficients between α=.63-.74 among 135 students recruited from a university Student Disability Services department. In the current study, a total of 504 students completed all 18 items (total instrument α=.83), representing a composite measure calculated from Part A (α=.72, n=540) and Part B (α=.78, n=516).

Barratt Impulsiveness Scale – short form (BIS-15). The BIS-15 comprised 15 items measured on a 4-point Likert scale (1-4, with six items reverse scored as previously reported (36, 37). The instrument included three subscales: Attention (A), Motor (M), and Non-Planning (NP), which previously produced Cronbach's alpha coefficients (α) between α=.60-.78 in university students and α=.x-.y in our prior study of adolescents (reference). In the current study, a total of 464 students completed all 15 items (α=.75), representing a composite measure of impulsivity calculated from A (α=.66, n=505), M (α=.75, n=540), and NP (α=.73, n=493) subscales.

Sources of Science Self-Efficacy (SSSE). SSSE applied Usher and Parajes' validated mathematics scale (38) previously reworded for science (39). The instrument comprised 24 items that addressed four constructs: mastery experiences (ME), vicarious experiences (VE), social persuasion (P), and psychological and affective state (PH). Items were scored based on a 6-point Likert scale (0-5, with seven items reverse scored and scores ranging from 0-120). Previous test reliability among 1225 middle and high school students produced (α=.87, .71, 85, and .86) for the four constructs, respectively. In the current study, 268 students completed all 24 items (α=.92), representing a composite measure calculated from, ME (α=.89, n=400), VE (α=.88, n=464), P (α=.89, n=462) and PH (α=.92, n=324).

Mindset. Mindset describes the continuum of a student's felt beliefs of being able to increase personal intelligence through effort (termed "growth mindset") versus it being a static trait conferred at birth ("fixed mindset", 33, 34). A short 5-item instrument designed by Dweck (33, 34) was scored on a 4-point Likert scale (1-4, with 2 items reverse-scored) and addressed two subscales: fixed (F) and growth (G) mindset. Previous test reliability among 1759 students completing all 20 items produced α=.75. In the current study, a total of 357 students completed all 5 items (α=.29), representing a composite measure calculated from, Fixed (α=.78, n=442). Subscale growth was not included due to an inadequate number of variables required to perform a valid statistical calculation.

STEM Interest. A simple 2-item question pair assessed student interests in either a future science and/or math career (42, 43). Items were scored based on a numeric response of 1-10 indicating their interest, with 10 being the highest. Previous test reliability among 174 teenage students ranged from (α=.84-.93), with 415 students completing both items in the current study, (α=.70).

Science Self-Determination Theory (SSSDT). SSDT applied the Basic Psychological Needs at Work Scale (69) that was modified for science for use in this study with middle school aged students. The instrument comprised 21 items that addressed three constructs: Autonomy

(A), Competence (C), and Relatedness (R). Items were scored based on a 7-point Likert scale (1-7, with seven items reversed scored and scores from 0-147). In the current study, a total of 111 students completed all 21 items (α=.92), representing a composite measure of SSDT calculated from A (α=.61, n=267), R (α=.71, n=222), and C (α=.84, n=162).

Urgency, Premeditation, Perseverance, and Sensation Seeking – revised, child version (UPPS-R-C). The UPPS-R- is a modified version of Whiteside and Lynam's Five Factor Model to measure impulsivity in adults (70, 73). The instrument comprised 40 items that addressed five factors of impulsivity: negative urgency (NU), positive urgency (PU), (lack of) premeditation (LPM), (lack of) perseverance (LP), and sensation seeking (SS). Items were scored based on a 4-point Likert scale (1-4, with fifteen items reverse scored). Scores range from 0-160. Previous test reliability among 120 adolescents produced Cronbach's alpha coefficients (α) between α =.79-.95. The current analysis of 186 students completed all 40 items (α=.88), representing a composite measure calculated from, NU (α=.86, n=260), PU (α=.93, n=246), LPM (α=.77, n=254), LP (α=.85, n=244), and SS (α=.85, n=258).

Survey Processing and Statistical Analyses

Paper surveys were scanned using Remark software that populated survey data into Excel for statistical analyses by IBM SPSS Statistics, version 24. Statistical modeling was implemented using R. Geographical location and school demographics were obtained from 2017-2018 NCES data (35).

Statistical Analyses. Data were cleaned and analyzed using SPSS (IBM, version 24). Likert scale responses were converted numerically and summed for each subscale and composite total score. Scale data were analyzed as continuous variables (e.g., impulsivity, mindset, SSSE, STEM interest). Blank entries were not included in calculations. ANOVA was used to compare overall differences across multiple groups (e.g., grade, gender, race), with Bonferroni post-hoc tests used to assess and compare group differences.

The general linear modeling function within SPSS was used to examine the main effects of impulsivity, ADHD, science self-determination theory (SSDT), mindset, and risk tasking on sources of science self-efficacy (SSSE) in middle school students.

Results

Participants

A total of 612 middle school students were enrolled at the survey site (NCES 2017) and had the opportunity to complete all survey measures. Participants were 47% female and 37.4% of the total number of students qualified for free or reduced lunch. A total of 21% of students identified as underrepresented minorities (URM) in science according to National Institute of Health definitions, which included American Indian/Alaska Native (3.9%), Black or African American (6.2%), Hispanic or Latino (9.3%), and/or Native Hawaiian or Pacific Islander (3.8%). Students identifying as Two or More Races represented an additional 11.3% of the total student population (Table 1).

Table 1. Participant demographics reported by the school and by students completing each survey.

	Overall School Demographics NCES Data (n=771)	**Our Sample Demographics (n=612)**
Gender		
Female	371 (48.1%)	290 (47.4%)
Male	400 (51.9%)	276 (45.1%)
Non-Binary	N/A	13 (2.1%)
Prefer Not to Say	N/A	33 (5.4%)
Grade		
6	243 (31.5%)	180 (29.4%)
7	237 (30.7%)	191 (31.2%)
8	291 (37.8%)	230 (37.6%)
Free or Reduced Lunch Eligible	288 (37.4%)	N/A
Race/Ethnicity		
American Indian/Alaska Native	8 (1%)	24 (3.9 %)
Asian	93 (12.1%)	70 (11.4%)
Black/African American	26 (3.4%)	38 (6.2%)

Hispanic/Latino	156 (20.2%)	57 (9.3%)
Native Hawaiian/ Pacific Islander	21 (2.7%)	23 (3.8%)
White	376 (48.8%)	184 (30.1%)
Prefer Not to Say	N/A	294 (48%)
Two or More Races	91 (11.8)	69 (11.3%)
Total*	771	612
Underrepresented Minority*	N/A	130 (21.2%)

Demographics of students attending sample middle school.
*Total number of race and ethnicity groups is greater than 100 due to some students reporting more than one race.
*National Institutes of Health (NIH) definition of underrepresented minority is racial and ethnic groups comprising American Indians or Alaska Natives, Blacks or African Americans, Native Hawaiians or Other Pacific Islanders as well as Hispanics or Latinos.

Behavioral Measures

Impulsivity. A total of 464 students completed the impulsivity scale (mean=32.5, SD=6.4; Table 2). No differences in impulsivity subscales were observed for either grade or URM status. Gender had an effect on impulsivity (p=0.001; partial η^2= 0.03), with similar effects observed for both M (p=0.0004; partial η^2= 0.013) and A (p=0.0002; partial η^2= 0.016) subscales. Specifically, students who identified as non-binary or preferred not to answer had the highest impulsivity levels as well as motor and attentional subscale scores.

Attention Deficit Hyperactivity Disorder. A total of 504 students completed the ADHD instrument (mean=26.5, SD=11.9; Table 2). Although, no differences in ADHD total score or its subscales were observed for grade, gender, or underrepresented minority status.

Sources of Science Self-Efficacy (SSSE). A total of 269 students completed the science self-efficacy instrument in its entirety (mean=87.5, SD=19.4; Table 3). Gender had no significant effect on total SSSE (p=0.12; partial η2= 0.02), however, the social persuasion subscale was significantly influenced by gender (p=0.009; partial η^2= 0.025), where non-binary students and those who preferred not to answer had higher P subscale scores than binary-identifying students. Grade and URM status also had no significant effect on total SSSE, though mastery experience subscale did differ between groups. Specifically, 6^{th} grade students and those who preferred not to answer their grade had higher ME scores (p=0.0009; partial η^2= 0.04). Non-URM students also had higher mastery experience subscores than other students (p<0.0001; partial η^2=.047).

Table 2. Means and effect sizes of impulsivity and ADHD scores across gender, grade, and URM status demographics.

	ADHD Part A	**ADHD Part B**	**ADHD Total**	**Impulsivity A**	**Impulsivity M**	**Impulsivity NP**	**Impulsivity Total**
Overall Mean + SD (n)	9.4, 4.1, n=541,	17.3, 8.4, n=515	26.5, 11.9, n=504	10.8, 3, n=505	9.3, 3, n=506	12.4, 3.2, n=493	32.5, 6.4, n=464
Gender	F(3, 540)=1.79, p=0.15, partial n2=0.01	F(3, 503)=0.82, p=0.48, partial n2=0.003	F(3, 514)=0.44, p=0.72, partial n2=0.005	F(3, 504)=6.53, p=0.0003*****, partial n2=0.04	F(3,505)=6.04, p=0.0005*****, partial n2=0.03	F(3, 492)=1.65, p=0.18, partial n2=0.01	F(3, 463)=5.31, p=0.0013*****, partial n2=0.03
Male	9.5, 4.1, n=237	17.3, 8.7, n=225	26.6, 12.1, n=220	10.9, 3, n=222	9.2, 2.9, n=219	12.7, 3.3, n=212	32.8, 6.5, n=201
Female	9.1, 3.9, n=267	17.2, 7.9, n=250	26.2, 11.2, n=247	10.5, 2.9, n=248	9, 2.9, n=254	12.2, 3, n=247	31.7, 6.2, n=234
Non binary	11.7, 6.5, n=13	19.9, 11.5, n=13	31.5, 17.4, n=13	14.1, 2.4, n=12	12.1, 4, n=11	11, 3, n=12	37.1, 5.6, n=11
Prefer not to say/ No answer	9.1, 4.8, n=24	17.7, 9, n=27	26.4, 13.4, n=24	11.9, 3.4, n=23	10.9, 3.9, n=22	12.1, 3.3, n=22	36.1, 7.2, n=18
Grade	F(3, 540)=0.33, p=0.81, partial n2=0.002	F(3, 514)=0.72, p=0.54, partial n2=0.004	F(3, 503)=0.47, p=0.701, partial n2=0.003	F(3, 504)=0.61, p=0.61, partial n2=0.01	F(3, 505)=1.66, p=0.17, partial n2=0.01	F(3, 492)=1.98, p=0.12, partial n2=0.004	F(3, 463)=0.97, p=0.41, partial n2=0.006
6	9.2, 4.1, n=156	17.7, 8.3, n=148	26.8, 11.7, n=144	11, 3.2, n=142	9, 2.8, n=143	12.9, 3.3, n=140	33, 6.5, n=130
7	9.6, 4.1, n=170	17.7, 7.9, n=164	27, 11.3, n=159	10.6, 3, n=158	9, 2.7, n=158	12.9, 3.3, n=140	31.7, 6.3, n=142
8	9.3, 4.1, n=209	16.6, 8.7, n=197	25.8, 12.3, n=195	10.9, 2.9, n=199	9.6, 3.3, n=199	12.1, 3.2, n=192	32.7, 6.5, n=186
Prefer not to say/ No answer	10, 6.3, n=6	19.3, 13.9, n=6	29.3, 19.9, n=6	9.8, 3.4, n=6	10.3, 4.3, n=6	11.8, 1.8, n=6	32, 5.3, n=6
URM	F(2, 540)=0.4, p=0.67, partial n2=0.001	F(2, 514)=1.82, p=0.16, partial n2=0.007	F(2, 503)=0.86, p=0.42, partial n2=0.003	F(2, 504)=1.79, p=0.12, partial n2=0.007	F(2, 505)=1.58, p=0.21, partial n2=0.01	F(2, 492)=1.01, p=0.37, partial n2=0.004	F(2, 463)=2.51, p=0.08, partial n2=0.01
URM	9.1, 4.5, n=122	17.3, 9.2, n=117	26.1, 13.2, n=115	11.21, 2.84, n=122	9.48, 2.85, n=124	12.31, 3.06, n=115	33.12, 5.64, n=110
Not URM	9.4, 3.8, n=189	16.4, 7.4, n=182	25.8, 10.6, n=181	10.55, 3.14, n=185	8.95, 3.03, n=184	12.14, 3.11, n=178	31.61, 6.67, n=170
Prefer not to say/ No answer	9.5, 4.1, n=230	18, 8.7, n=216	27.3, 12.2, n=208	10.88, 3.03, n=198	9.4, 3.03, n=198	12.6, 3.29, n=200	32.89, 6.56, n=184

Results shown as mean, SD, and sample size (N) when analyzed by one-way ANOVA (gender, grade and URM). Effect size benchmarks define small (partial $\eta 2= 0.01$), medium (partial $\eta 2= 0.06$), and large (partial $\eta 2= 0.14$) effects (47, 48). Bonferroni post-hoc tests were used to determine differences between groups through multiple comparisons. For gender, * denotes differences between measurements of impulsivity, specifically constructs of motor (M) and attention (A), at the $p<0.001$ level.

Table 3. Means and effect sizes of Science Self-Efficacy (SSSE), and mindset across gender, grade, and URM status demographics.

	Science Self-Efficacy (SSE) ME	**Science Self-Efficacy (SSE) VE**	**Science Self-Efficacy (SSE) P**	**Science Self-Efficacy (SSE) PH**	**Science Self-Efficacy (SSE) Total**	**Fixed Mindset**	**Growth Mindset**	**Mindset Total**
Overall Mean ± SD (n)	24.8, 6.5, n=401	22.5, 7.4, n=464	18.7, 8.6, n=462	18.5, 5.3, n=324	87.5, 19.4, n=269	11.2, 2.7, n=360	3, 1.5, n=447	14.2, 3.1, n=357
Gender	F(3, 400)=0.6, p=0.62, partial n2=0.004	F(3, 463)=1.63, p=0.20, partial n2=0.01	F(3, 461)=3.86, p=0.0096*****, partial n2=0.025	F(3, 323)=0.27, p=0.85, partial n2=0.003	F(3, 268)=1.97, p=0.12, partial n2=0.02	F(3, 359)=1.59, p=0.20, partial n2=0.013	F(3, 446)=0.34, p=0.80, partial n2=0.002	F(3, 356)=0.93, p=0.43, partial n2=0.008
Male	24.7, 6.6, n=172	21.7, 7.6, n=201	17.9, 8.3, n=202	18.7, 5.1, n=160	85.3, 18.8, n=130	10.9, 2.8, n=158	3, 1.5, n=194	13.9, 3.3, n=156
Female	24.9, 6.5, n=206	23.1, 7.2, n=230	18.8, 8.7, n=228	18.4, 5.3, n=148	89.1, 20.2, n=125	11.5, 2.7, n=182	2.9, 1.4, n=224	14.4, 2.9, n=181
Non binary	27.4, 4.4, n=9	24.7, 6.7, n=11	22.9, 7.4, n=11	18, 5.8, n=5	104.5, 11.1, n=4	10.7, 2.5, n=7	3.3, 1.3, n=11	14, 2.9, n=7
Prefer not to say/ No answer	24, 5.7, n=14	22.4, 8.2, n=22	23.6, 9.5, n=21	17.5, 6.8, n=11	90.1, 14.1, n=10	11.4, 2.7, n=13	3.1, 1.9, n=18	14.1, 3, n=13
Grade	F(3, 400)=5.59, p=0.0009*, partial n2=0.04	F(3, 463)=1.1, p=0.35, partial n2=0.007	F(3, 461)=1.07, p=0.36, partial n2=0.007	F(3, 323)=0.91, p=0.44, partial n2=0.008	F(3, 268)=1.27, p=0.28, partial n2=0.014	F(3, 359)=0.79, p=0.78, partial n2=0.007	F(3, 446)=0.06, p=0.06, partial n2=0	F(3, 356)=0.33, p=0.33, partial n2=0.003
6	26.5, 5.8, n=111*	22.6, 7.4, n=123	18.7, 8.6, n=120	19.2, 5.2, n=82	88.3, 17.8, n=71	11, 2.9, n=89	3, 1.6, n=117	14, 3.3, n=87
7	23.5, 6.4, n=124	22.8, 7.4, n=155	18.5, 8.4, n=155	17.9, 5.6, n=107	86.2, 20.4, n=86	11.1, 2.7, n=121	2.9, 1.4, n=147	14.1, 2.9, n=120
8	24.5, 6.8, n=161	22, 7.4, n=179	18.7, 8.8, n=180	18.5, 5.1, n=130	87.4, 19.6, n=107	11.5, 2.6, n=145	3, 1.5, n=177	14.4, 3.1, n=145
Prefer not to say/ No answer	29.6, 4.2, n=5	26.6, 8.8, n=7	24.4, 8, n=7	19.6, 4.4, n=5	103.2, 17.7, n=5	11.4, 3.6, n=5	2.8, 1.2, n=6	14.2, 4.3, n=5
URM	F(2, 400)=9.91, p=0.0001*****, partial n2=0.047	F(2, 463)=1.05, p=0.35, partial n2=0.005	F(2, 461)=0.36, p=0.70, partial n2=0.002	F(2, 323)=2.48, p=0.08, partial n2=0.015	F(2, 268)=2.76, p=0.06, partial n2=0.02	F(2, 359)=2.74, p=0.06, partial n2=0.015	F(2, 446)=0.25, p=0.78, partial n2=0.001	F(2, 356)=1.95, p=0.14, partial n2=0.011
URM	24.6, 6.3, n=106	23, 7.5, n=122	18.9, 8.7, n=124	19.4, 5.2, n=80	90.1, 20.3, n=70	10.9, 2.6, n=94	3, 1.4, n=125	14, 3.1, n=93
Not URM	26.4, 6, n=160 *	22.8, 7.7, n=182	19, 8.6, n=184	18.7, 5.1, n=140	88.9, 20.2, n=115	11.6, 2.7, n=164	2.9, 1.5, n=189	14.5, 3.1, n=163
Prefer not to say/ No answer	23.1, 6.7, n=135	21.8, 7.1, n=160	18.2, 8.6, n=154	17.7, 5.4, n=104	83.5, 16.9, n=84	11, 2.9, n=102	2.9, 1.5, n=133	13.8, 3.1, n=101

Results shown as Mean, SD, and sample size (N) when analyzed by one-way ANOVA (gender, grade and URM). Effect size benchmarks define small (partial $\eta 2= 0.01$), medium (partial $\eta 2= 0.06$), and large (partial $\eta 2= 0.14$) effects (47, 48). Bonferroni post-hoc tests were used to determine differences between groups through multiple comparisons. For gender, * denotes differences between measurements of SSSE, specifically the construct of social persuasion (P), at the $p<0.01$ level whereas for grade and URM, * denotes differences on the construct of mastery experience (ME) at the $p<.001$ and $p<.0001$ levels.

Mindset. A total of 357 students completed the mindset scale (mean=26.5, SD=11.9; Table 3), however no differences for grade, gender, or underrepresented minority status were observed.

STEM Career Interest. A total of 415 students completed the two STEM career interest questions (i.e., science and math; mean=8.9, SD=3.3; Table 4). No differences in either science or math career interest were observed for gender. Grade had an effect on science career interest (p=0.03; partial η^2= 0.019), with 8th grade students having a higher score than their peers. URM status had had a significant effect on overall STEM career interests (i.e., combined math and science interest), where students who identified as non-URM reported lower overall STEM career interests than URM students or those who preferred not to answer.

Science Self-Determination Theory (SSDT). A total of 111 students completed the science self-determination theory instrument in its entirety (mean=78.2, SD=19.4; Table 4). Gender had a significant effect on total self-determination scores (p=0.0080; partial η2= 0.104), which were also observed for all three subscales including A (p=0.0041; partial η^2=0.05), C (p=0.04; partial η^2=0.04), and R (p=0.004; partial η^2=0.08). Specifically, non-binary students had higher total and subscale scores, whereas students who preferred not to answer had significantly lower scores across all constructs. No differences in SSDT total scores or subscales were observed for grade. URM status had a significant effect on total self-determination scores (p=0.0139; partial η2= 0.076), as well as all three subscales including A (p= 0.01; partial η^2=0.03), C (p= 0.02; partial η^2=0.03), and R (p=0.004; partial η^2=0.06). Precisely, students who identified as URM had the highest scores on all three subscales autonomy, competence, and relatedness.

Table 4. Means and effect sizes of STEM interest (science and math careers) and Science Self-Determination Theory (SSDT) across gender, grade, and URM status demographics.

	Interest in a Math Career	**Interest in a Science Career**	**Interest in STEM Career Total**	**Science Self-Determination Theory (SSDT) A**	**Science Self-Determination Theory (SSDT) C**	**Science Self-Determination Theory (SSDT) R**	**Science Self-Determination Theory (SSDT) Total**
Overall Mean ± SD (n)	4.5, 3.3, n=420	4.2, 3.3, n=442	8.9, 5.8, n=415	28.1, 6.1, n=267	20.6, 5.9, n=222	32.1, 8.4, n=162	78.2, 19.4, n=111
Gender	F(3, 419)=2.46, p=0.06, partial n2=0.017	F(3, 441)=2.17, p=0.09 partial n2=0.015	F(3, 414)=0.69, p=0.55, partial n2=0.005	F(3, 266)=4.52, p=0.0041*, partial n2=0.05	F(3, 221)=2.75, p=0.0435*, partial n2=0.04	F(3, 161)=4.58, p=0.0042*, partial n2=0.08	F(3, 110)=4.15, p=0.0080*, partial n2=0.104
Male	4.8, 3.3, n=179	4, 3.2, n=192	4.5, 3.3, n=420	27.9, 6.1, n=121	20.7, 5.5, n=109	31.3, 7.9, n=76	78.2, 19.1, n=54
Female	4.4, 3.3, n=212	4.3, 3.3, n=222	8.8, 5.9, n=211	28.8, 5.8, n=130	20.9, 6.2, n=100	33.5, 8.5, n=79	79.8, 18.6, n=50
Non binary	2, 3.1, n=10	5.3, 4, n=10	7.3, 6.2, n=10	28.1, 6.2, n=7	23, 6.4, n=5	46, 0, n=1	119, 0, n=1
Prefer not to say/ No answer	4.9, 3.7, n=19	5.8, 3.6, n=18	10.4, 6.2, n=18	21.2, 7.5, n=9	15.1, 3.3, n=8	22.8, 6.2, n=6	57.7, 13.1, n=6
Grade	F(3, 419)=0.38, p=0.78, partial n2=0.003	F(3, 441)=2.88, p=0.0358*, partial n2=0.019	F(3, 414)=1.15, p=0.33, partial n2=0.008	F(3, 266)=0.46, p=0.71, partial n2=0.01	F(3, 221)=2.14, p=0.09, partial n2=0.03	F(3, 161)=1.28, p=0.28, partial n2=0.02	F(3, 110)=0.9, p=0.45, partial n2=0.024
6	4.5, 3.3, n=112	3.7, 3.2, n=120	8.4, 5.4, n=112	28.4, 5.9, n=57	21.7, 6.7, n=51	34.1, 8.2, n=38	82.3, 20.3, n=24
7	4.3, 3.4, n=135	4.2, 3.4, n=145	8.7, 6.3, n=134	27.7, 6.6, n=94	20.7, 5.4, n=73	31.8, 8.5, n=62	75.7, 20, n=39
8	4.7, 3.3, n=167	4.6, 3.3, n=171	9.2, 5.6, n=163	28.3, 5.9, n=111	19.8, 5.6, n=94	31.3, 8.3, n=61	78.5, 18.6, n=47
Prefer not to say/ No answer	5, 2.8, n=6	7, 2.6, n=6	12, 4.7, n=6	30.6, 6.8, n=5	25.5, 7.2, n=4	23, 0, n=1	59, 0, n=1
URM	F(2, 419)=2.4, p=0.09, partial n2=0.011	F(2, 441)=1.37, p=0.26, partial n2=0.006	F(2, 414)=3.25, p=0.0397*, partial n2=0.016	F(2, 266)=4.29, p=0.0147*, partial n2=0.03	F(2, 221)=3.84, p=0.0229*, partial n2=0.03	F(2, 161)=5.51, p=0.0049*, partial n2=0.06	F(2, 110)=4.45, p=0.0139*, partial n2=0.076
URM	4.9, 3.5, n=111	4.2, 3.4, n=125	2.6, 2.3, n=121	28.9, 5.8, n=90	21.7, 6, n=72	33.5, 8, n=59	81.2, 17.7, n=39
Not URM	4.7, 3.3, n=181	4.5, 3.3, n=188	2.0, 1.9, n=184	28.3, 5.9, n=142	20.6, 5.9, n=119	32.6, 8.1, n=80	79.9, 19.5, n=55
Prefer not to say/ No answer	4, 3.1, n=128	3.9, 3.3, n=129	2.5, 2.1, n=222	25.4, 7.1, n=35	18.3, 5, n=31	27, 8.9, n=23	65.7, 19.2, n=17

Results shown as Mean, SD, and sample size (N) when analyzed by one-way ANOVA (gender, grade and URM). Effect size benchmarks define small (partial η2= 0.01), medium (partial η2= 0.06), and large (partial η2= 0.14) effects (47, 48). Bonferroni post-hoc tests were used to determine differences between groups through multiple comparisons. For gender, * denotes differences between measurements of SSDT on the constructs of autonomy (A), relatedness (R), and competence at the p<0.001 and p<0.01 levels whereas for URM * denotes differences on similar constructs at the p<0.001 and p<0.05 levels. For grade, * denotes differences between measurements of interest in a STEM career, specifically science, at the p<0.05 level.

Risk Tasking - Urgency, Premeditation, Perseverance and Sensation Seeking (UPPS). A total of 186 students completed the risk-taking instrument in its entirety (mean=90.6, SD=15.1; Table 5). Gender and grade had no significant effect on total UPPS scores or any of its subscales. URM status had a significant overall effect on total UPPS scores, where non-URM students had significantly lower total UPPS scores. Likewise, significant effects were observed for subscales lack of premeditation (LPM, p=0.0082; partial η^2= 0.04) and lack of perseverance (p=0.0042; partial η2= 0.044) where URM identifying students had significantly lower scores than other students.

Table 5. Means and effect sizes of UPPS across gender, grade, and URM status demographics.

	UPPS NU	**UPPS PU**	**UPPS LPM**	**UPPS LP**	**UPPS SS**	**UPPS Total**
Overall Mean ± SD (n)	18.9, 5.4, n=260	17.6, 6, n=246	16.4, 4.1, n=254	15.7, 4.6, n=244	22.1, 5.7, n=258	90.6, 15.1, n=186
Gender	F(3, 259)=1.54, p=0.20, partial n2=0.018	F(3, 245)=0.91, p=0.44, partial n2=0.01	F(3, 253)=1.49, p=0.22, partial n2=0.02	F(3, 243)=1.65, p=0.18, partial n2=0.02	F(3, 257)=1.21, p=0.31, partial n2=0.01	F(3, 185)=0.88, p=0.45, partial n2=0.01
Male	18.4, 5.2, n=120	17.1, 5.8, n=111	16.8, 3.8, n=118	16.1, 4.8, n=113	22.6, 5.6, n=119	90.3, 13.4, n=86
Female	19, 5.7, n=120	18, 5.9, n=118	15.9, 4.4, n=119	15.3, 4.4, n=112	21.6, 5.6, n=122	90, 16.6, n=89
Non binary	21.1, 5.8, n=8	20, 7.3, n=7	18.3, 2.7, n=6	18.3, 4.5, n=8	19.7, 5.6, n=7	101.5, 13.6, n=4
Prefer not to say/ No answer	21.1, 3.6, n=12	18.4, 7.6, n=10	15.6, 2.6, n=11	14.7, 4, n=11	23.2, 7.1, n=10	94.1, 15.9, n=7
Grade	F(3, 259)=0.27, p=0.85, partial n2=0.003	F(3, 245)=0.17, p=0.91, partial n2=0.002	F(3, 253)=0.69, p=0.56, partial n2=0.01	F(3, 243)=0.06, p=0.98, partial n2=0.001	F(3, 257)=0.6, p=0.61, partial n2=0.01	F(3, 185)=0.71, p=0.55, partial n2=0.01
6	18.8, 6.3, n=56	18, 6.1, n=51	16.6, 4.7, n=57	15.7, 5.1, n=49	22.6, 5.4, n=55	91.6, 17.5, n=37
7	18.4, 4.7, n=77	17.5, 5.8, n=75	15.8, 3.3, n=76	15.9, 4.1, n=77	21.7, 5.4, n=80	89.7, 13.7, n=55
8	19.1, 5.4, n=122	17.6, 6.2, n=116	16.6, 4.3, n=117	15.6, 4.7, n=114	22.2, 6, n=119	91, 15, n=91
Prefer not to say/ No answer	18.6, 4.7, n=5	16, 5.4, n=4	15.8, 3.4, n=4	15.3, 2.5, n=4	19.3, 4, n=4	79.3, 6.1, n=3
URM	F(2, 259)=1.77, p=0.17, partial n2=0.014	F(2, 245)=1.54, p=0.22, partial n2=0.012	F(2, 253)=4.9, p=0.0082*****, partial n2=0.04	F(2, 243)=5.6, p=0.0042*****, partial n2=0.044	F(2, 257)=1.94, p=0.15, partial n2=0.015	F(2, 185)=5.41, p=0.0052*****, partial n2=0.06
URM	19.5, 5, n=86	18.3, 6, n=82	16.7, 3.9, n=83	15.8, 4.9, n=81	22.5, 5.6, n=82	92.4, 12.7, n=59
Not URM	18.3, 5.6, n=135	17, 6.1, n=125	15.7, 4.1, n=133	15.1, 4.1, n=127	22.3, 5.6, n=137	87.5, 15.6, n=99
Prefer not to say/ No answer	19.5, 5.1, n=39	18.5, 5.7, n=39	17.9, 4.2, n=38	17.9, 4.7, n=36	20.5, 5.9, n=39	97.2, 15.5, n=28

Results shown as Mean, SD, and sample size when analyzed by one-way ANOVA (gender, grade and URM status). Effect size benchmarks define small (partial η2= 0.01), medium (partial η2= 0.06), and large (partial η2= 0.14) effects (47, 48). Bonferroni post-hoc tests were used to determine differences between groups through multiple comparisons. For URM, * denotes differences between measurements of risk tasking, specifically on the constructs of lack of premeditation (LPM) and lack of perseverance (LP), at the p<0.01 level.

Relationship between Instruments on Sources of Science Self Efficacy

Table 6. ADHD, impulsivity, mindset, STEM career interest, SSDT, and UPPS had significant effects on students Sources of Science Self-Efficacy (SSSE).

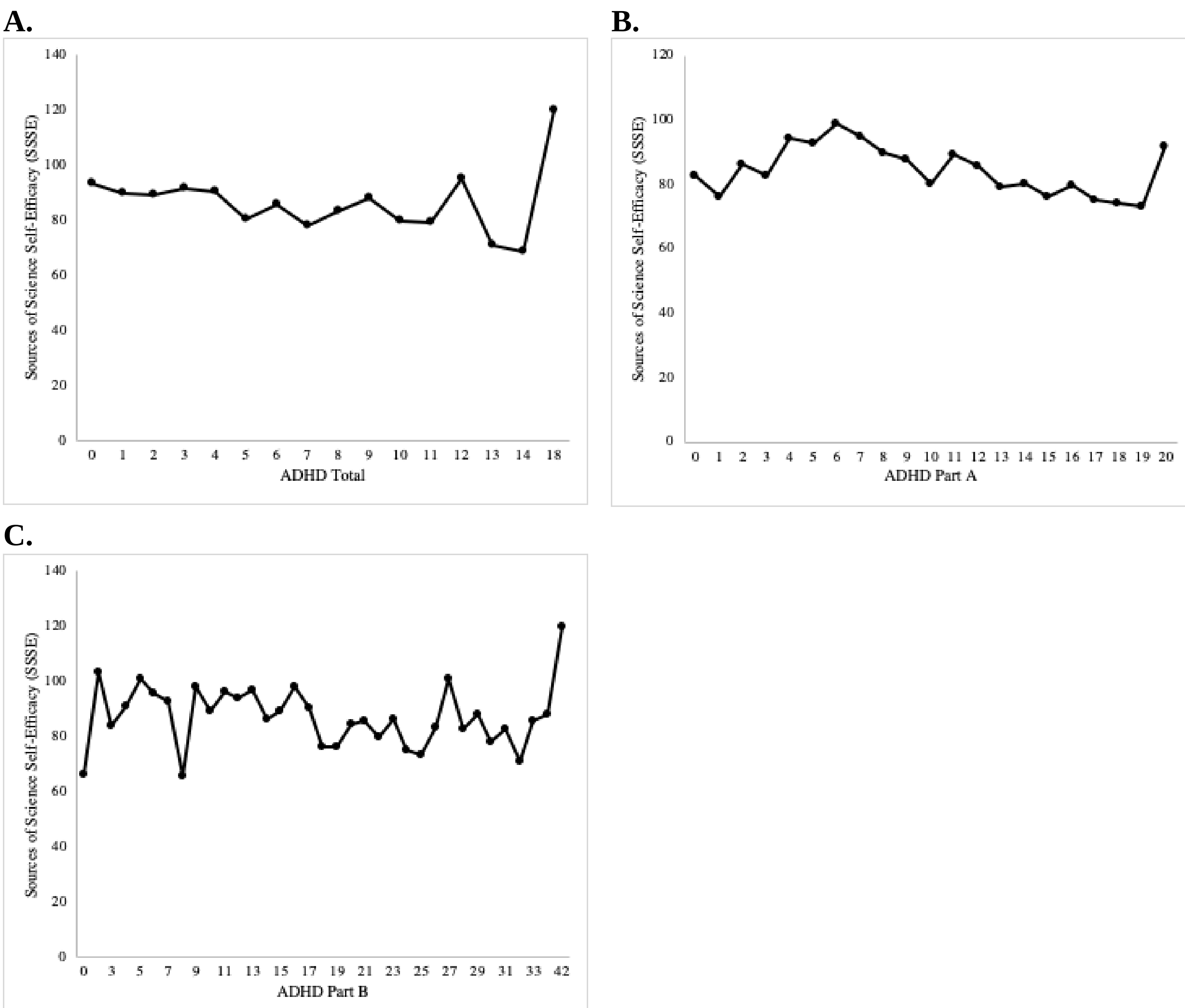
Metrics	r	SS	df, n	MS	F	Sig (p)
ADHD Total	-.139*	9595.077	15, 251	639.672	1.742	0.044*
ADHD Part A	-.134*	8955.493	20, 264	447.775	1.193	0.261
ADHD Part B	-.129*	21083.25	34, 255	620.096	1.812	0.006*
Impulsivity (BIS) Total	-.380**	22248.378	30, 242	741.613	2.203	0.001*
Attention (A)	-.345**	21713.928	13, 261	113.4	1.723	0.000*
Motor (M)	-.226**	4511.152	13, 261	1670.302	5.442	0.549
Non-Planning (NP)	-.420**	21096.992	15, 253	1406.466	4.368	0.000*
Mindset Total	-0.022	11700.985	16, 221	731.312	2.093	0.010*
Growth	.275**	14300.587	5, 255	2860.117	8.596	0.000*
Fixed	0.119	5822.576	13, 222	447.890	1.206	0.277
STEM Interest Total	.351**	16877.027	20, 238	843.851	2.441	0.001*
Science Career	.349**	15795.938	10, 251	1579.594	4.708	0.000*
Math Career	.296**	6157.757	10, 241	615.776	1.610	0.104
SDT Total	.164*	24508.264	41, 72	597.763	4.255	0.000*
Autonomy (A)	.583**	34972.319	29, 167	1205.942	5.668	0.000*
Competence (C)	.767**	35429.173	22, 148	1610.417	10.181	0.000*
Relatedness (R)	.774**	25761.187	29, 93	888.317	3.419	0.000*
Risk Taking (UPPS) Total	-.545**	24197.230	48, 111	504.109	1.520	0.060
Perseverance (LP)	.664**	30678.114	19, 143	1614.638	7.236	0.000*
Premeditation (LPM)	-.639**	23820.037	18, 145	1323.335	4.772	0.000*
Negative Urgency (NU)	-.387**	12610.775	22, 149	573.217	1.515	0.080
Positive Urgency (PU)	-.181*	11947.992	22, 139	543.091	1.418	0.120
Sensation Seeking (SS)	-0.157	12839.645	22,152	583.620	1.597	0.056

The GLM function within SPSS was used to analyze effects of ADHD, impulsivity, mindset, STEM interest, SSDT and risk taking on sources of science self-efficacy (SSSE) as the outcome variable. Pearson product moment correlations were generally small (r<|0.30|) for ADHD and mindset, moderate (r<|0.5|) for impulsivity, STEM career interest, and risk taking, and moderate-large (r<|0.70|) for self-determination constructs.

ADHD on SSSE

Using general linear modeling, ADHD total score had a negative effect on SSSE ($F_{(15,251)}$=1.742, p<0.05; Table 6; Figure 1a) as did subscale part B ($F_{(34, 255)}$=1.812, p<0.01; Table 6; Figure 1c), whereas part A had no significant effect (p=0.261; Table 6; Figure 1b).

Figure 1. ADHD secondary symptomology had a significant negative effect on students Sources of Science Self-Efficacy (SSSE).

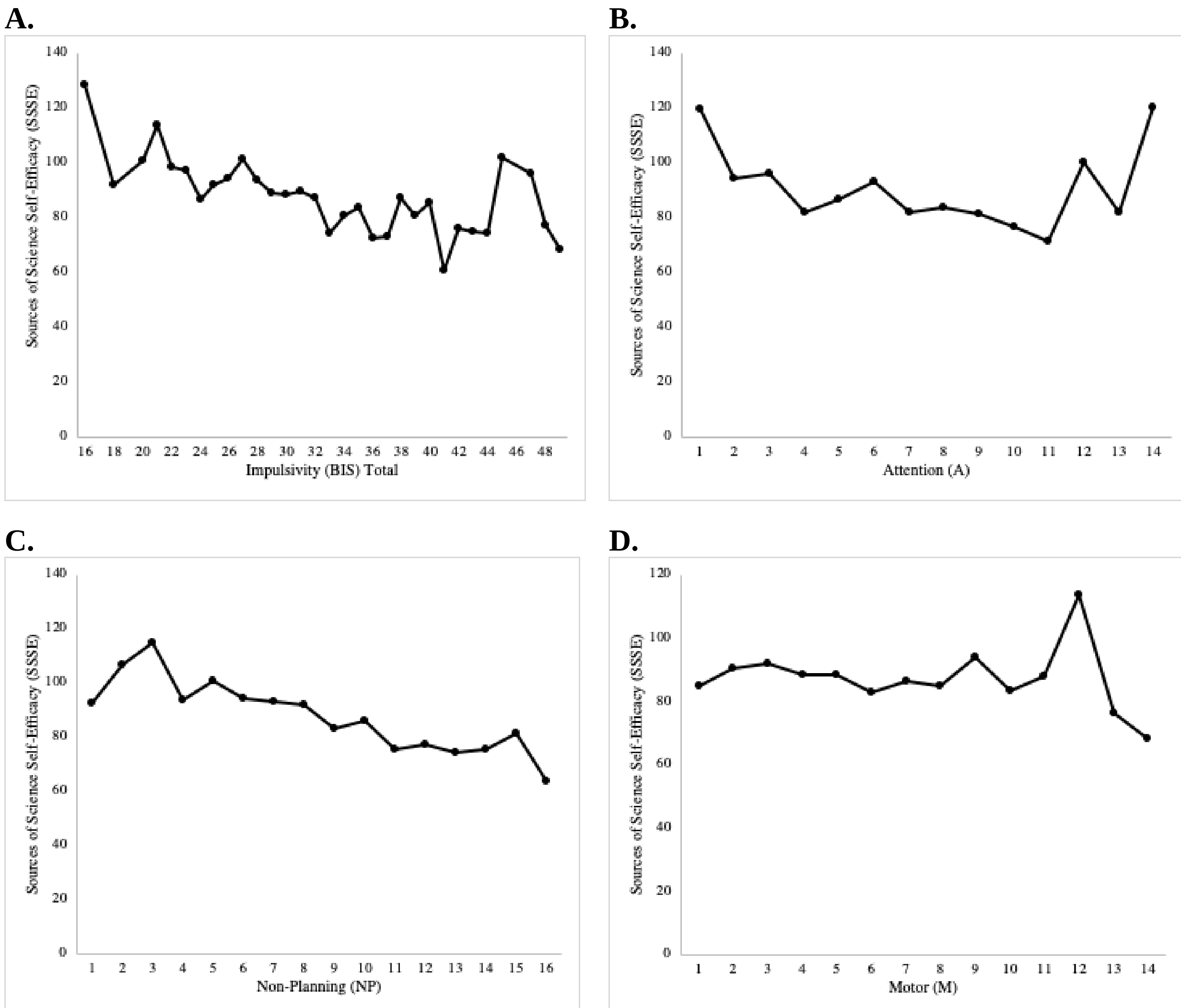


Total scores on ADHD symptomology had a significant effect on SSSE (A; p=.044). ADHD subscale part A did not have an effect (B; p=0.26) while ADHD subscale part B had a significant negative effect on SSSE (C; p=0.006).

Impulsivity on SSSE

Impulsivity had a negative effect on SSSE ($F_{(30,242)}=2.203$, $p<0.01$; Table 6; Figure 2a). Attention ($F_{(13, 261)}=1.723$, $p<0.0001$; Table 6; Figure 2b) and non-planning ($F_{(15, 253)}=4.368$, $p<0.0001$; Table 6; Figure 2c) subscales had negative effects on SSSE whereas motor subscale had no effect ($p=0.55$; Table 6; Figure 2d).

Figure 2. Impulsivity total scores had a significant negative effect on students Sources of Science Self-Efficacy (SSSE).

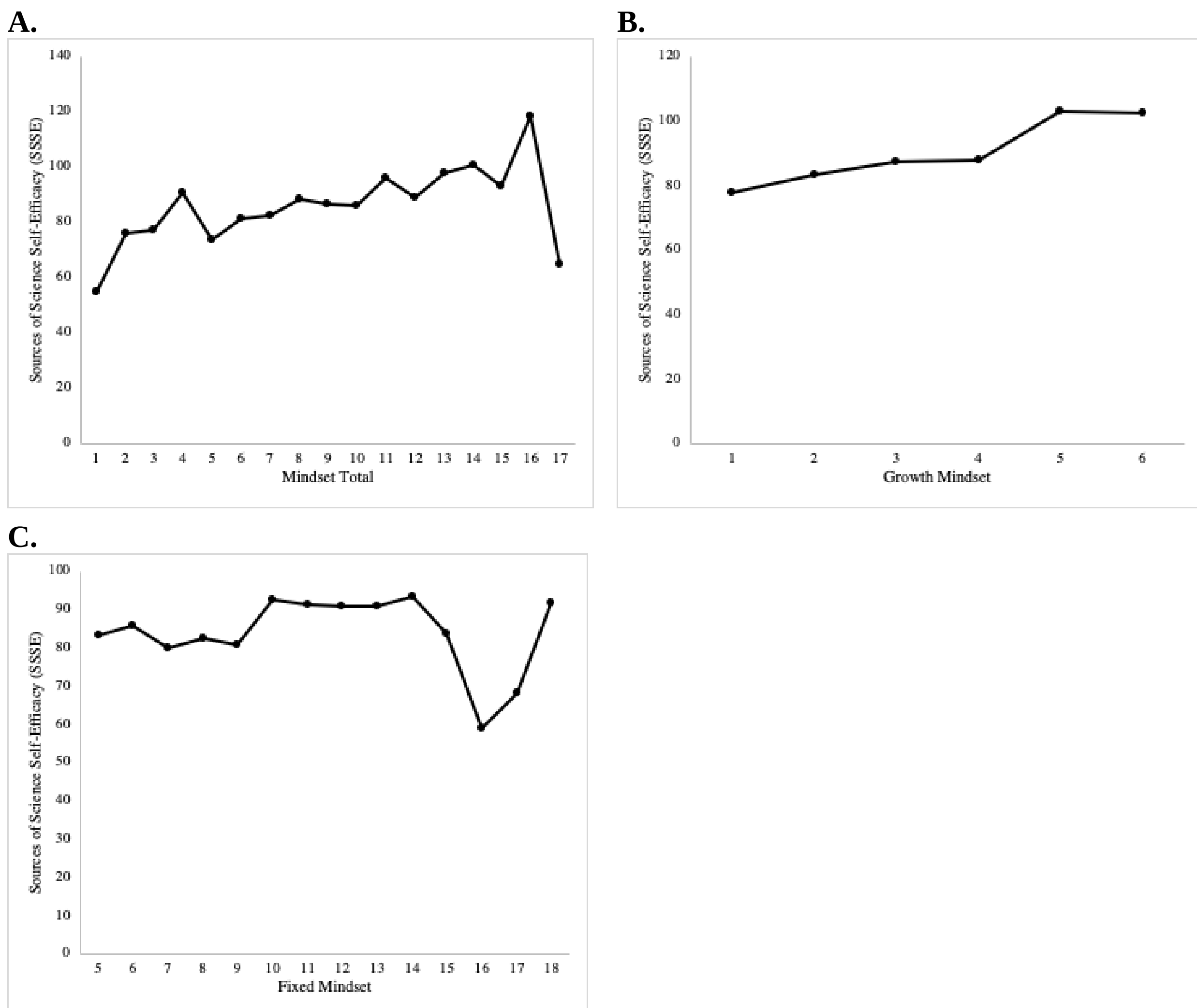


Total scores on impulsivity had a negative effect on SSSE (A; $p=0.001$). Attention and non-planning subscales had a significant negative effect (B; $p<0.01$ and C; $p<0.01$, respectively) whereas motor did not have an effect on SSSE (D; $p=0.55$).

Mindset on SSSE

Mindset total score ($F_{(16,221)}=2.093$, $p<0.05$; Table 6; Figure 3a) and its growth mindset subscale ($F_{(5, 255)}=8.596$, $p<0.00$; Table 6; Figure 3b) both had significant positive effects on SSSE. Fixed mindset subscale had no impact on SSSE ($p=0.27$; Table 6; Figure 3d).

Figure 3. Growth mindset had a significant positive effect on students Sources of Science Self-Efficacy (SSSE).

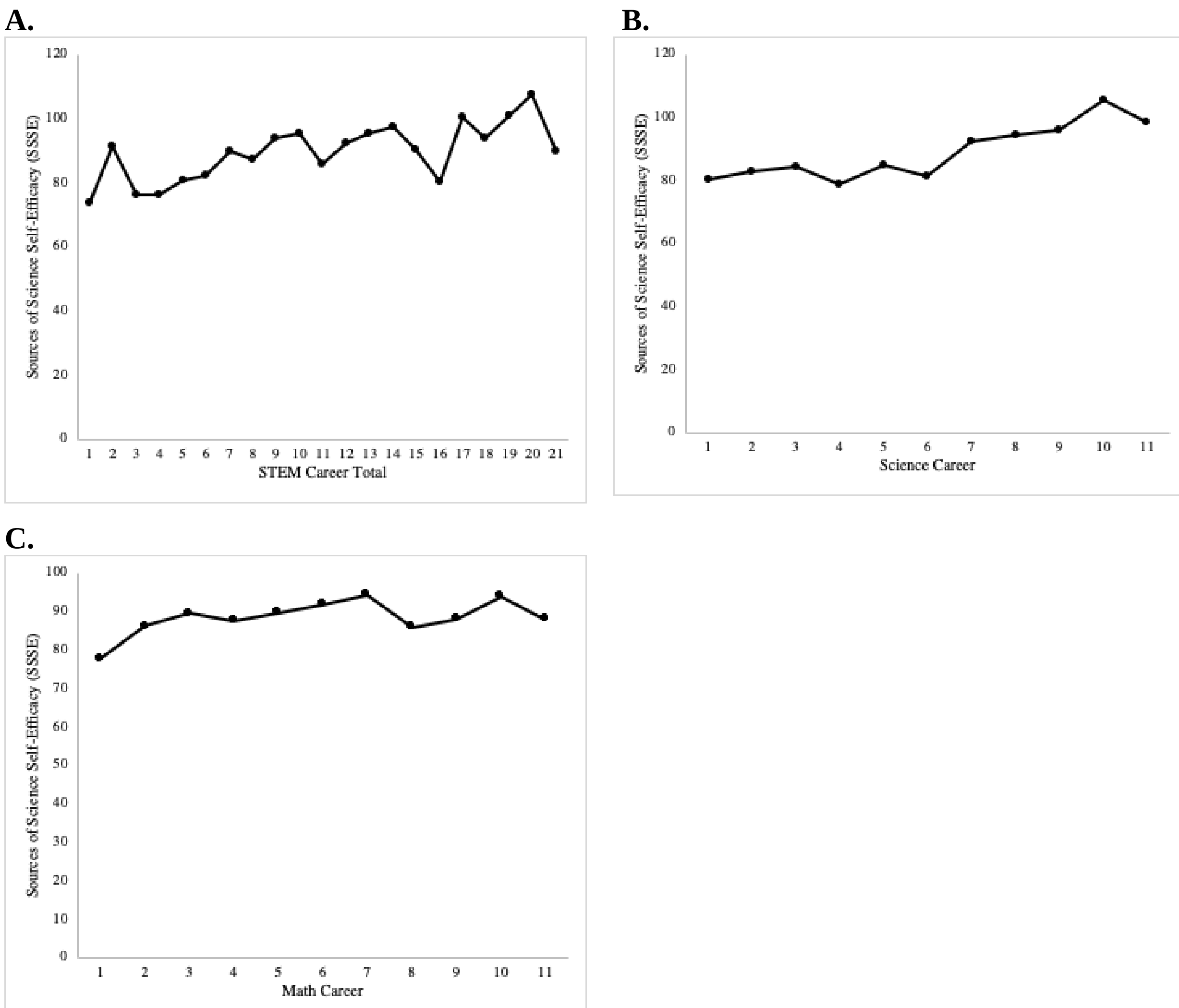


Total scores on mindset had a significant positive effect on SSSE (A; $p<0.02$) as did its growth mindset subscale (B; $p<0.01$). The fixed mindset subscale did not have a significant effect on SSSE (B; $p=0.27$).

STEM Career Interest on SSSE

Overall STEM career interests (i.e., science and math) had a significant positive effect on SSSE ($F_{(20,238)}=2.441$, $p<0.01$; Table 6; Figure 4a) . Science career interest had a positive effect on SSSE ($F_{(10, 251)}=4.708$, $p<0.0001$; Table 6; Figure 4b) whereas math career interest had no effect on SSSE ($p=0.104$; Table 6; Figure 4d).

Figure 4. STEM career interest (science and math) had a significant positive effect on students Sources of Science Self-Efficacy (SSSE).

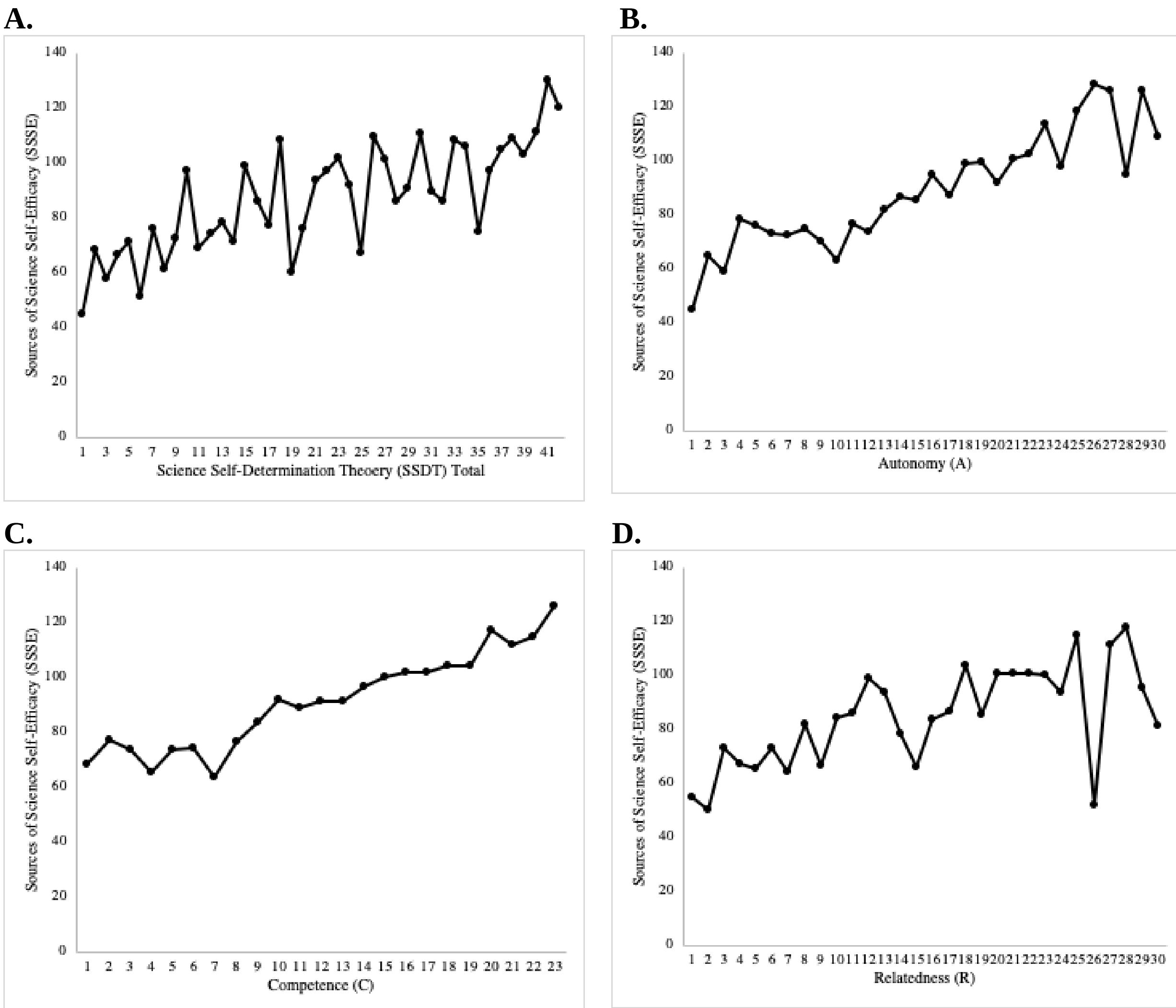


Total scores on STEM career interest (i.e. science and math combined) had a significant positive effect on SSSE (A; p<0.001). Science career interest had a positive effect on SSSE (B; p<0.001), whereas math career interest did not have an effect on SSSE (C; p=0.104).

Science Self-Determination Theory on SSSE

Total scores on the Science Self-Determination Theory (SSDT) instrument and all three of its subscales, autonomy, competence, and relatedness, had a significant positive effect on SSSE (, $p<0.0001$; Table 6). Total SSDT scores had a positive effect on SSSE ($F_{(41, 72)}=4.255$, $p<0.0001$; Figure 5a), as did subscales of autonomy ($F_{(29, 1678)}=5.668$, $p<0.0001$, Figure 5b), competence ($F_{(22, 148)}=10.181$, $p<0.0001$, Figure 5c), and relatedness ($F_{(29, 93)}=3.419$, $p<0.0001$, Figure 5d).

Figure 5. Science Self-Determination Theory (SSDT) and its subscales had a significant positive effect on students Sources of Science Self-Efficacy (SSSE).

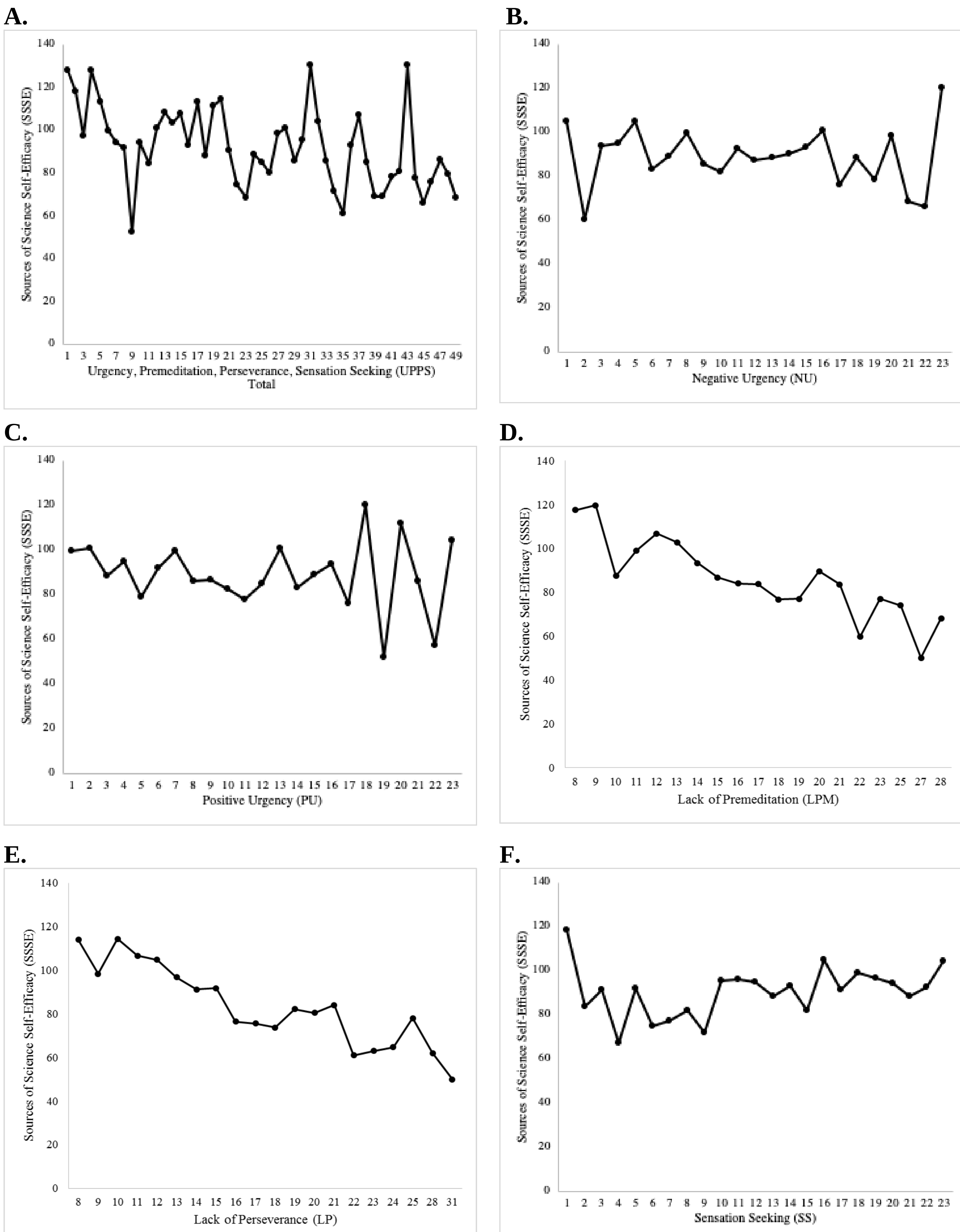


Total scores on SSDT had a positive effect on SSSE (A; $p<0.001$) as did all three subscales of autonomy (B; $p<0.001$), competence (C; $p<0.001$), and relatedness (D; $p<0.01$).

Risk taking (UPPS) on SSSE

Risk taking (UPPS) total score had no significant negative effect on SSSE ($p=0.06$; Table 6; Figure 612), nor did subscales of negative urgency ($p=0.08$), positive urgency ($p=0.12$), or sensation seeking ($p=0.05$). In contrast, the subscales lack of perseverance ($F_{(19, 143)}=7.236$, $p<0.0001$, Figure 6d) and lack of premeditation ($F_{(18, 145)}=4.772$, $p<0.0001$; Figure 6e) had a significant negative effect on SSSE.

Figure 6. Lack of perseverance (LP) of lack of premeditation (LPM) had a significant negative effect on students Sources of Science Self-Efficacy (SSSE).



Total scores on UPPS had no significant effect on SSSE (A; $p=0.06$). The subscales lack of premeditation (D; $p<0.001$) and lack of perseverance (E; $p<0.001$) had a negative effect on SSSE whereas subscales of positive urgency (B; $p=0.12$), negative urgency (C; $p=0.08$), and sensation seeking (E; $p=0.056$) had no effect on SSSE.

Discussion

The current research examined the relationship between impulsivity, including its related constructs of ADHD symptomology and risk taking, on students' beliefs in their science abilities that were measured using the Sources of Science Self-Efficacy (SSSE) instrument. Consistent with our prior work (72), we observed a negative effect of impulsivity on SSSE, which this study extends to include aspects of ADHD and risk taking.

This study evaluated the effects of ADHD symptomology, though data did not confirm that primary ADHD symptomology (i.e., part A of the ADHD screener survey), had an effect on students' science self-efficacy. In contrast, total ADHD scores and part B of the screener, which describe secondary symptomology, demonstrated a significant negative effect on SSSE (Figure 1). In addition, this study measured characteristics of risk taking, which did not have an overall effect on SSSE, though two of its subscales, lack of premeditation and lack of perseverance, had significant negative effects on students' science self-efficacy (Figure 6). Previous research has examined risk taking mostly in the context of addiction when treating substance abuse, (70) however our data suggest that constructs of risk taking may influence academics as well, such that when students are lacking in premeditation or perseverance, their science beliefs and self-efficacy may be negatively affected. Together, our data suggest that risk taking and non-clinical and/or undiagnosed symptoms of ADHD, which is estimated to have a prevalence within the U.S. school population of 5.9%-7.1% (30), may be more important than once believed for influencing students' beliefs in their science abilities. Prior work has documented that lower science self-efficacy can negatively impact a student's academic performance in STEM (72), though it remains unknown if impulsivity and related constructs of ADHD and risk taking, measured in middle school, would translate into reduced academic performance in STEM measured concurrently or later in students' academic careers, such as high school or college.

While students with ADHD or high impulsivity may struggle with STEM coursework, our current data show a positive effect of mindset that replicates our prior work (72). Dweck's mindset theory (33, 34, 54), which describes the belief that intelligence can be grown through hard work and effort, was positively associated with science self-efficacy in the current study. Likewise, we show in the current study that Deci & Ryan's Self-Determination Theory (69) also positively affected science self-efficacy, suggesting that perceived disadvantages stemming from impulsivity constructs may be offset when individuals engage in growth mindset as well as have their psychological needs met. Specifically the measurement of science self-determination theory produced the strongest influence on student's science self-efficacy, both in total scale and in all three subscales of autonomy, competence, and relatedness. This suggests that when students' basic psychological needs are being met in these three areas within the context of science, then students' self-beliefs in their science abilities may also increase. Comparatively, the measurement of mindset, specifically the subscale growth mindset also had a significant positive influence on students' science self-beliefs, whereas fixed mindset had no significant effect on SSSE. These findings may be of importance to educators when contemplating how to better meet the needs of neurodiverse students in STEM, such as those with ADHD, students who may be impulsive, or display risk taking characteristics.

The current study raises the question of whether these neurodiverse phenotypes may impact students' interests and performance in STEM fields. Previous literature has suggested that ADHD and characteristics such as impulsivity may encourage students not to engage in STEM due to the involvement of repetitive and time-consuming tasks (3). These data reinforce the concept that when students have increased science self-efficacy, their STEM (or science) interests and performance also increases. Additionally, when we think about STEM, the disciplines of math and science are often clumped together even though they are two very different disciplines, which elicit two different interest levels that are reflected in these current results. When examined together, our data offer preliminary evidence that mindset interventions and bolstering science self-determination theory may be beneficial accommodations for neurodiverse students and may be of use to educators wanting to support students' self-beliefs and performance in STEM.

References

1.Jones BD, Paretti MC, Hein SF, Knott TW. An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans. Journal of Engineering Education. 2010;99:319-336.
2.Lent R, Brown S, Schmidt J, Brenner B, Lyons H, Treistman D. Relation of contextual supports and barriers to choice behavior in engineering majors: Test of alternative social cognitive models. Journal of Counseling Psychology. 2003;50:458–465.
3.Simpkins SD, Davis-Kean PE, Eccles JS. Math and science motivation: A longitudinal examination of the links between choices and beliefs. Dev Psychol. 2006;42(1):70-83.
4.Parsons JS, Adler TF, Meece JL. Sex differences in achievement: A test of alternate theories. Journal of Personality and Social Psychology. 1984;46:26-43.
5.Maltese AV, Tai RH. Pipeline persistence: examining the association of educational experiences with earned degrees in STEM among U.S. students. Science Education. 2011;95(5):877-907.
6.Tai RH, Qi Liu C, Maltese AV, Fan X. Career choice. Planning early for careers in science. Science. 2006;312(5777):1143-1144.
7.Graham MJ, Frederick J, Byars-Winston A, Hunter AB, Handelsman J. Science education. Increasing persistence of college students in STEM. Science. 2013;341(6153):1455-6.
8.Spinella M, Miley W. Impulsivity and academic achievement in college students. College Student Journal. 2003;37(4).
9.Moeller FG, Barratt ES, Dougherty DM, Schmitz JM, Swann AC. Psychiatric aspects of impulsivity. Am J Psychiatry. 2001;158(11):1783-1793.
10.Evenden J. Impulsivity: a discussion of clinical and experimental findings. J Psychopharmacol. 1999;13(2):180-192.
11.Green L, Myerson J. How many impulsivities? A discounting perspective. J Exp Anal Behav. 2013;99(1):3-13.
12.Luman M, Tripp G, Scheres A. Identifying the neurobiology of altered reinforcement sensitivity in ADHD: a review and research agenda. Neurosci Biobehav Rev. 2010;34(5):744-754.
13.Robbins TW, Gillan CM, Smith DG, de Wit S, Ersche KD. Neurocognitive endophenotypes of impulsivity and compulsivity: towards dimensional psychiatry. Trends Cogn Sci. 2012;16(1):81-91.
14.Mitchell SH, de Wit H. Impulsivity. In: Stolerman I, editor. Encyclopedia of Psychopharmacology. 2nd ed. Heidelberg, Germany: Springer-Verlag; 2015.
15.Weafer J, Mitchell SH, de Wit H. Recent Translational Findings on Impulsivity in Relation to Drug Abuse. Curr Addict Rep. 2014;1(4):289-300.
16.White JL, Moffitt TE, Caspi A, Bartusch DJ, Needles DJ, Stouthamer-Loeber M. Measuring impulsivity and examining its relationship to delinquency. J Abnorm Psychol. 1994;103(2):192-205.
17.Dalley JW, Everitt BJ, Robbins TW. Impulsivity, compulsivity, and top-down cognitive control. Neuron. 2011;69(4):680-694.
18.Fineberg NA, Potenza MN, Chamberlain SR, Berlin HA, Menzies L, Bechara A, et al. Probing compulsive and impulsive behaviors, from animal models to endophenotypes: a narrative review. Neuropsychopharmacology. 2010;35(3):591-604.

19.Nugent K, Smart W. Attention-deficit/hyperactivity disorder in postsecondary students. Neuropsychiatr Dis Treat. 2014;10:1781-91.
20.Tymms P, Merrell C. ADHD and academic attainment: Is there an advantage in impulsivity? Learning and individual differences. 2011;21:753-758.
21.Kerr B, Kurpius S. Encouraging talented girls in math and science: effects of a guidance intervention High Ability Studies. 2004;15(1):2004.
22.Ghahremani DG, Oh EY, Dean AC, Mouzakis K, Wilson KD, London ED. Effects of the Youth Empowerment Seminar on impulsive behavior in adolescents. Journal of Adolescent Health. 2013;53(1):139-141.
23.Wentzel KR, Weinberger DA, Ford ME, Feldman SS. Academic achievement in preadolescence: The role of motivational, affective, and self-regulatory processes. . Journal of Applied Developmental Psychology. 1990;11:179-193.
24.Duckworth AL, Seligman ME. Self-discipline outdoes IQ in predicting academic performance of adolescents. Psychological Science. 2005;16(12):939-944.
25.Vigil-Colet A, Morales-Vives F. How impulsivity is related to intelligence and academic achievement. Span J Psychol. 2005;8(2):199-204.
26.Williams J, Dayan P. Dopamine, learning, and impulsivity: a biological account of attention-deficit/hyperactivity disorder. J Child Adolesc Psychopharmacol. 2005;15(2):160-179; discussion 57-9.
27.Frazier TW, Youngstrom EA, Glutting JJ, Watkins MW. ADHD and achievement: meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. Journal of Learning Disabilities. 2007;40(1):49-65.
28.McGee R, Prior M, Willams S, Smart D, Sanson A. The long-term significance of teacher-rated hyperactivity and reading ability in childhood: findings from two longitudinal studies. J Child Psychol Psychiatry. 2002;43(8):1004-1017.
29.Merrell C, Tymms PB. Inattention, hyperactivity and impulsiveness: their impact on academic achievement and progress. Br J Educ Psychol. 2001;71(Pt 1):43-56.
30.Willcutt EG. The prevalence of DSM-IV attention-deficit/hyperactivity disorder: a meta-analytic review. Neurotherapeutics. 2012;9(3):490-499.
31.Pullen PC. Prevalence of LD from parental and professional perspectives: A comparison of the data from the National Survey of Children's Health and the Office of Special Education Programs' Reports to Congress. Journal of Learning Disabilities. 2016.
32.CDC. Prevalence of autism spectrum disorder among children aged 8 years - autism and developmental disabilities monitoring network, 11 sites, United States, 2010. MMWR Surveill Summ. 2014;63(2):1-21.
33.Dweck C. Self-theories: Their role in motivation, personality, and development Philadelphia: Psychology Press; 1999. 212 p.
34.Dweck C. Mindset: The new psychology of success. New York: Random House; 2006.
35.National Center for Education Statistics: Search for Schools and Colleges [Internet]. U.S. Department of Education Institute of Education Sciences. 2017.
36.Spinella M. Normative data and a short form of the Barratt Impulsiveness Scale. Int J Neurosci. 2007;117(3):359-368.
37.Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. J Clin Psychol. 1995;51(6):768-774.
38.Usher EL, Parajes F. Sources of self-efficacy in mathematics: A validation study. Contemporary Educational Psychology. 2009;34:89-101.

39.Chen JA, Usher EL. Profiles of the sources of science self-efficacy. Learning and Individual Differences. 2013;24:11-21.
40.Blackwell L, Trzesniewski K, Dweck C. Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention Child Development. 2007;78(1):246-263.
41.Midgley C, Maehr ML, Hruda L, Anderman E, Anderman L, Freeman K, et al. Manual for the Patterns of Adaptive Learning Scales. In: Michigan Uo, editor. Ann Arbor, MI: http://www.umich.edu/~pals/manuals.html; 2000.
42.Knezek G, Christensen R, Tyler-Wood T. Contrasting perceptions of STEM content and careers. Contemporary Issues in Technology and Teacher Education. 2011;11(1):92-117.
43.Tyler-Wood T, Knezek G, Christensen R. Instruments for Assessing Interest in STEM Content and Careers Journal of Technology and Teacher Education. 2010;18(2):341-363.
44.Felder RM, Spurlin J. Applications, reliability, and validity of the Index of Learning Styles. International Journal of Engineering Education. 2005;21(1):103-12.
45.Jamieson S. Likert scales: how to (ab)use them. Med Educ. 2004;38(12):1217-8.
46.Norman G. Likert scales, levels of measurement and the "laws" of statistics. Adv Health Sci Educ Theory Pract. 2010;15(5):625-632.
47.Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Front Psychol. 2013;4:863.
48.Cohen J. Statistical power analysis for the behavioral sciences (rev. ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.; 1988.
49.Wuensch K. Karl Wuensch's Statistical Help Page: Placing a confidence interval on multiple Rsquared Greenville, North Carolina: East Carolina University; 2016 [Available from: http://core.ecu.edu/psyc/wuenschk/StatHelp/CI-R2.htm.
50.NIH. Frequently Asked Questions: Recruitment and Retention Plan to Enhance Diversity Washington DC: National Institutes of Health; 2009 [Available from: htttp://grants.nih.gov/TRAINING/FAQ_DIVERSITY.HTM#867.
51.Nix S, Perez-Felkner L, Thomas K. Perceived mathematical ability under challenge: a longitudinal perspective on sex segregation among STEM degree fields. Front Psychol. 2015;6:530.
52.Visser SN, Danielson ML, Bitsko RH, Holbrook JR, Kogan MD, Ghandour RM, et al. Trends in the parent-report of health care provider-diagnosed and medicated attention-deficit/hyperactivity disorder: United States, 2003-2011. J Am Acad Child Adolesc Psychiatry. 2014;53(1):34-46.e2.
53.Good C, Rattan A, Dweck CS. Why do women opt out? Sense of belonging and women's representation in mathematics. Journal of Personality and Social Psychology. 2012;102:700-717.
54.Yeager D, Dweck C. Mindsets that promote resilience: when students believe that personal characteristics can be developed. Educational Psychologist. 2012;47(4):302-314.
55.Yeager DS, Johnson R, Spitzer BJ, Trzesniewski KH, Powers J, Dweck CS. The far-reaching effects of believing people can change: implicit theories of personality shape stress, health, and achievement during adolescence. J Pers Soc Psychol. 2014;106(6):867-884.
56.Halperin E, Crisp RJ, Husnu S, Trzesniewski KH, Dweck CS, Gross JJ. Promoting intergroup contact by changing beliefs: group malleability, intergroup anxiety, and contact motivation. Emotion. 2012;12(6):1192-1195.

57.Mangels JA, Good C, Whiteman RC, Maniscalco B, Dweck CS. Emotion blocks the path to learning under stereotype threat. Soc Cogn Affect Neurosci. 2012;7(2):230-241.
58.Rattan A, Savani K, Naidu NV, Dweck CS. Can everyone become highly intelligent? Cultural differences in and societal consequences of beliefs about the universal potential for intelligence. J Pers Soc Psychol. 2012;103(5):787-803.
59.Aronson J, Fried C, Good C. Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. Journal of Experimental Social Psychology. 2012;38:113-125.
60.Paunesku D, Walton GM, Romero C, Smith EN, Yeager DS, Dweck CS. Mind-set interventions are a scalable treatment for academic underachievement. Psychological Science. 2015:784-793.
61.Taylor E, Kendall T, Asherson P, Bailey S, Bretherton K, Brown A, et al. Attention Deficit Hyperactivity Disorder: The NICE guideline on diagnosis and management of ADHD in children, young people, and adults: national clinical practice guideline number 72. London: The British Psychological Society and the Royal College of Psychiatrists; 2009.
62.Chan E, Fogler JM, Hammerness PG. Treatment of Attention-Deficit/Hyperactivity Disorder in Adolescents: A Systematic Review. JAMA. 2016;315(18):1997-2008.
63.Dickman SJ. Functional and dysfunctional impulsivity: Personality and cognitive correlates. Journal of Personality & Social Psychology. 1990;58(1):95-102.
64.Jackson D, Starobin S, Laanan F. The Shared Experiences: Facilitating Successful Transfer of Women and Underrepresented Minorities in STEM Fields. New Directions for Higher Education. 2013;162:69-72.
65.Reyes M. Unique Challenges for Women of Color in STEM Transferring from Community Colleges to Universities. Harvard Educational Review. 2011;81(2):241-262.
66.NSF. Women, Minorities, and Persons with Disabilities in Science and Engineering Washington D.C. National Science Foundation. 2015.
67.Britner S, Parajes F. Sources of science self-efficacy beliefs of middle school students. J Res Sci Teach. 2006; 43:485-499.
68.Alspaugh JW. Achievement loss associated with the transition to middle school and high school. The Journal of Educational Research. 1998;92(1):20-5.
69.Deci, EL, Ryan, RM, Gagné, M, Leone, DR, Usunov, J, Kornazheva, BP. Need Satisfaction, Motivation, and Well-Being in the Work Organizations of a Former Eastern Bloc Country: A Cross-Cultural Study of Self-Determination. Personality and Social Psychology Bulletin. 2001: 27(8): 930-942.
70.Tomko, RL, Prisciandaro, JJ, Falls, SK, Magid, V. The structure of the UPPS-R-Child impulsivity scale and its relations with substance use outcomes among treatment-seeking adolescents. Drug and Alcohol Dependence. 2016: 161: 276-283.
71. Gray, S, Woltering, S, Mawjee, K, Tannock, R. The Adult ADHD Self-Report Scale (ASRS): Utility in college students with attention-deficit/hyperactivity disorder. PeerJ, 2. 2014.
72. Marriott, LK, Coppola, L, Mitchell, SH, Bouwma-Gearhart, J, Chen, Z, Shifrer, D, Shannon, JK. Opposing effects of impulsivity and mindset on sources of science self-efficacy and STEM interests in adolescents. 2018.
73. Whiteside, SP, & Lynam, DR. The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. Personality and Individual Differences, 2001;30(4):669-689. doi:10.1016/s0191-8869(00)00064-7