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The Malleability of Gender-Science Implicit Bias

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ABSTRACT

Women in STEM are underrepresented in the media, which leads to the strengthening of the implicit bias that females do not belong in STEM fields since humans form expectations based on patterns that they observe. Past studies on racial implicit bias have shown that implicit bias can be temporarily shifted through exposure to images that go against stereotypical expectations. Therefore, the research question for this paper is: how will gender-science implicit bias shift when a participant from Grassfield High School is exposed to an advertisement containing varying degrees of female representation in STEM fields? A survey was distributed to participants at Grassfield High School that collected demographic data in addition to providing instructions for participants to take and record their scores from a gender-science Implicit Association Test, watch an advertisement of varying degrees of female representation in STEM, and then retake the gender-science IAT. The research hypothesis was that participants who were exposed to advertisements including counter stereotypes of women in STEM would have IAT results that were less stereotypical than the results from the initial test, and vice versa. The results indicate that females who are exposed to counter stereotypical media will have more stereotypical implicit associations, possibly due to the presence of stereotype threat. Although it became clear that gender-science implicit bias is not easily shifted, counter stereotypical media may not be an ideal way to reduce the gender-science implicit bias of young women at Grassfield High School against women in STEM.

Literature Review

Implicit Bias

Humans rely on cognitive short-cuts to process information and use the patterns that they perceive to set expectations (*Implicit Bias in Academia*, 2018). These stereotypical expectations contribute to a person's implicit bias, or flawed information processing based on experiences or preferences that an individual is not aware of (*Implicit Bias in Academia*, 2018; Perception Institute, 2019). For example, men have historically been in positions of political power, so most people typically assume that a politician is male.

Implicit bias is different from explicit bias, which is bias that a person is aware of and is measured through self-reporting (Greenwald et al., 2022). There are many different examples of implicit biases that people hold, such as unconsciously associating "Thin" with "Beautiful," or "Black" with "Unpleasant" (*About the IAT*, n.d.; Greenwald et al., 1998). This unknown preference for/aversion to a socio-demographic group can predict how a person thinks and acts sometimes more accurately than a person's conscious beliefs (Perception Institute, 2019). Implicit biases are often a factor for racism, sexism, homophobia, etc., so these unconscious associations are socially repulsive and are therefore rejected as being true. Nevertheless, numerous studies discuss the presence and impact of implicit biases, so it is important to acknowledge and understand these associations in order to reduce unconscious discrimination (Davies et al., 2002; Greenwald et al., 2022; *Implicit Bias in Academia*, 2018; Macdonald, 2021; Perception Institute, 2019; Santoniccolo et al., 2023). The implicit bias that this research will focus on is the tendency to associate "Female" with "Liberal Arts" and "Male" with "Science."

Gender Stereotypes

Most people in the United States hold an implicit bias against women in STEM fields, meaning that people unconsciously believe that women function better in “verbal” fields as opposed to “quantitative” fields or are bad at math/science (Davies et al., 2002; Del Carlo & Wagner, 2019; *Implicit Bias in Academia*, 2018; Macdonald, 2021; Moss-Racusin et al., 2015; Santoniccolo et al., 2023; Wille et al., 2018). In data collected from over 628,000 participants by a cognitive test used to measure implicit associations, 70% of respondents associate “Male” more closely with “Science” and “Female” more closely with “Liberal Arts,” which is consistent with literature that asserts that people are biased against women in scientific fields (See Appendix A) (*About the IAT*, n.d.). Other examples of gender stereotypes include “clever/brainy” being incompatible with “normal” and “girly,” as well as “ambition,” “competence,” and “intelligence” being associated more strongly with men (Macdonald, 2021; Santoniccolo et al., 2023). These gender stereotypes are perpetuated by the representation of women in the media since implicit biases stem from the patterns that people perceive (Haris et al., 2023; *Implicit Bias in Academia*, 2018; Macdonald, 2021; Santoniccolo et al., 2023).

Media’s Influence on Gender Stereotypes

The way that media is able to change or support stereotypes aligns with cultivation theory, developed in 1998 (Ward & Grower, 2020). Cultivation theory states that television presents a distorted view of the world and frequent exposure to television will cause a viewer to develop social attitudes that align with the world from television. Results from several studies about gender, science, and the effect of the media certainly agree with cultivation theory. In 2002, women who viewed television advertisements reinforcing the stereotype that women are bad at math avoided math questions on an aptitude test and expressed more interest in fields requiring less math content to avoid the negative stereotype (Davies et al., 2002). In 2018, 355 5th graders who watched a math educational video that perpetuated the idea that girls are worse at math increased the students’ acceptance of these stereotypes (Wille et al., 2018). Three meta-analyses that analyzed findings from 2000 to 2020 concluded that there is a small but consistent association between frequent television viewing and expressing more stereotypical gender beliefs (Ward & Grower, 2020). In 2012, the Geena Davis Institute on Gender in Media found that the ratio of male characters in STEM to female characters is 15:1 with the typical television scientist being portrayed as a white, highly intelligent male (Geena Davis Institute on Gender in Media & Lyda Hill Foundation, n.d.; Macdonald, 2021). Since humans use past experiences to set expectations and the media portrays women as unqualified for STEM fields, the implicit bias that women are unsuited to work in STEM areas is created for viewers (Haris et al., 2023; *Implicit Bias in Academia*, 2018; Macdonald, 2021; Santoniccolo et al., 2023; Ward & Grower, 2020; Wille et al., 2018).

Lack of STEM Female Representation

The underrepresentation of women in STEM fields is both a cause and effect of gender stereotypes perpetuated by the media (Macdonald, 2021). Men are 4.5 times more likely than women to pursue majors high in math-content while women are 2.5 times more likely to drop out of these “quantitative” majors (Davies et al., 2002). Women occupy only a quarter of STEM jobs in the United States (Geena Davis Institute on Gender in Media & Lyda Hill Foundation, n.d.). Since producers and writers make money by providing media that fit viewer’s expectations, gender norms are often reinforced by all types of media (Haris et al., 2023). The portrayal of STEM fields as masculine domains causes men and women to internalize the idea that STEM jobs are for men. This causes women to avoid pursuing STEM careers due to the belief that they do not have the skill sets to succeed in STEM areas due to the severe lack of role models in the media to show anything different (Davies et al., 2002; Haris et al., 2023; Santoniccolo et al., 2023; Wille et al., 2018). The lack of women in STEM in the media and the lack of women in STEM in real-life careers are causes and effects of each other, creating a self-perpetuating cycle (Macdonald, 2021). Out of the STEM characters in various films, television shows, and streaming content from 2007-2017 that were analyzed by the Geena Davis Institute on Gender in Media, 62.9% were male while 37.1% were female (Geena Davis Institute on Gender in Media & Lyda Hill Foundation, n.d.). From 2018-2022, the percentage of female STEM characters only increased to 32%. This disparity echoes how 72.8% of people with a STEM degree are male and 27.2% are female.

Implicit Association Test

The Implicit Association Test (IAT) is used to identify the strength of implicit bias that someone has based on how closely they unconsciously associate certain concepts together, or implicit association (Greenwald et al., 1998). IATs are widely taken with over 40 million tests completed since its creation (*About the IAT*, n.d.). This test demonstrates that being able to connect two objects/concepts faster means that a person has a stronger implicit association between those objects and therefore a stronger implicit bias (Greenwald et al., 1998). The results of the IAT show the test-takers' strength of association between two groups. For additional information on the Implicit Association Test, see Appendix B.

How Interventions Affect Implicit Bias in the Short Term

The more that someone watches television, the more strongly they believe in gender norms or that women are limited in fields requiring science and math (Davies et al., 2002; Santoniccolo et al., 2023; Ward & Grower, 2020; Wille et al., 2018). Conversely, consuming media where characters go against gender occupational stereotypes leads to viewers having less stereotypical views and can be thought of as an intervention for gender-science implicit bias (Joy-Gaba & Nosek, 2010; Ward & Grower, 2020). Although long-term exposure to a counterstereotypical role model has a positive correlation with a person's aspiration for/engagement with that role, even a brief exposure to these role models can sometimes temporarily change stereotypical beliefs about women (Olsson & Martiny, 2018). For example, girls exposed to television characters that went against gender occupational stereotypes expressed less stereotypical beliefs about gender roles in occupations (Ward & Grower, 2020). A 2016 study found that interventions for racial implicit bias were effective in the short term, but not after several hours or days (Lai et al., 2016). In 2001, Anthony Greenwald, a developer of the Implicit Association Test, co authored a study that tried to determine the malleability of racial implicit bias in the short term and found a demonstrated effect of 0.82 for the relationship between being shown counter stereotypical images and changes in racial implicit bias (Dasgupta & Greenwald, 2001). In 2010, Brian Nosek, another developer of the Implicit Association Test, replicated Greenwald's study and found a demonstrated effect that was over 70% smaller than what was found in the 2001 study (Joy-Gaba & Nosek, 2010). However, Nosek concluded that implicit bias can be weakly shifted. The difference in the demonstrated effect found by Greenwald and Nosek, two developers of the IAT, provides space for further analysis, especially almost 15 years after Nosek's study.

Area of Interest

It is of interest to understand exactly how the consumption of media can affect implicit bias because a person's unknown preference for/aversion to a socio-demographic group can predict how a person will act (Greenwald et al., 1998; *Implicit Bias in Academia*, 2018; Perception Institute, 2019). The academic world operates based on meritocracy, or the system where power is allocated to those who deserve it, but gender implicit bias can give more merit to men (*Implicit Bias in Academia*, 2018). The stereotype that women are bad at math could cause an employer to discredit the qualifications of a woman seeking a job in a math-based field if he/she unconsciously believes in that stereotype. Moreover, a woman could be discouraged from pursuing a career in a STEM field if they hold an implicit bias indicating that they would succeed in a verbal career as opposed to a quantitative one (Davies et al., 2002; Macdonald, 2021). Therefore, it is important to understand how changing representations of women in the media could decrease gender-science implicit biases.

Gap

Although research has been done to analyze how racial implicit bias can be shifted through exposure to counter stereotypical images, there is both a methodological and population gap as only limited research has been conducted for how gender-science implicit biases, measured by the Implicit Association Test, can be changed in the short term by exposure to counter stereotypical advertisements, with minimal focus on high school STEM Academies. Accordingly, the question guiding the researcher's work was: how does gender-science implicit bias change in the short term when a person is exposed to counter stereotypes of women in STEM in the media?

Methodology

This experiment aims to determine how the "strength" of the intervention (the degree of female STEM representation) affects the change in gender-science implicit bias before and after the intervention, if at all. Therefore, the researcher employed experimental methodology via the use of the Implicit Association Test to quantify the effect of interventions on gender-science implicit bias. The results can be used to form conclusions about whether counter stereotypical media can affect implicit bias and thereby how media can be adjusted to reduce gender-science implicit bias, a significant barrier to women pursuing STEM careers.

First, four YouTube videos of varying degrees of female STEM representation were identified and classified in addition to one unrelated video. Then, participants were asked to take the gender-science Implicit Association Test to establish his/her original level of bias, watch a video of varying degrees of female representation in STEM/counter stereotypes, and then retake the gender-science IAT to determine how his/her implicit bias shifted. Additionally, data about the participants' age, gender, association with the Governor's STEM Academy, and participation in high-level classes was collected.

Hypothesis

The researcher hypothesized that participants who watched counter stereotypical videos would have IAT results that were more counter stereotypical than the results from their initial test and participants who watched stereotypical videos would have IAT results that were more stereotypical than the results from their initial test. Alternatively, the results may yield the null hypothesis, which is no correlation between the degree of female STEM representation in the intervention and the change in IAT score.

Implicit Association Test

The Implicit Association Test (IAT) is a cognitive test that measures a participant's strength of implicit association between two categories in order to identify implicit bias (*About the IAT*, n.d.; Greenwald et al., 1998). In this research, the gender-science IAT was used as an indicator of whether a participant's implicit bias was stereotypical or counter stereotypical before and after the intervention in order to determine if the interventions can affect implicit bias.

Interventions

According to a 2022 study from Pew Research Center, YouTube, an online video sharing and social media platform, is used by 95% of teens with one in five teens using it "almost constantly" (Vogels et al., 2022). A different 2022 study from Statista found that 72% of adults have a YouTube account (Ceci, 2022). Due to the popularity of YouTube and the likelihood that a participant would have familiarity with a YouTube video, four YouTube videos with different degrees of female STEM representation were selected as "interventions" for participants' gender-science implicit bias. All videos were cut to the same length to ensure that the length of the video did not affect the strength of the intervention. Additionally, 30 second video advertisements were found as the "sweet spot" since 30 second ads were cheaper than 60 second ads but allowed for more viewer recall of the advertised good/service than 15-second ads, as found in a 2019 study about the relationship between advertisement length and recall of certain brands (Varan et al., 2019). The selected videos were cut to 30 seconds to model video advertisements that are 30 seconds to minimize the cost of producing/broadcasting the advertisement and maximize consumer recall. Since each intervention had to exhibit characteristics of different degrees of female STEM representation, the videos were cut to include specific actions, actors, and narration that support each degree (See Table 1).

Various YouTube videos associated with the STEM field were viewed and classified into high female STEM representation, high-medium representation, low-medium representation, low representation, and unrelated. From here, one video from each classification was chosen for a total of five videos, or interventions. Video 1 had the highest degree of female STEM representation while Video 4 had the lowest degree of representation. Video 5 was unrelated to gender or science and was used as the comparison condition.

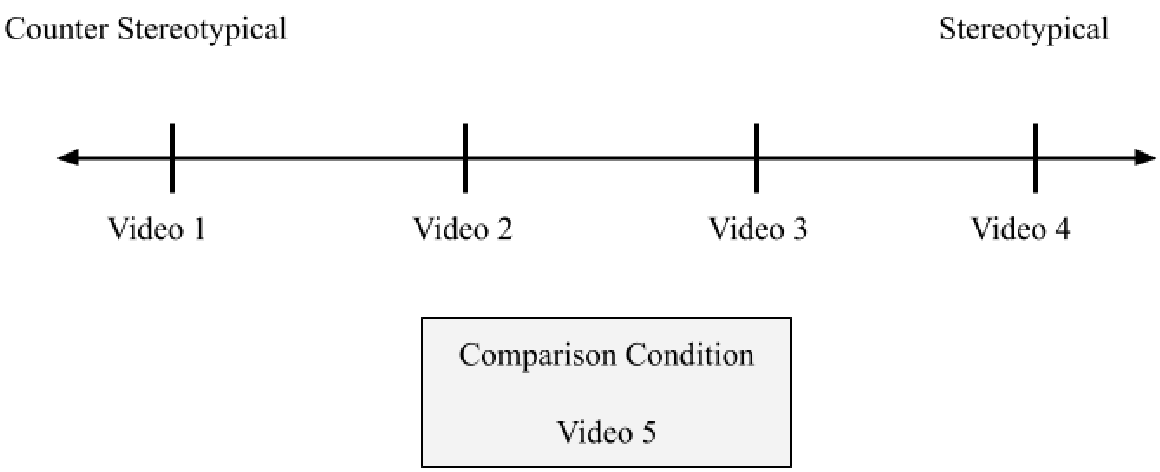

Figure 1. Scale for degrees of female representation in STEM.

Table 1. Videos were classified based on certain elements relating to gender and STEM.

Degree of Female STEM representation	Video Link	Description
High	Video 1	L'Oréal USA for Women in Science Fellowship advertisement: all scientists were women; counter stereotypical narration about the influence of women in STEM fields

High-medium	Video 2	Northrop Grumman advertisement: even mix of male and female engineers; narrated by a woman detailing aspects of the company
Low-medium	Video 3	Take 2 STEM interview: a male Chief Scientist discusses his role; narration is paired with a male scientist and a female scientist in the background.
Low	Video 4	CBS Evening News from May 22, 1995: woman tries to set up her personal computer but she is visibly struggling; male technicians take calls to offer assistance
Unrelated	Video 5	Chevrolet advertisement: a woman's life events that she shared with her beloved dog are connected to how a Chevrolet car can be a friend for life

Comparison Condition

After corresponding with Dr. Brian Nosek, a professor of psychology at the University of Virginia and one of the original developers of the IAT, the researcher chose to include a comparison condition during the experiment. According to Dr. Nosek, a person's strength of associations according to the IAT declines over time as a person gains more experience taking the test (B. Nosek, personal communication, November 9, 2023). Without a comparison condition, there is no way to know if the decrease of a participant's strength of association as measured by the IAT is due to the intervention or just the effect of a participant getting experience with completing the measure. During the survey, participants were asked to randomly choose a number 1-5 having no knowledge of the significance of the number. The number each person chose corresponded to one of 5 different videos where videos 1, 2, 3, and 4 were related to gender and STEM while video 5 was completely unrelated. If the participants' strength of association after watching video 5 decreased on the Gender-Science IAT, then any decrease on the Gender-Science IAT for the participants who watched videos with a higher degree of female STEM representation was at least partially due to the participants gaining experience with the IAT. If the strength of association for participants who watched video 5 did not decline on the second IAT, then the intervention would be responsible for the change in strength of associations on the Gender-Science test for the participants who watched the other 4 videos. This comparison condition is similar to the comparison condition used in a 2010 implicit bias malleability study about four different types of biases by Dr. Joy-Gaba and Dr. Nosek where counter-stereotypical portraits and descriptions were switched to cartoon characters for a group of participants (Joy-Gaba & Nosek, 2010). Since representations in the media have changed over time, determining a population's associations between gender and science nearly 15 years after the 2010 study will be informative in addition to investigating how short advertisements can change associations as opposed to portraits with descriptions.

Population

Grassfield High School in Chesapeake, Virginia, is the host school for the Governor's STEM Academy where additional engineering, computer programming, and entrepreneurship classes and opportunities are offered. Grassfield High School was chosen as the population of study because the presence of the STEM Academy closely relates to implicit biases against women in STEM fields. Also, the gender distribution between the three pathways in the STEM Academy (Engineering, Programming, and Entrepreneurship) of the past 6 incoming classes provides an opportunity for further analysis and stronger implications. See Appendix C for gender distribution data of STEM students in each pathway.

Both the engineering and programming pathways are stereotypical as seen by the large male:female ratio. The entrepreneurship pathway, by contrast, is female dominated. Although entrepreneurship is included in the Governor's STEM Academy, it can be argued that entrepreneurship is in the field of liberal arts, meaning that it is also stereotypical. Therefore, the Governor's STEM Academy at Grassfield High School has a stereotypical gender distribution with more males in STEM classes and more females in liberal arts classes. Grassfield High School also has high enrollment rates in Advanced Placement (AP) and Dual Enrollment (DE) classes in science/math classes and liberal arts classes. Participants were pulled from these groups in addition to the STEM Academy to yield data on how interventions might affect the gender-science implicit bias of participants who already are strongly associated with STEM fields and/or liberal arts fields. Therefore, a survey (in the format of a Google Form) including both demographic questions and questions about the amount of STEM Academy classes, AP/DE science/math classes, and AP/DE liberal arts each participant has or is taking was distributed to students via Grassfield High School teachers in order to gather as many participants as possible.

Additionally, the survey contained all of the instructions needed for participants to take the Implicit Association Tests, be assigned and watch an intervention, and report their results from both of the IATs. Students and faculty members were allowed to complete the survey on their own time and it was assumed that all participants completed the survey to the specifications contained in the Google Form. Prior to completing the survey, the participants were informed that the experiment could reveal attitudes that they might prefer not to demonstrate, similar to the guidance given in the original 1998 Implicit Association Test study (Greenwald et al., 1998). Participants were required to agree to complete the survey before being allowed to continue to the next section to ensure that participants were informed about any possible effects of the survey (See Appendix D).

IRB Approval Exemption

Some human subjects research requires direct approval from the Institutional Review Board, or IRB (Office for Human Resource Protections, 2018). The research is exempt from this approval under Exemption 45 CFR 46.104(d)(2) of the Human Subject Regulations Decision Charts since the Implicit Association Test is an educational cognitive test (See Appendix E). Additionally, Personal Identifiable Information (PII) is defined by the U.S. Department of Labor as information that could be used to determine or reasonably infer an individual's identity, which includes a person's name, address, social security number, email address, or phone number (*Guidance on the Protection of Personal Identifiable Information*, n.d.). PII does not include an individual's place of work, job title, gender, etc. Although the exemption does not apply when the research involves children and includes PII, the data collected by the researcher does not collect PII and therefore maintains its eligibility to be exempt from IRB approval under Exemption 45 CFR 46.104(d)(2) (Office for Human Resource Protections, 2018).

Procedure

Participants from STEM Academy classes and high-level science/math/liberal arts classes were asked to fill out a Google Form distributed to them by their teacher. The teachers of these classes were also asked to fill out the same Google Form. After agreeing to complete the survey, the next section the participant completed was a questionnaire collecting data about the participant's age, gender, and association with the Governor's STEM Academy and high-level science/math/liberal arts classes (See Appendix F). The age groupings that adult participants could choose from was based on the generations of Generation Z, Millennials, Generation X, Boomers II, and Boomers I. The survey was therefore able to collect data based on generations and, in the event that there were enough generational differences, could provide an analysis. Ages 14, 15, 16, 17, and 18 were separated out from Generation Z because it was predicted that more participants of these ages would fill out the survey since the study was conducted at a high school. Data about gender was collected because this research is inextricably linked to gender, so results of the Implicit Association Tests and interventions could vary based on gender (Macdonald, 2021). These gender variations were seen in a 2018 study that showed fifth grade students television programs that reinforced gender-science stereotypes where boys experienced a positive change to their sense of belonging and a negative change to their social utility while girls experienced no effects (Wille et al., 2018). Participants' involvement in the Governor's STEM Academy, high-level science/math courses, and high-level liberal arts courses was another variable in this research since implicit bias is formed from past experiences that set expectations which cause humans to associate certain roles with certain demographics (*Implicit Bias in Academia*, 2018). Then, specific instructions for how the participants should have completed the gender-science Implicit Association Test on https://implicit.harvard.edu/implicit/selectatest.html were given as well as a multiple choice question allowing participants to report their "scores" (See Appendix G).

On the next section of the survey, participants were instructed to choose a number ranging from 1 to 5. The number that they chose corresponded to the number of the video that they watched with varying degrees of female representation in STEM, with video 5 as the comparison condition (See Appendix H). Since the participants were instructed to choose a number randomly with no knowledge of the result of their choice, about an equal number of participants watched each video. After randomly selecting a number, participants were presented with the corresponding video and asked to enlarge the video and watch it in its entirety (See Appendix I). In the last section of the survey, the same instructions for the initial test were presented to the participants as well as a question for them to report their score after the intervention. After this last section, the participants submitted the form, after which a thank-you message appeared. To summarize, after data about demographics and involvement in certain classes was collected, participants took a gender-science IAT, watched an intervention, and then retook the same IAT to see how scores changed.

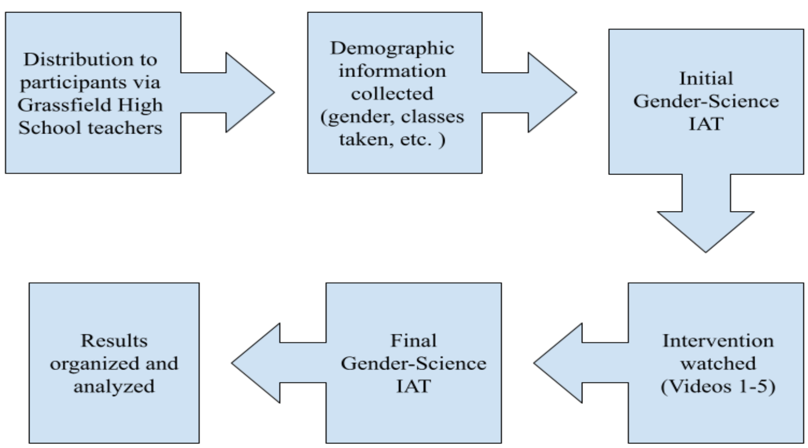

Figure 2. Flow chart for steps of data collection.

Results

Based on the information collected in the review of the existing literature, implicit associations can be shifted when shown counter stereotypical images (Joy-Gaba & Nosek, 2010; Ward & Grower, 2020). However, this research was not conducted about gender-science implicit bias specifically at Grassfield High School. Additionally, since the results focus on the effect of media on teenagers, it is important to note that past literature examining the malleability of implicit bias studied adult populations that did not experience the popularity of YouTube, a social media platform that was the source of the five videos used as interventions.

The researcher hypothesized that the implicit biases of participants would shift to become less stereotypical after viewing counter stereotypical media, and vice versa. Survey results detailing the initial score of each participant on the IAT, which numbered video they watched, the final score of each participant on the IAT, and the change between each participant's final and initial score are shown in the results section to study this hypothesis. A negative change shows that a person's associations as measured by the IAT became more stereotypical (associating male more closely with science and female more closely with liberal arts) after watching the video while a positive change shows that a person's associations as measured by the IAT became less stereotypical (associating male more closely with liberal arts and female more closely with science).

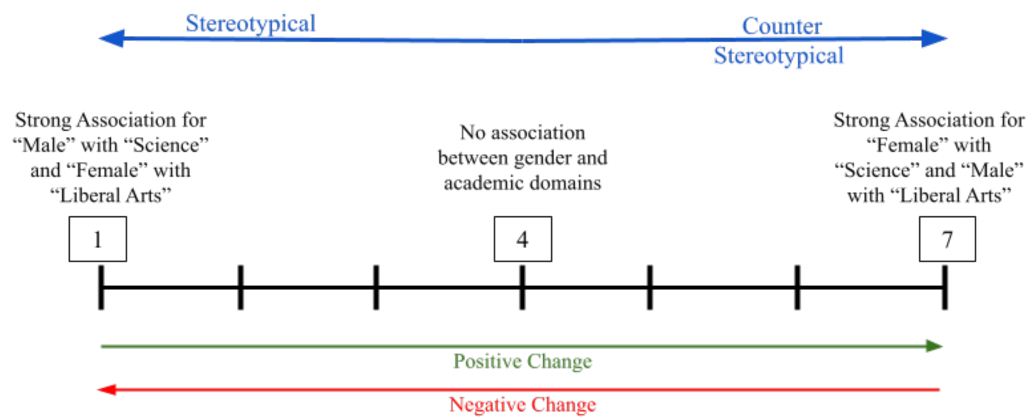

Figure 3. Scale for association between gender and academic domains.

Although data on the age of the participants was collected in order to determine the correlation between generation and change in IAT score, not enough participants of different generations completed the survey, so age data was not reported on. Additionally, participant 1 was eliminated from the results because he provided impossible demographic information where he indicated that he was over 69 years of age and had taken every STEM Academy, AP/DE science/math, and AP/DE liberal arts class at Grassfield High School despite Grassfield High School opening for the first time in 2007, decades after a person over 69 years of age would have been in high school.

The data collected was organized into several tables (See Appendix J) and was developed into boxplots and scatterplots to visualize the effect of variables on change in IAT score.

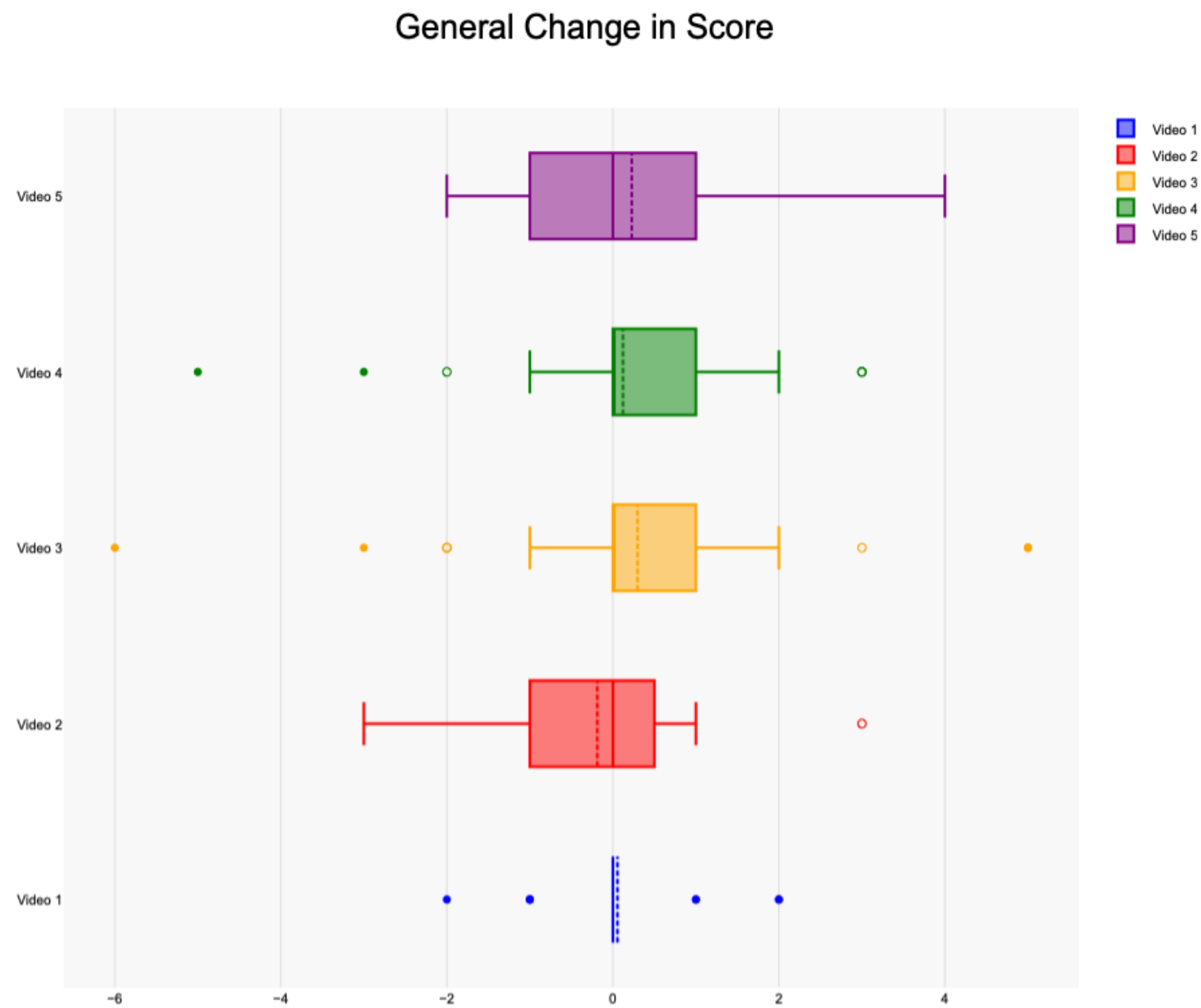

Figure 4. Change in IAT Score for all five videos.

Boxplot 1 shows data from every participant for all five videos. Although the degree of female representation in STEM was manipulated according to which video the participant watched, the average change in IAT score was close to zero for each video, signifying that exposure to stereotypical or counter stereotypical media had no effect on average for all genders. The change in IAT score for the comparison condition, video 5, had a mean of 0, indicating that most changes in the IAT score were due to influences from the media and did not result from participants improving at taking the IAT.

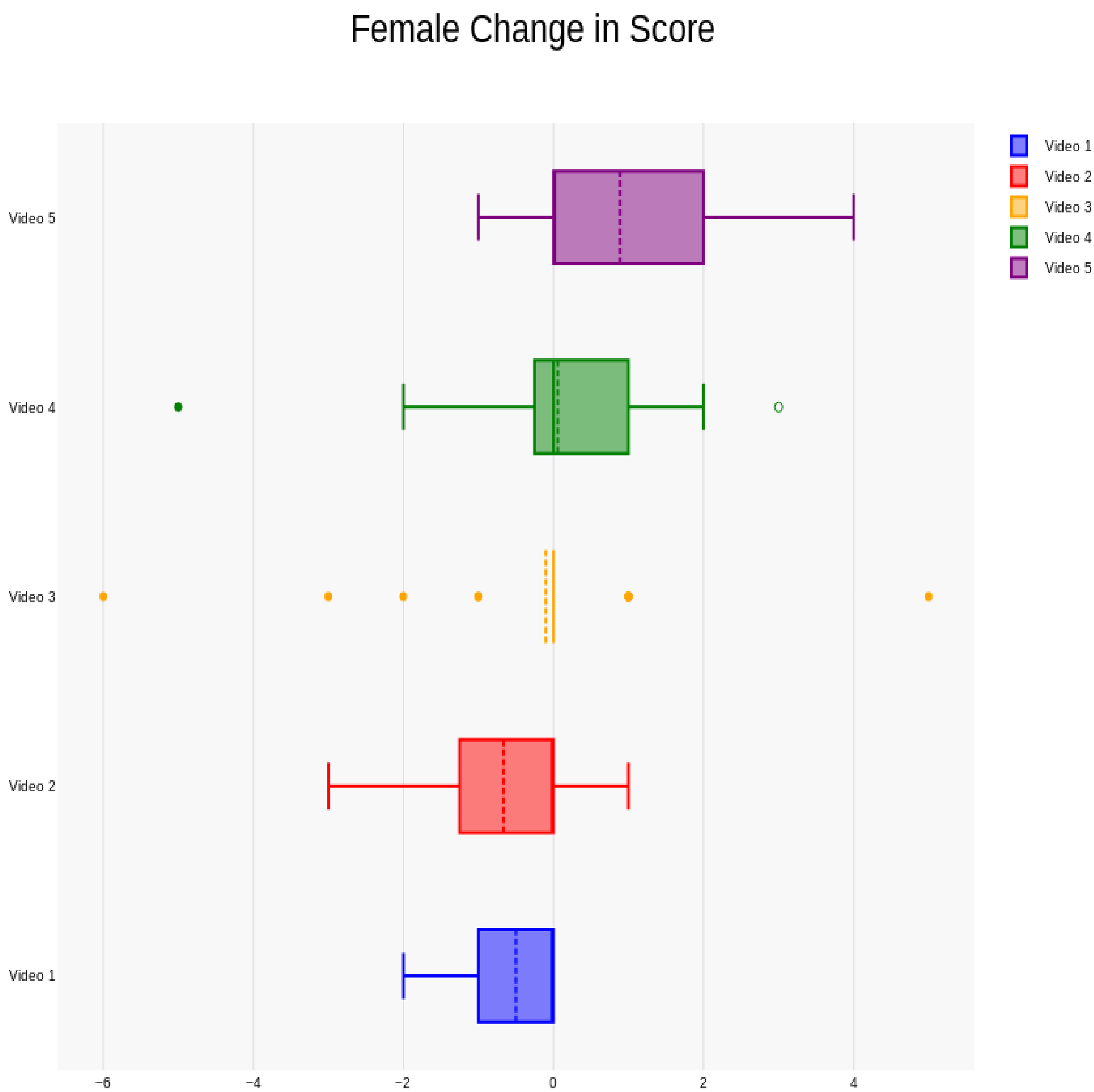

Figure 5. Change in IAT score for females.

As seen in Boxplot 2, female participants in general experienced a negative change when exposed to Videos 1 and 2 (mean change of -0.58333), the counter stereotypical media, and experienced almost no change when exposed to the stereotypical media of Videos 3 and 4 (mean change of -0.08114). The implicit bias of female participants, therefore, was more likely to shift to a more stereotypical view of gender and academic domains when viewing counter stereotypical media and more likely to stay constant when viewing stereotypical media.

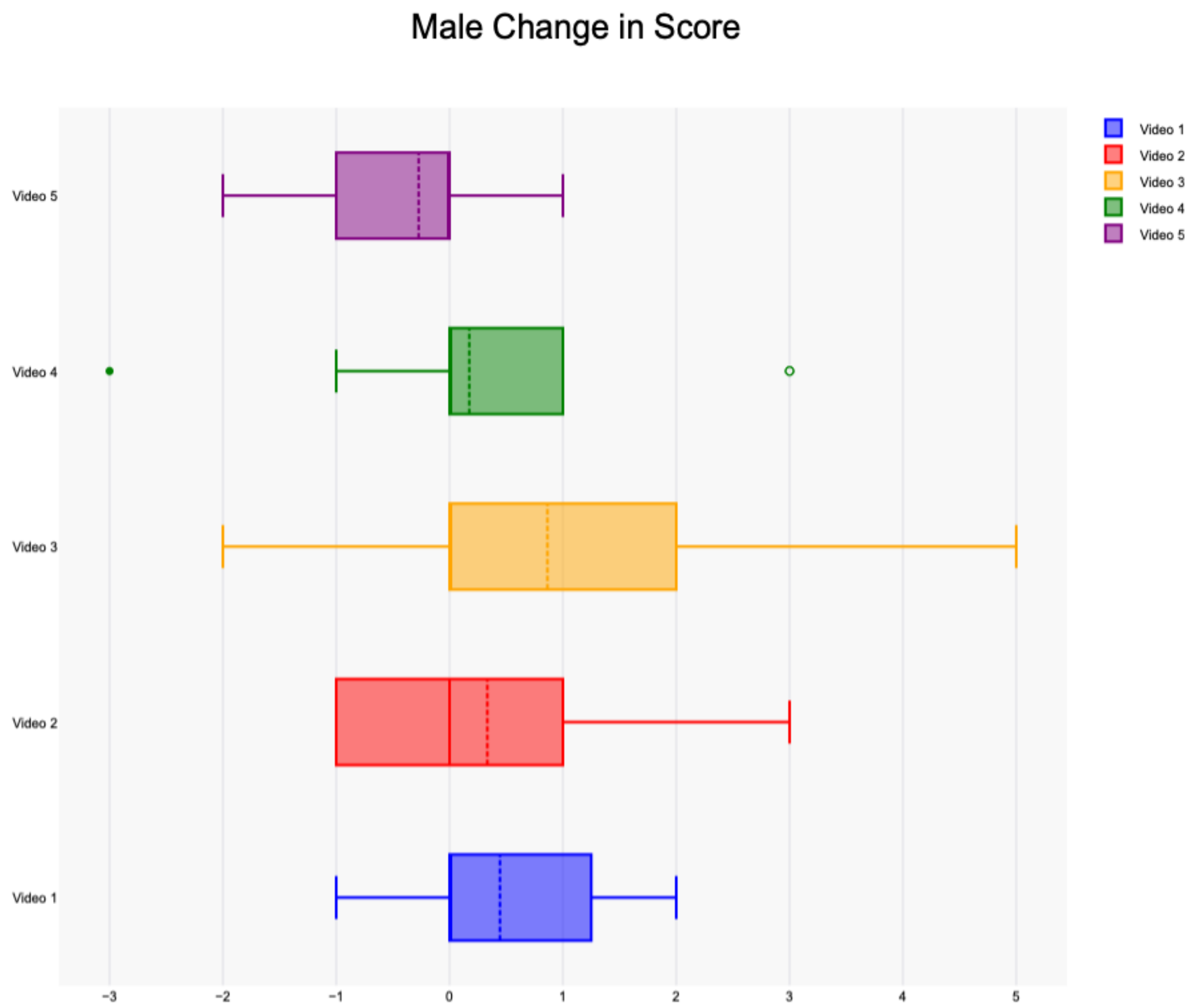

Figure 6. Change in IAT score for males.

Male participants, as portrayed in Boxplot 3, experienced a positive change (mean change of 0.45381) after being exposed to all four videos containing various representations of females in STEM. In other words, the implicit bias of male participants was more likely to become less stereotypical after watching all videos, regardless of whether the media was stereotypical or counter stereotypical.

The change in IAT score for the comparison condition, video 5, had a mean of 0, indicating that most changes in the IAT score were due to influences from the media and did not result from participants improving at taking the IAT. In terms of gender differences for the comparison condition, female participants who watched Video 5 experienced a positive change (mean change of 0.88888) while male participants who watched Video 5 experienced a negative change (mean change of 0.27273).

Scatterplots were generated from the gathered data in order to determine the relationship between the number of STEM Academy, AP/DE science/math, and AP/DE liberal arts courses taken and change in IAT score. The line of best fit shown on the scatterplots assumes a linear relationship between two variables and predicts the change in a participant's IAT score based on the amount of classes they have taken in each field. A slope of zero indicates that the change in IAT score is not statistically related to the amount of classes taken. A positive slope indicates that IAT scores are more likely to increase as the amount of classes taken in each domain increases while a negative slope indicates that IAT scores are more likely to decrease as the amount of classes taken in each domain increases.

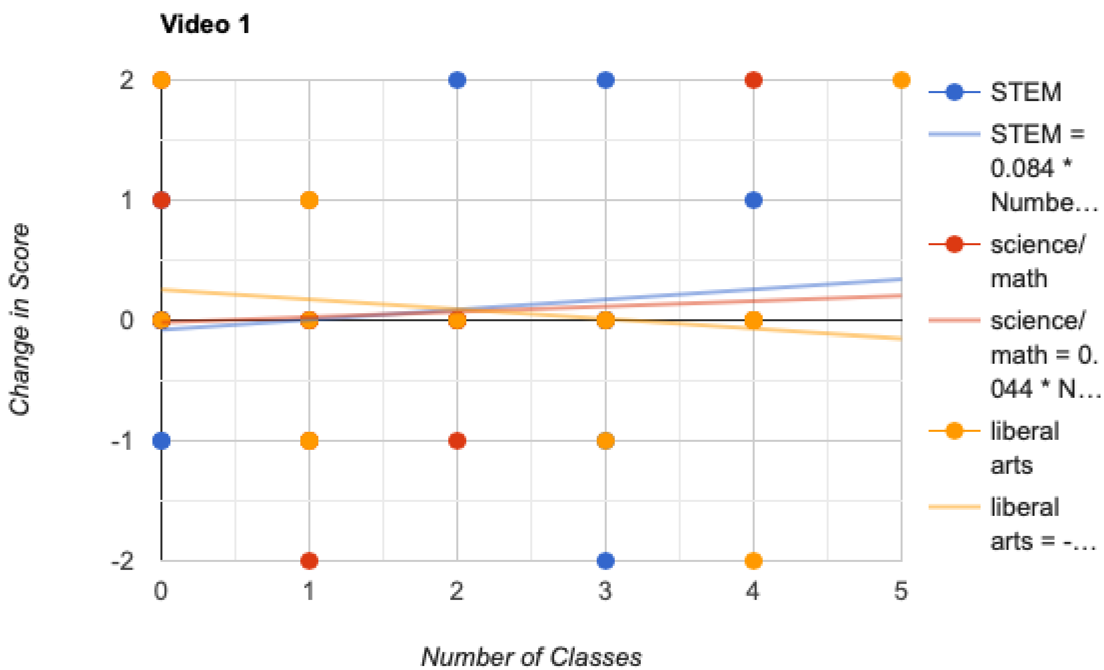

Figure 7. Video 1 participants.

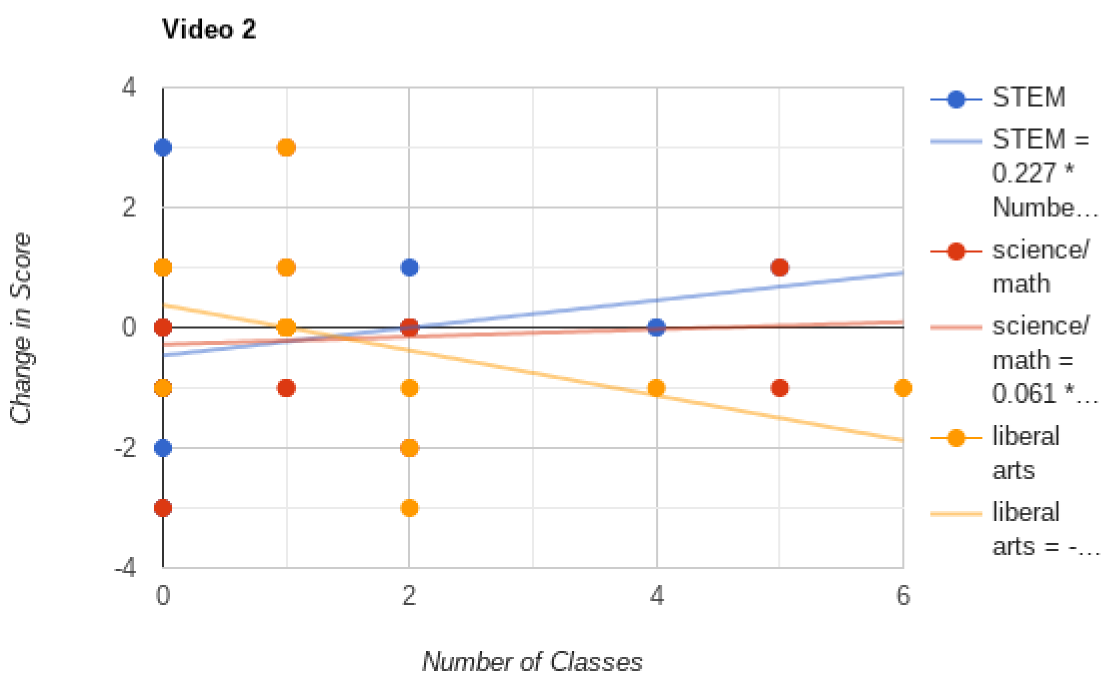

Figure 8. Video 2 participants.

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Although the points on all of the data plots are seemingly haphazard, the line of best fit on Scatterplots 1 and 2, the counter stereotypical media, for high-level liberal arts has a negative slope while the line of best fit for STEM Academy classes shows a positive slope. This indicates that people who view counter stereotypical media are more likely to experience a positive shift if they have taken more STEM Academy courses and a negative shift if they have taken more AP/DE liberal arts courses, which is consistent with the conclusions drawn from the correlation coefficients.

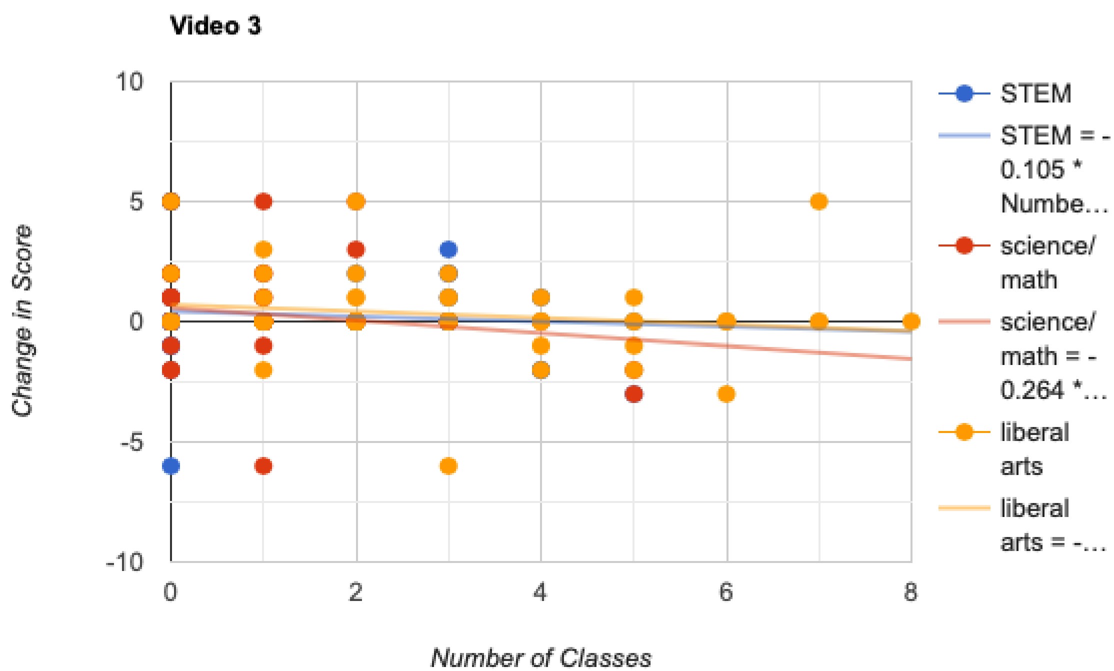

Figure 9. Video 3 participants.

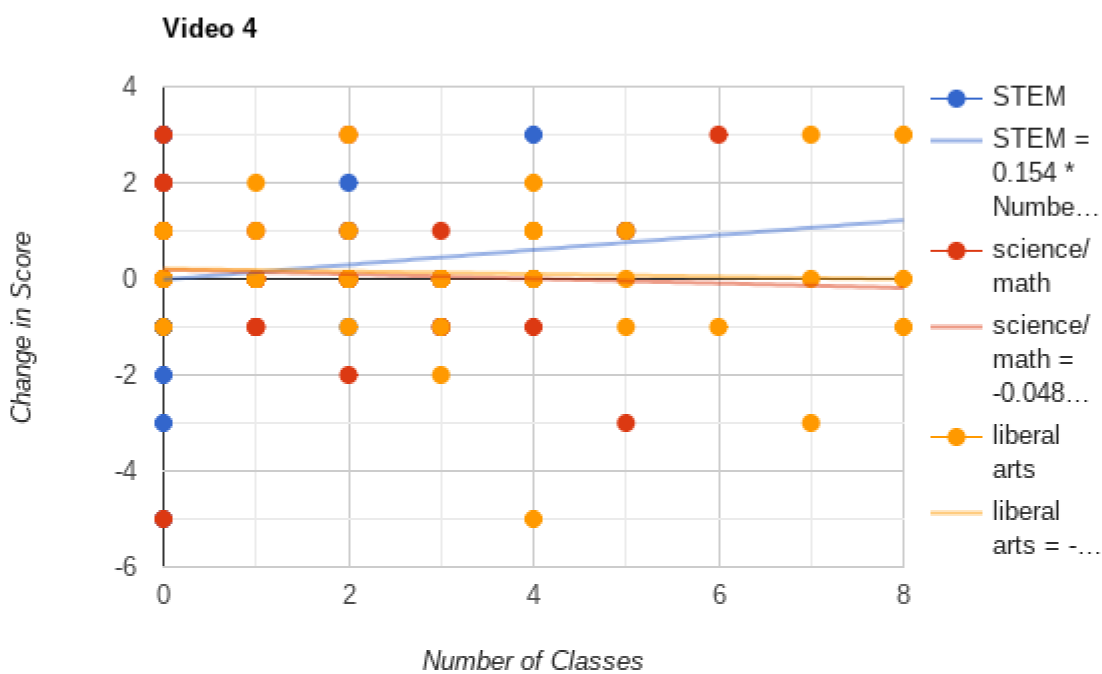

Figure 10. Video 4 participants.

For Scatterplots 3 and 4, the lines of best fit have a slope closer to zero which indicates that there is no correlation between the amount of classes participants have taken in various academic domains and change in IAT score after viewing stereotypical media.

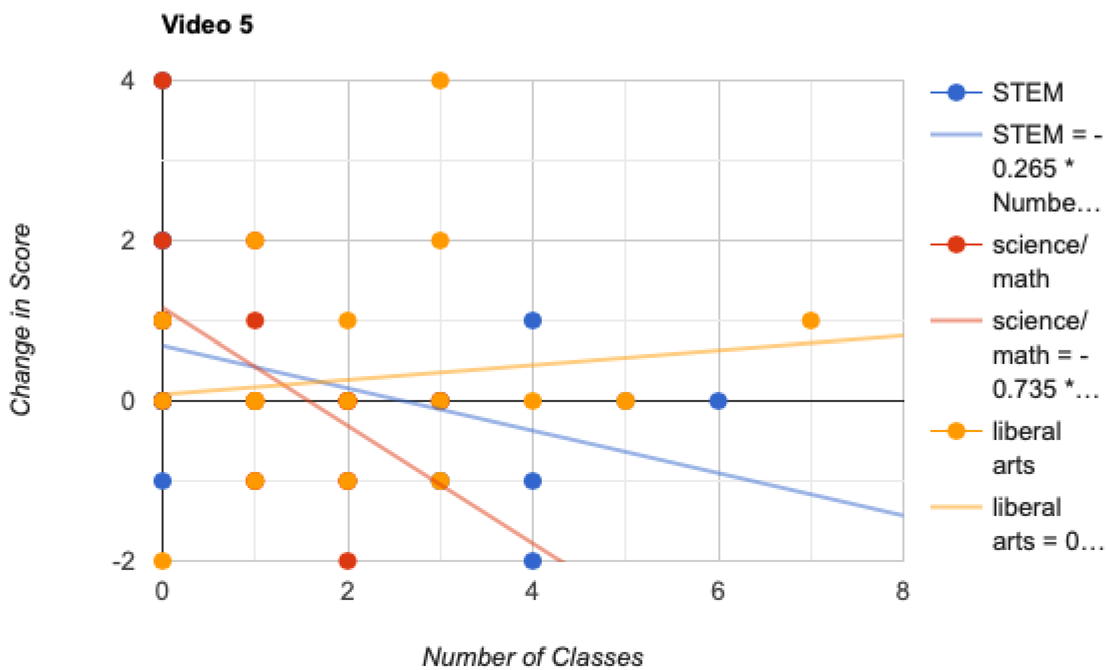

Figure 11. Video 5 participants.

For Scatterplot 5, the comparison condition, the lines of best fit for the high-level liberal arts courses and STEM Academy courses had the opposite slope from videos 1 and 2 with the line of best fit for AP/DE science/math classes having a much steeper negative slope. This indicates that people who viewed media with no relationship between gender and academic domains are more likely to experience a negative shift if they have taken more high-level science/math courses.

Table 2. Correlation coefficients as calculated by Google Sheets between change in score and amount of classes in each category taken across the five videos are shown.

	Video 1	Video 2	Video 3	Video 4	Video 5
STEM Academy classes	-0.0037915	0.022856	-0.0193227	-0.0270206	-0.0151569
AP/DE science/math classes	-0.2017189	-0.1840508	-0.1351669	-0.1350643	-0.2028573
AP/DE liberal arts classes	-0.1671477	-0.1767134	-0.094347	-0.089223	-0.1708452

A correlation coefficient of 1 would indicate a nearly perfect direct correlation while a coefficient of -1 would indicate a nearly perfect indirect correlation. A coefficient closer to 0 indicates that there is no correlation between the two variables. All of the correlation coefficients determined for the collected data are close to zero, which would indicate that there is little correlation between any of the variables. However, the correlation coefficients between change in IAT score and the number of STEM Academy classes taken across all five videos is much closer to zero when compared to the coefficients for high-level science/math/liberal arts courses. The correlation coefficient between STEM Academy classes and change in IAT score for video 1 is -0.0037915 while the coefficient for AP/DE science/math classes and change in IAT score is -0.2017189. The correlation coefficient for AP/DE liberal arts classes at -0.1671477 is also much higher than the coefficient for STEM Academy classes. This indicates that the amount of high-level science/math classes and high-level liberal arts classes taken have a stronger (inverse) correlation with changes in IAT scores than with the amount of STEM Academy classes taken. In short, a person who takes more high-level science/math/liberal arts classes is more likely to experience a negative shift in IAT scores than a person who takes more STEM Academy classes.

Discussion

The researcher's initial research question investigated how gender-science implicit bias, as measured by the Implicit Association Test, could be shifted after exposure to media implying an association between gender and STEM. Due to past research on the malleability of implicit associations in the short-term, the researcher expected to find that IAT results from participants would become less stereotypical when exposed to counter stereotypical media and more stereotypical when exposed to stereotypical media. The researcher found that watching a 30-second video with varying degrees of female representation in STEM was not a strong enough intervention to shift implicit bias when analyzing the data from both genders. Thus, the research hypothesis was rejected since IAT scores did not shift in relation to the media participants were exposed to.

However, when the data collected was separated out between genders, clear differences emerged. The implicit associations of females were more likely to become more stereotypical implicit associations after watching counter stereotypical videos while males were more likely to have counter stereotypical associations when shown counter stereotypical media. Female participants experiencing a negative shift even when exposed to counter stereotypical media could be due to the concept of stereotype threat. Well-documented results from over 200 experiments show that people who are a part of demographic groups that are stereotypically considered to be at an intellectual disadvantage perform in ways that align with those stereotypes when they are reminded of belonging to that demographic group (Aronson et al., 2013; Pennington et al., 2016). Similarly, women that are reminded that there is a discrepancy between how women and men are perceived in STEM fields will be more likely to adopt those implicit biases. Therefore, stereotype threat might be the cause of female participants experiencing a negative change after watching videos 1-4 that involve stereotypes/counter stereotypes of gender and academic domains. Further evidence for the presence of stereotype threat in the experiment is that female participants who watched video 5 that did not involve gender or academic domains experienced a positive change (mean change of 0.88888), which contrasts with the negative change experienced for the other videos. Although the generated data conveys a new understanding about the difficulty of changing females' gender-science implicit bias through exposure to counter stereotypes, additional research is recommended to confirm the presence and effect of stereotype threat.

Additionally, participants who took STEM Academy classes were more likely to experience no change in IAT score than participants who took high-level science/math/liberal arts courses, who were more likely to experience a negative change. However, data about the gender distribution of students in AP/DE classes was not collected, so it is impossible to conclude whether or not the gender composition of those classes align with stereotypical assumptions. Gender distribution from STEM Academy classes was acquired and determined to align with stereotypical assumptions (See Pie Charts 1, 2, and 3). Since participants who took STEM Academy classes were more likely to experience no change in IAT score than participants who took high-level science/math/liberal arts courses, it is possible that repeatedly experiencing an environment that aligns with stereotypical associations decreases the ability of an intervention to enact a change to a participant's implicit bias, as measured by the IAT. However, more research is needed to confirm the correlation between gender distribution in classes taken and shifts in IAT score in relation to whether or not the gender composition of those classes is stereotypical.

Implications

The broader implications of these results apply to Grassfield High School and confirm past findings about the malleability of implicit bias in the field of psychology. 62% of the participants associated "male" more closely with "science" and "female" more closely with "liberal arts" on the initial test. Therefore, students and teachers at Grassfield High School are a part of the majority that are implicitly biased against females in science. Since Grassfield High School is home to the Governors' STEM Academy, it poses a significant barrier to women attempting to enter STEM fields. The results of this paper show that counter stereotypical media may implicitly encourage males to accept women in science fields, at least in the short term. However, this counter stereotypical media may not be the best way to reach young women at Grassfield High School due to the presence of stereotype threat which will unconsciously motivate females to adopt stereotypical associations that further prevent them from entering STEM fields. The data generated also showed how difficult it is to shift implicit associations, even in the short-term.

Although clear differences could be seen between genders in addition to how change in IAT score was correlated with the amount of STEM Academy, AP/DE science/math, and AP/DE liberal arts courses, most shifts were close to zero. These results are similar to the 2010 study about shifting racial biases through counter stereotypical images conducted by Joy-Gaba and Nosek, who concluded that though implicit associations are malleable, it is more difficult to shift them than past literature has implied (Joy-Gaba & Nosek, 2010). Therefore, it is challenging for implicit associations about gender and academic domains to be changed even temporarily by brief exposure to interventions. Additionally, implicit bias, as seen in a 2016 study on racial bias by Calvin Lai, is not malleable after several hours or days, which makes it difficult to change implicit attitudes on a large scale to aid demographics that are unconsciously discriminated against (Lai et al., 2016). More research should be conducted to determine how to reduce implicit bias against women in STEM, especially in the long term.

Limitations

There are a variety of other factors that could have affected the data collected by the researcher. One limitation is the Implicit Association Test, which, as acknowledged by the creators, does not have "individual diagnostic value" (Greenwald et al., 2022). This means that the IAT cannot determine a person's true implicit bias, so the change between each IAT score recorded in this paper may not be completely reliable. An additional limitation are the videos used as interventions. Although each video had characteristics relating to female representation in STEM, the aspects of the videos may not have been strong enough to count as a true intervention. Another limitation is that the survey filled out by each participant may not have been completed in the same short period of time. Participants could have also misreported their score on each IAT, inaccurately recorded the classes that they had taken, and/or completed the survey incorrectly. Additionally, although the trends seen in the data collected may shed light on the gender-science implicit bias at Grassfield High School, it is important to note that the results are only indicative of the 150 participants that were surveyed and may not accurately predict the results of the other thousands of students at Grassfield High School.

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