Exploring Science-related Implicit Gender Stereotypes with Draw-a-Scientist-Test: A Study of Indian School Children

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Abstract

The Draw-a-Scientist-Test (DAST) has been one useful tool for studying science-related implicit gender stereotypes among children. The current study attempted to explore science-related perceptions in a sample of male school children (N=202, Age=12-15 years) in India. To realize that purpose, the present piece of research used DAST and a Word Association Test. The result of DAST reveals substantial gender stereotyping; i.e., 82% of the participants drew a male scientist, and only 2% depicted a female figure. Further, the words associated with a scientist disclosed three significant domains: lab work (chemical, lab, experiment, the microscope, invention, and test tube), male role model scientists (Albert Einstein, A.P.J. Abdul Kalam, and Newton), and perceived traits associated with science (hard-working, crazy, insane, genius and intelligent). The results displayed that the majority perceived a scientist as a male who works primarily in closed spaces, working in a laboratory with chemicals, beakers, and test tubes. The results of these gendered stereotypes are discussed at length.

Keywords: children; DAST; drawing; gender; India; scientist; stereotypes

"If one of the goals of science education is to prepare students who are scientifically literate and to encourage students to pursue postsecondary study and careers in science and related fields, then students need to possess more positive images of scientists – the role in which they themselves may function in the future." - (Finson, Beaver, & Cramond; 1995; p.201)

The socio-economic destiny of a nation massively depends on research and innovation in science (Fuller, 2000; Galiston & Stump, 1999; Kola, 2013). However, selecting and pursuing a career in science is broadly determined by students' perceptions of science and scientists (Chambers 1983; Emvalotis & Koutsianou 2017; She 1998; Steinke et al. 2007), and these perceptions are often formed in childhood itself. Children with negative perceptions about science, for instance, are less likely to pursue STEM (Science, Technology, Engineering, & Mathematics) (Buldu 2006; Finson 2002). Nevertheless, the perception of science and scientists is found to be coloured by gender stereotypes, especially since science is often perceived as masculine (Bowling & Martin, 1985; Kelly, 1985; Lemke, 2011). This might explain the existing gap in gender representation across the science disciplines around the globe (Chiu & Cesa, 2020; Sinnes & Loken, 2014).

Social psychologists have long been intrigued by the stereotyping process. A stereotype is an attribute that "is representative of a class if it is very diagnostic; that is, the relative frequency of this attribute is much higher in that class than in the relevant reference class'' (Tversky & Kanheman, 1983). Stereotypes are "generalized and usually value-laden impressions that members of one social group use in characterizing members of another group" (Lindgren, 1994, p. 468). Gender stereotypes, therefore, are value-laden and antagonistic (mostly) beliefs around genders; i.e., 'women are physically weak' is an example of a gender stereotype. Gender stereotyping that questions women's potential in mathematics and science is robust (Smeding, 2012), and these stereotypes have severe impacts on women's high levels of science anxiety (Brownlow, Jacobi, & Rogers, 2000), low level of science self-efficacy (Aurah, 2017; Kiran & Sungur, 2012), and career-aspirations in STEM (Makarova, Aeschlimann, & Herzog, 2019). Stereotype threat also explains women's lower performance in gender-stereotype-relevant situations (Schmader, 2012; Smith & Hung, 2008; Steele & Aranson, 1995).

Stereotypes might not always be overt; rather they are often "indirect, subtle, and seemingly innocuous" (Banaji, Greenwald, & Olson, 1994; p.56) and implicit in nature. Implicit stereotypes are the "unconscious operation of beliefs about social groups in judgments of individual members of a social group" (Banaji et al., 1994; p. 57). Implicit stereotypes tend to have similar or more robust effects on human behaviour than explicit stereotypes. While it is more challenging to measure implicit stereotypes as compared to explicit ones, the Draw-A-Scientist test (DAST) is one measurement that successfully traces implicit science-related gender stereotypes.

In 1983, David Chambers came up with the Draw-A-Scientist test (DAST) to learn about how children perceived scientists and at what age the popular stereotype of scientists began to emerge. The DAST can be used alone or in combination with other approaches, such as surveys, essays, or observations, in order to overcome the shortcomings of oral or written tests, particularly when investigating with schoolchildren in a short amount of time (Avraamidou 2013; Buldu 2006; Finson et al., 1995). Drawings are regarded as "windows into student cognition" (Ainsworth, Prain, & Tytler, 2011; p. 1097). While DAST has been used in diverse populations for several years (Buldu 2006; Huber & Burton 1995), including educators and university students (Rahm & Charbonneau 1997; Subramaniam, Harrell, & Wojnowski 2013), the majority of the study has been focused on children (Barman 1997; Chambers 1983;

Emvalotis & Koutsianou 2017; Finson 2002). Chambers (1983) suggested Lab coats, eyeglasses, facial hair, symbols of research (scientific/laboratory instruments), symbols of knowledge (books, filing cabinets), technology, and pertinent captions (equations, formulas, taxonomic classification, etc.) as the seven indicators for the "standard image" of a scientist when assessing drawings. Though the stereotypical conditioning might have happened during adolescence, both adults and scientists themselves exhibit similar stereotypes in DAST (Chambers 1983). Children's perceptions of scientists have been the subject of numerous research studies in Western countries (Bernard & Dudek 2017; Chambers 1983; Christidou, Hatzinikita, & Samaras 2012; Finson 2002), but there is a dearth of DAST literature in Asian countries. In the context of India, we could detect only a few studies that have exhaustively investigated implicit science-related gender stereotypes. Narayan and colleagues (2009; 2013), through a cross-cultural DAST analysis, observed science-related gender stereotypes among Indian students. Other than this study, there is a general lack of extended and exhaustively carried out DAST research in India.

The current study aims to contribute an Indian context to the global DAST literature to supplement the paucity of research in India. The study was performed on school children to explore whether Indian school children have gender-stereotypical images of science and scientists.

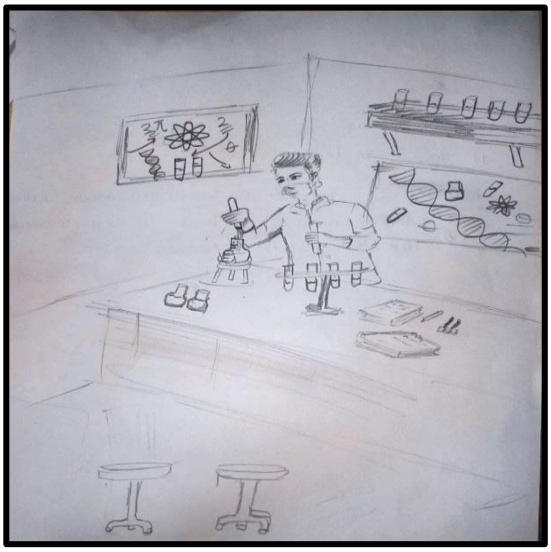
Method

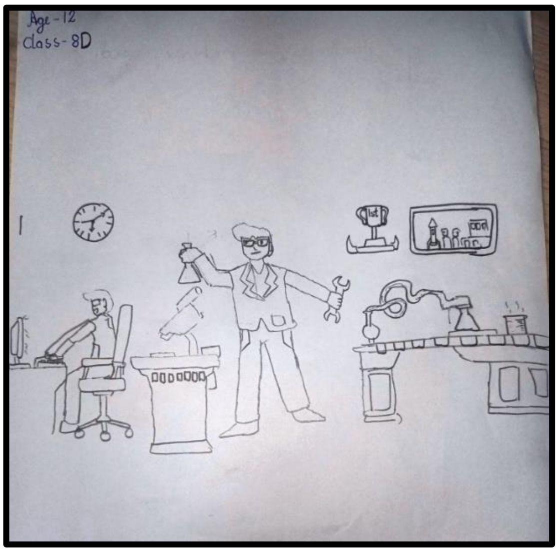
Sample and Study design

The current study was conducted on 202 Indian male seventh and eighth-graders. The study took place in two different schools in two different Indian states, i.e., Jharkhand and Maharashtra. In the batch of 202, 24% of the students were from the seventh standard while 76% were from the eighth standard. At the beginning of the study, A4-sized blank papers were distributed among the students and they were asked to report some basic information about themselves, i.e., gender, age, and standard. As per the provided demographic data, the age group of the students for standard 7th was 12-13 years, with an average being 12.46 years, and for standard 8th was 12-15 years with an average of 13.09 years. After that, the students were provided with the prompt, “Draw a scientist who is working in the lab. Time given is 15 minutes”. The prompt was verbally announced as well as written on the green board. In no way any inputs or references were given to the students. At the end of 15 minutes, the students were instructed to stop drawing. Then, they were asked to note down answers to the following two questions; 1. Are you planning to take up science in the future? (Yes/No) 2. Write 5 words that come to your mind when you think of scientists. These two questions were also verbally announced and written on the green board. The time given for the word association test was 5 minutes after which the test was stopped.

Content analysis

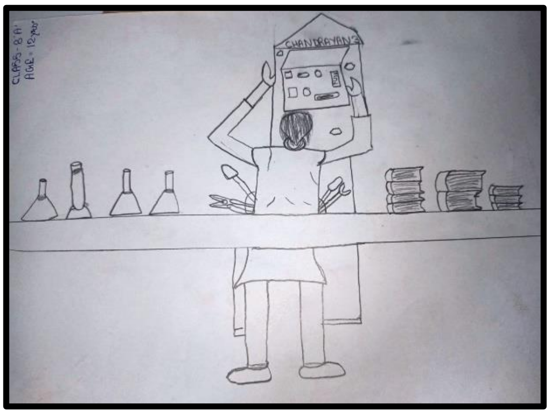
The study literature provided the basis for each category's coding as a dichotomous variable. A coding sheet derived from Barman's (1999) research was used to analyse the drawings. Based on research into media portrayals of female scientists, more variables were added to Barman's (1999) system (Steinke 2004, 2005). In order to evaluate stereotypes of scientists, the following

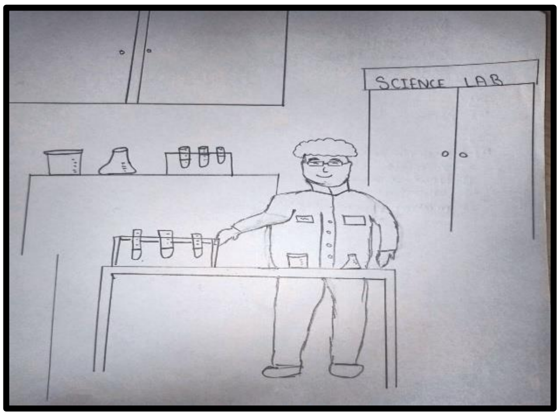




seventeen categories were used: gender, lab coat, spectacles (glasses), facial hair, young or elderly, working site/location, laboratory, facial expression (smiling/ not smiling), hair (thin/crazy), research symbols (lab equipment, experimental animals, plants, dissection and scientific instruments), knowledge symbols (books, bookshelf, written equations), technology present (computer, drones), signs of danger (skull, "secret", fumes, sparks, poison) and signs of secrecy (closed/locked cabinets, lockers, "do not enter"). Due to the researchers' inability to determine the race and ethnicity of the selected scientists, a category from Barman's (1999) coding scheme, "Caucasian", was removed. A new category named "face shield/mask" was added to the coding scheme by the authors since the COVID pandemic has made some students explicitly depict those in their drawings.

(a) (b)





(c) (d)

Figure 1. Illustrations of scientists made by 7th and 8th grade school children. (a) A typical male scientist with a face mask. (b) A young male scientist with his accolades on display. (c) A female scientist working on Indian Moon mission – Chandrayaan 3. (d) A smiling male scientist.

Table 1. Percentages of implicit stereotypes in DAST drawings of Indian school children

Characteristics/Indicators	Mumbai (n=74)	Dhanbad (n=128)	Total Count (%) (n=202)
1. Male gender	69(93%)	96(75%)	165(82%)
2. Female gender	2(3%)	2(2%)	4(2%)
3. Both (more than 1 figure)	1(1%)	1(1%)	2(1%)
4. Cannot be identified	2(3%)	29(23%)	31(15%)
5. Lab coat	43(58%)	47(37%)	90(45%)
6. Glasses	20(27%)	27(21%)	47(23%)
7. Facial hair	7(9%)	12(9%)	19(9%)
8. Elderly	4(5%)	4(3%)	8(4%)
9. Cannot be identified	70(95%)	124(97%)	194(96%)
10. Lab work	63(85%)	106(83%)	169(84%)
11. Work site/ laboratory	11(15%)	9(7%)	20(10%)
12. Expression -smiling	32(43%)	50(39%)	82(41%)
13. Expression - not smiling	19(26%)	48(38%)	67(33%)
14. Cannot be identified	23(31%)	30(23%)	53(26%)
15. Crazy/thin hair	25(34%)	45(35%)	70(35%)

16. Research symbols	7(9%)	17(13%)	24(12%)
17. Knowledge symbols	3(4%)	14(11%)	17(8%)
18. Technology present	2(3%)	10(8%)	12(6%)
19. Indication of danger	9(12%)	9(7%)	18(9%)
20. Signs of secrecy	1(1%)	3(2%)	4(2%)
21. Use of mask/ face shield	10(14%)	12(9%)	22(11%)
22. Future response to STEM			
- Yes	35(47%)	106(83%)	141(70%)
- No	37(50%)	19(15%)	56(28%)
- Don't know	2(3%)	3(2%)	5(2%)

Each stereotype-displaying indicator in a drawing was assigned one point. It is significant to note that neither the coding nor the score was affected when multiple signs of the same indicator appeared in a single drawing. For instance, there might have been multiple indications of research symbols, but only one indication was considered (Chambers 1983; Subramaniam, Harrell, & Wojnowski 2013).

Results

Around 141 students (70%) indicated that they would study science in the future, while 56 (28%) stated that they won't pursue science, and 5 students (2%) did not state anything.

The word association with scientist revealed three significant areas: lab work (chemical, lab, experiment, the microscope, invention, and test tube); male scientists (Albert Einstein, A.P.J. Abdul Kalam, and Newton); and typical perceived traits (hard-working, crazy, insane, genius and intelligent).

All the drawings were whole body figures with students depicting 41% smiling and 33% neutral expressions. It was difficult to identify the age of the scientists depicted in the majority of the illustrations (96%). Laboratory work (84%), lab coats (45%), and crazy hair (35%) were the additional stereotypes that were most frequently shown in the images. Three typical drawings of Einstein, C.V. Raman and Newton were categorized in the male gender indicator. Few drawings stood out from the rest of the samples: a thought process of how a scientist comes up with new inventions, a female scientist working on India's Moon mission "Chandrayaan 3", an unidentified scientist with a NASA lab coat, and another working on a remote-controlled robot. Students with ordinary drawing skills wrote statements like "Science is Life", "Everything works on Science", "Newton makes gravity" and "Science can do anything".

Looking at the percentages of the two cities in Table 1, not much significant difference was seen in other stereotype indicators except gender.

Discussions

All the drawings made by the students were quite lifelike since they featured whole body figures with no definite age (Barman, 1999; Emvalotis & Koutsianou, 2017; Subramaniam, Harrell, & Wojnowski, 2013). Furthermore, it is encouraging to note that almost all drawings featured smiling scientists. Results are consistent with the international studies, which show that scientists are primarily male, have stereotyped features, and work indoors (Emvalotis & Koutsianou 2017; Medina-Jerez, Middleton, & Orihuela-Rabaza 2011; Rosenthal 1993). Only four participants (2%) drew female scientists.

Since women are significantly underrepresented in the fields of STEM, researchers have frequently emphasized the need for more interactions between students and scientists, more so between students and female role models (Avraamidou 2013; Barman 1997; DeWitt, Archer, & Osborne 2014; Huber & Burton 1995; She 1998; Song & Kim 1999). Finson (2003; p.15) mentioned that “A shortage of scientific personnel will occur in the future, and unless there is an increase in minority and women participation in scientific fields, [many countries] will be unable to meet […] future technical and scientific needs”. According to the United Nations, India has the greatest proportion of women in the world among STEM graduates (43%), but just 14% of STEM professions in India are held by women. Moreover, India is placed 140th out of 156 nations in the World Economic Forum's Global Gender Gap Report 2021, earning a score of 0.625 (out of 1). Making STEM more inclusive for women is one essential step that might alter these existing unfortunate statistics.

The current study included a number of significant limitations.

First of all, the assignment may have limited the pupils to produce a single drawing (Rahm & Charbonneau, 1997). Their assignment was to depict "a " scientist (Miele 2014). Different results might be obtained if we give students the option to draw more than one drawing, repeat the assignment, or ask them specifically to depict a male or female scientist (Emvalotis & Koutsianou 2017).

This could be a valuable addition to the existing studies, especially in light of some researchers' critique that students may have many perceptions as to what a scientist appears like. The Indirect Depict-a-Scientist Test (InDAST), which Bernard and Dudek (2017) just devised, asks participants to draw individuals engaged in scientific research rather than a scientist. The appearance, placement, and activity of scientists in drawings are classified as a categorical variable (either exaggerated, conventional, or broader than traditional) in the DAST Rubric, which was introduced by Farland-Smith (2012) to assist the analysis. Additionally, Losh, Wilke, and Pop (2008) requested their participants to sketch other professions in addition to scientists so that they might draw comparisons.

Second, only the real drawings were examined for the current study. In order to gather deeper insights, researchers could go a step further and ask the students for justifications and sources for their drawings (e.g., in interviews or questionnaires) (Barman 1997; Fung 2002; Tan, Jocz, & Zhai 2015). For instance, Koren and Bar (2009) extended the DAST by using a variety of methods to evaluate pictures of scientists.

Thirdly, and along the same lines, coders may have trouble determining the gender of the individual in the drawing (see also Bernard & Dudek 2017; Rosenthal 1993; She 1998). Students may be asked to identify the gender of the figures in their drawings. A quiz of this type may additionally ask about the image's age and demographics and assess participants' socioeconomic level (Chambers 1983; Emvalotis & Koutsianou 2017). A narrative relating to the participant's image was requested by some researchers (Subramaniam, Harrell, & Wojnowski 2013).

Fourth, some pupils may have stronger drawing skills than others (Medina-Jerez, Middleton, & Orihuela-Rabaza 2011). From that perspective, allowing students to make written remarks after completing the DAST would be encouraging.

Fifth, only children from two standards at two Indian schools were included in the current study. Future studies might incorporate more institutions, faculties, and grades from the other Indian states.

Sixth, the samples of only male participants were taken due to alternate school timings for both genders. Hence the study was limited, with no results on any stereotypes in females when it comes to their participation in STEM.

Seventh, in future trials, the DAST should take longer than five minutes to complete.

Despite these drawbacks, the DAST nonetheless showed great promise for evaluating students' opinions and impressions of scientists, particularly in the Indian setting. However, the test does not permit inferences about the motivations behind (stereotypical) images (Emvalotis & Koutsianou 2017; Fung 2002). Future studies should concentrate on that. The authors think that this essay offers some intriguing suggestions for moving forward.

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