IMPLICIT GENDER BIASES AFFECTING INDIVIDUAL LIMIT RECOGNITION IN CARDIOPULMONARY RESUSCITATION SIMULATIONS

By

SADIE PAULINE KEESLER

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Approved by:

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Dr. Allan J. Hamilton, MD, FACS
Executive Director, ASTEC
Clinical Professor, Radiation Oncology
Professor, Surgery
Professor, Psychology
Professor, Electrical and Computer Engineering

Abstract

Implicit biases permeate our everyday behavior and take many different forms. This study was carried out to identify if implicit gender biases exist within the medical student and resident populations, and then whether those biases affect a compressor's ability to recognize their limitations during a cardiopulmonary resuscitation (CPR). A survey containing the Neosexism Scale[1] was sent to University of Arizona college of Medicine- Tucson medical students and residents in the emergency and internal medicine programs. No statistically significant differences were discovered, although males and medical students trended to possess a higher average neosexism score than females and residents respectively. Twenty-three undergraduate student participants (5 male; 18 female) were recruited and placed in all female identifying or mixed gender identifying teams to complete CPR simulation scenarios. CPR compression quality was assessed and statistically analyzed using student's t-tests. In comparing the amount of time providing poor quality compressions during simulation CPR scenarios, females preformed poor quality compressions longer when in a group of male teammates than when in a group of only females ($p = 0.02$).

Introduction

Implicit Bias

Human behavior is driven by both explicit, conscious actions and unconscious, implicit biases.[2] Due to these implicit biases people do not always possess full "conscious intentional" control of their behaviors, or awareness of the motivators for their actions.[2] Implicit bias takes many forms, most notably racial and gender, but can primarily occurs towards individuals not within a person's ingroup.[2] Implicit biases affect behavior through the influence of past experiences on current actions without that influence being known to the actor.[3]

Neuroscience of Bias

Implicit bias has been an interest of neuroscience researchers in recent years. Neuroscientific methodology is extremely useful for studying how implicit biases form, influence behavior, and are regulated on a functional neuroanatomy level[4]. Certain brain structures have been identified as potential players in implicit biases, especially those involved with facial recognition and emotional processing[4]. Functional Magnetic Resonance Imaging (fMRI) has thus far been the tool of choice for neuroscientists studying implicit bias in the brain.

Studying how implicit bias functions in the brain provides a new context for neuroscientists to study the functional regional areas involved in guiding the execution of complex behaviors, providing interest to the field of systems neuroscience.[4] There exists evidence provided by fMRI studies on implicit racial bias that a neural system associated with exhibition of bias exists.[5] The areas involved in this circuit involve the amygdala, fusiform face area, medial prefrontal cortex, dorsolateral prefrontal cortex, anterior cingulate cortex, and orbitofrontal cortex.[5] The brain

structures mentioned include those involved in facial recognition and emotional processing, as well as structures known as acting in neuromodulator circuits.

Specific survey scales have also been demonstrated as effective and sensitive measures for detecting implicit biases amongst groups of people.[1, 6] In order to better evaluate the prevalence of implicit gender biases in both populations of medical students and residents involved in cardiopulmonary resuscitation teams, this study utilized one such survey scale, the Neosexism scale. This study will utilize the Neosexism scale to evaluate the prevalence of gender biases amongst these groups of interest. The neosexism scale developed by Tougas et al. delves into gender biases by examining the participant's support, or lack thereof, of policies in place designed to improve women's station.[1] The advantage of using the neosexism scale is that it is sensitive to gender biases that are hidden by the believer due to an overall cultural shift away from overt prejudice along gender lines.[1] These "neosexist" beliefs as defined by Tougas et al. were demonstrated to have implications in employment scenarios, and as such it is not unreasonable to extrapolate that implication to other environments- perhaps healthcare or education.[1]

Implicit Bias in Healthcare

Human beings are all vulnerable to implicit biases including healthcare professionals.[7] There is a substantial body of research that physician's implicit bias affects the care their patients receive.[8] However, little research has been conducted on the effect of physicians' implicit biases on their team communication with other healthcare providers. Reasonably, implicit biases will affect interpersonal communication, as communication serves to mediate most of social behaviors.[9] This has been supported by preliminary studies evaluating gender bias among CPR teams.[10] Of particular note, it has been demonstrated that gender affects the experience of leading a CPR code response, so it stands to reason that gender would affect the experience of filling the other roles in the team.[11] As CPRs require effective teamwork and communication to optimize patient outcomes, they may provide an ideal model for studying the influence of implicit bias on healthcare communication.[10]

Chest compression quality has been determined to be a primary determinant of successful outcomes in cardiopulmonary arrest cases.[12] Performing quality chest compressions is physically demanding and compressors should, ideally, indicate that they are tiring before compressions lose quality.[13] This is referred to as a compressor recognizing their limitations in current medical education and training.

Cardiopulmonary rescue teams of different gender makeups have been found to have differential success rates in hands on time, delays in beginning cardio pulmonary resuscitation (CPR), and leadership statements.[14] However, gender has shown no effect on overall team cohesion, team leadership, and team competency- all factors that would also decrease the overall quality of CPR.[15] Previous studies have suggested that the proportion of female members of a team have no bearing on early team potency, social cohesion, or observer's perceptions of teamwork of teams with higher proportions of female members in male dominated fields.[15] The gender of the compressor also does not affect their ability to perform BLS tasks individually- including

compressions.[16] Based upon the above research, it is then able to be understood that while gender does not affect the CPR performance of the individual, gender composition of the team does affect team performance.
Simulation environments are often used to study CPR effectiveness, as it is the standard environment for teaching cardiopulmonary resuscitation at the medical student and resident level.[13] Simulation provides an environment for learning that is controlled and safe for learners, while ensuring no harm to comes to patients.[16]

Based on above research, it is possible gender appears to influence a compressors ability to recognize their own limitations and when they are preforming inadequate CPR. As recognizing poor compressions is a key factor for successful resuscitations, such gender-bias based limitations have immediate implications for CPR outcomes if they increase the time inadequate compressions are performed.[13] In the context of this project, of interest is the effect of implicit bias from experiences of gender discrimination will influence whether participants are willing to recognize their limitations as soon as required to prevent compressions from suffering in quality. If there is any significant difference among male or female behavior in different gendered teams, it would be critical to identify this implicit bias. By bringing into awareness any implicit bias that impacts CPR outcomes through intrateam communication, students can be taught to be more able to recognize limitations in themselves, and their teammates. Specifically, depending on the gender makeup of the team, team leaders can be taught to prompt compressors to switch more frequently and compressors can be taught to verbalize their need to switch more frequently. This data will be supplemented by the Neosexism survey results evaluating gender biases amongst medical students and residents. The combined results will provide a better understanding of both the prevalence of gender-biased beliefs and their potential effects on the critical services offered by CPR teams.

Methods

Survey:
The Neosexism Survey developed by Tougas, et al. was modified to remove specific mentions to nationality (Appendix) and was sent to Emergency Medicine Residents, Internal Medicine Residents and Medical Students at the University of Arizona College of Medicine-Tucson.[1] The survey was built into an electronic format via the Qualtrics program, and emailed out to prospective participants. The survey was introduced to participants in the introductory email as a supplement to simulation-based research at the Arizona Simulation Technology and Education Center (ASTEC). Informed consent was obtained via the first question in the survey. Participants self-identified their gender after consent, professional level, and experience with full code resuscitation before beginning the survey in full. All questions are scored based upon a 7-item Likert-type scale, where 1 represents total disagreement and 7 represents total agreement. Only the extremes were labelled to participants.

Simulation Compression Study:

The study took place at the Arizona Simulation Technology and Education Center with 23 undergraduate student participants (5 male; 18 female) recruited from the University of Arizona. Each room was set up with a Code Blue CPR mannequin and Zoll® R-Series defibrillator. For the purposes of this study, effective chest compressions are considered to be 100 beats per minute and at a depth of 4-6 cm.[17] CPR quality was monitored using OMNI 2 Real-Time CPR feedback technology.

Participants were placed in teams of all female-identifying participants or mixed-gender identifying teams based upon participant availability. Informed consent was procured and a demographics survey was completed by each participant before beginning the study. Then all teams were presented with a pre-scenario video exemplar of good teamwork and communication during a cardiopulmonary code situation.[18] Next, all participants were required to practice compressions with CPR monitor displayed in order to understand what effective compressions are considered. Practice was mandatory and went for as long as participants required to reach effective compression rate and depth maintained for 20 seconds. Airway techniques and use of the defibrillator were reviewed briefly for continuity of the simulation scenario. After the pre-training, each team participated in four cycles of a code scenario. Study facilitators served as team leads for all teams. Team leads did not ask compressors if they are tiring, or need to switch with the next compressor in line to provide for a control against another participant prompting compressors for limitations.

Each team had their scenario video recorded in order to compare the CPR log generated by OMNI 2 Real-Time CPR feedback with the timing in which compressions began to stop being effective and when the compressor acknowledged their limitations.

CPR quality was considered compromised if compression rate decreases below 100 beats per minute and/or compression depth strays from 4-6 cm.[17] Compressor was considered providing compromised CPR if they delivered 60% or more of chest compressions being less than 4 cm, or providing an average rate of compressions less than 100 beats per minute.[17]

Statistical Methods:

For the Modified Neosexism Survey, the average score of each participant was calculated after reversing the scores of questions 2 and 11. The average score on the Modified Neosexism Survey was compared between self-identifying males and self-identifying females using a paired student's T test. A P-value of < 0.05 was considered statistically significant. Microsoft Excel was utilized for all statistical analysis.

For the simulation study, the time for compressors of each gender to solicit compression relief after compressions became ineffective was compared using a paired student's T test to determine if there was a significant difference in average time between genders in both

onegender and mixed-gender groups. A P-value of < 0.05 was considered statistically significant. Microsoft Excel was utilized for all statistical analysis.

Results

The Neosexism Scale obtained from Tougas et al.[1], was included in this study as a measure of the general gender biases present in the student population at the University of Arizona College of Medicine- Tucson campus. The survey included both medical students and residents in emergency medicine and internal medicine programs. Table 1 below contains the demographic breakdown of the survey respondents.

Table 1: Demographic Summary of Survey Respondents

Gender	
Female	23
Male	14
Professional Status	
Medical Student	29
Resident	8
Participated in Full Code Resuscitation	
Yes	15
No	22

A total of 37 respondents completely answered the survey out of 680 medical students/residents yielding a 5.4% response rate. All partially completed surveys were discarded and not analyzed. Participant responses to the Neosexism Survey were analyzed based on their stated demographics (Table 2).

Table 2: Results of Student's T-Test Analysis of Neosexism Scale Results.

	Average ± SD Neosexism Score	p-value
Gender		0.17
Female	1.71 ± 0.54	
Male	2.16 ± 1.09	
Professional Status		0.23
Medical Student	1.94 ± 0.88	
Resident	1.66 ± 0.44	
Participated in Full Code Resuscitation		0.63
Yes	1.81 ± 0.52	
No	1.93 ± 0.97	

Demonstrated in Table 2, no statistically significant difference was observed between any of the groupings. Overall, males did possess a higher average neosexism score than females, even if that difference was not found to be statistically significant at this time. Residents showed lower average neosexism scores than medical residents, but this was found to not be significant. Lastly, there is no trend in difference of Neosexism score between respondents who have and have not participated in a full code resuscitation.

In order to provide a measure of implicit gender bias not sensitive to social desirability bias, the cardiopulmonary resuscitation scenarios were employed. A total of 32 participants volunteered for this study, and their demographic information is summarized in Table 3. All participants fell in the age range 18-24 years old, and no participant identified as transgender.

Table 3: Demographic Summary of Code Scenario Participants

Gender	
Female	18
Male	5
Race	
White	11
Black of African American	3
Asian	6
Latinx	2
Other	1
Wearing Religiously Significant Clothing	
Yes	1
No	22
Prior Code Experience	
No	17
Yes- Simulation/Training	5
Yes- Clinical	1

Participants were placed in groups of increasing concentration of males to females. One group composed of two females and two males (50 % female), two groups composed of one male and two females (66 % female), three groups composed of all female participants (100 % female), and one group composed of one female and one male. In order to fulfill at least three pre-defined roles a female study confederate served as the third participant in that last group, this group was analyzed as one grouping of two females and one male category. Several dimensions of analysis were considered, and the results of that analysis are summarized in Tables 4-7.

Table 4: Comparison of Males and Females

	Average ± SD Seconds of Inadequate Compressions	Average ± SD % Time Inadequate Compressions	p-value	
Male	21.9 ± 29.1	32.8 ± 39.7	Seconds:	0.25
Female	10.1 ± 18.7	22.8 ± 41.1	% Time:	0.50

Table 5: Comparison of Males as a Function of Females in Group

	Average ± SD Seconds of Inadequate Compressions	Average ± SD % Time Inadequate Compressions	p-value	
Males (50 % female group)	10.5 ± 17.2	14.3 ± 22.2	Seconds:	0.20
Males (66 % female group)	29.5 ± 34.2	34.2 ± 45.8	% Time:	0.12

Table 6: Comparison of Females as a Function of Females in Group

	Average ± SD Seconds of Inadequate Compressions	Average ± SD % Time Inadequate Compressions	Comparison	p-value	
Females (50 % female group)	26.2 ± 30.4	48.1 ± 55.6	50 % v 66 %	Seconds:	0.49
				% Time:	0.68
Females (66 % female group)	13.7 ± 18.2	33.8 ± 47.2	66% v 100%	Seconds:	0.19
				% Time:	0.24
Females (100 % female group)	3.3 ± 9.7	9.8 ± 29.4	50 % v 100%	Seconds:	0.23
				% Time:	0.26

Table 7: Comparison of Females with Males Present or Not Present

	Average ± SD Seconds of Inadequate Compressions	Average ± SD % Time Inadequate Compressions	p-value	
Females w/ Males Present	20.1 ± 24.0	42.0 ± 48.9	Seconds:	0.02

Females w/out Males Present	3.3 ± 9.7	9.8 ± 29.4	% Time:	0.03

From the analysis summary in Tables 4-6 there are no significant differences found between the compared groups. However, the analysis in Table 7 shows a statistically significant result. There is a significant difference in performance in female compressors between when males are present in the team and when the team is all-female. When males are present female compressors perform inadequate compressions for more seconds, and for a longer proportion of the time they are on the chest of the mannequin.

Discussion

This study was carried out to identify if implicit gender biases exist within the medical student and resident populations, and then whether those biases affect a compressor's ability to recognize their limitations. Primary results show that there is not a significant difference in Neosexism scores between groupings in the medical student and resident populations. However, implicit gender biases may observably affect how long a female compressor provides poor compressions before requesting relief.

Regarding the participation for the Modified Neosexism Survey, there was a substantial amount of non-response to the survey, which is likely due to the survey fatigue and busy schedules of medical students and residents.

The trend that males possessed a higher average Neosexism score is of particular importance. This is the expected trend[1], with males expected to show higher levels of bias towards female outgroup. However, this trend was not found to be statistically significant. Of interest is the trend that medical residents that answered this survey possessed lower average Neosexism scores, this finding could possibly be due to exposure to more bias training. Residents are further along their careers and would have had more opportunity to participate in these trainings and reduce their implicit biases. It would be worthwhile to investigate this further and see if medical residents truly do have a lower Neosexism score than medical students by replicating this study with larger sample sizes and more residency programs included.

There are several plausible reasons why the Neosexism Scale did not produce statistically significant results, the most likely being due to small sample size and effects from social desirability bias. However, there always exists the potential that there are no significant trends in the population and any variation between groups observed is due to random variation in this particular sample. The t-test preformed for the average neosexism score between male and female respondents did not yield a significant p-value, but this is likely due to the small size of each group. The mean neosexism score between these two groups were different, and with a larger sample size, it is not without reason to predict that the results may indeed become significant. Secondly, social desirability bias may also have affected the mean neosexism scores

for each grouping by affecting the tendency of respondents to answer the questions truthfully to their actual views.[19] Openly admitting sexist views is viewed unfavorably by society in modern times[19], so even though the survey was conducted so as to not collect any personal identifiable information respondents may have underreported any personal beliefs they view to be sexist.[19]

The implications of the CPR results are that implicit gender biases affect individual limit recognition in CPRs. Within the scope of these results, we can only generalize this finding to females, since we were not able to compare male behavior when females were and were not included in the group.

As statistically significant evidence was discovered that implicit gender biases affect a compressor's ability to recognize their own individual limitations and request relief before providing inadequate compressions, there are implications for patient care. Chest compression quality is a large determinant of patient outcomes during a resuscitation effort.[12] Thus the effects of these biases may facilitate poorer quality compressions and negatively affect patient outcomes. Further study is necessary to determine if these biases exist or disappear in different settings- such as with more experienced professionals. If they are found to exist, it is also necessary to investigate if there are implications on CPR delivery in these populations. It is imperative, if after further study these effects are found in other populations, to include trainings designed to minimize implicit biases in order to maintain high quality CPR efforts.

While statistically significant results were found in the analysis, there are limitations to the study design and application that need to be taken into consideration when interpreting these results. The most important limitation is inadequate subject numbers. Only 23 subjects participated in the study, such a small sample size likely lead to the comparatively large standard deviations in the data. Recruitment was impacted by the COVID-19 pandemic, leading to the reduced numbers. Related to, but distinct from just the minimal number of participants was the distribution in recruitment that lead to a participant pool that was primarily female, and that possessed little experience with preforming chest compressions. Out of 23 total participants, 18 were female and 17 had no prior experience with chest compressions in either a simulation or clinical environment. While recruitment emails were sent to several pre-medical undergraduate major advisors and undergraduate pre-medical student clubs, the majority of interest was from female students. The lack of male students volunteering for the study created logistical difficulties. No group was able to be created with more than 50 % of the group identifying as male. Therefore no comparison was able to be made between all male, and mixed-gender groups. Secondly, by virtue of recruiting undergraduate students for this study most participants were learning how to preform chest compressions for the first time during the training phase of the study scenario. It is thus not unreasonable to assume that utilization of first-time compressors may affect the data produced. One especially pertinent byproduct is that many participants tended to either fully provide adequate compressions for the entirety of the time spent on the chest of the mannequin compressing, or for none of the time compressing. The participants who spent the entirety of the time producing quality compressions were likely paying more attention to the

motor movements required to compress the chest, as is common in the primary stages of skill learning.[20] The extra attention paid to compressing- while beneficial as it facilitated higher quality compressions- may not represent the actual behavior of more experienced compressors who are likely to pay less attention to the motor movements involved in compressing. With less attention paid the opportunity for implicit bias to affect behavior may be greater.

Other limitations to the data exist from methodological sources. Compression depth was measured using the built-in OMNI 2 Real-Time CPR feedback mechanism. This is a convenient method for measuring compression depth, since the tool is built into the Code Blue CPR mannequins utilized in this study. However, the program is not without its drawbacks, namely the way the program marks a compression depth into the printable log. If a compressor does not provide enough chest recoil, compressions are lumped together and only the peak depth and length of time is recorded. If several insufficient compressions and one sufficient compression are performed in quick enough succession, only the adequate compression depth is recorded. Due to this drawback, inadequate compressions may have been missed and participants may have been analyzed as preforming better than they did in actuality.

As discussed the study does present limitations, however the results suggest that there is an effect on individual limit recognition from implicit gender biases. This is worth further study with compressors with more compression experience in order to evaluate the effect of experience on the results found in this study. In addition, more sensitive compression monitoring methods may yield greater differentiation. It is also worthwhile repeating the Neosexism Scale survey efforts with a larger sample size, especially considering including residency programs outside of emergency and internal medicine. Lastly, this study provided evidence that studying implicit gender biases in student populations is worthwhile, as identifying bias in the student population provides more opportunity for anti-bias training before students enter the healthcare field as professionals. This study also may suggest that there is a need for better, objective methods for identifying when a compressor needs to switch, as leaving it up to compressor self-report is inadequate due to effects of implicit factors on self-report.

Appendix

Table 8: Neosexism Scale Obtained From Tougas et al.[1]

1	Discrimination against women in the labor force is no longer a problem in Canada.
2	I consider the present employment system to be unfair to women.
3	Women shouldn't push themselves where they are not wanted.
4	Women will make more progress by being patient and not pushing too hard for change.
5	It is difficult to work for a female boss.
6	Women's requests in terms of equality between the sexes are simply exaggerated.
7	Over the past few years, women have gotten more from government than they deserve.

8	Universities are wrong to admit women in costly programs such as medicine, when in fact, a large number will leave their jobs after a few years to raise their children.
9	In order not to appear sexist, many men are inclined to overcompensate women.
10	Due to social pressures, firms frequently have to hire underqualified women.
11	In a fair employment system, men and women would be considered equal.

Table 9: Demographic Survey Attached to Neosexism Scale

1	Please indicate your professional role. Resident (Specialty) _____ Medical Student Other (Please Specify) _____
2	Please indicate your identified gender Female Male Other (Please Specify) _____

Table 10: Demographic Survey Given to CPR Scenario Participants

1	Which race do you identify as? White Black or African American Native American Asian Latinx Other
2	Which gender do you identify as? Male Female Other
3	Do you identify as transgender? Yes No Prefer not to answer
4	Which age range do you belong? 18-24 25-34 35-49 50+

5	Are you currently wearing religiously significant clothing or jewelry? Yes No
6	Do you have any prior code experience? Yes- clinical patient care Yes- training/simulation No

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