UNIVERSITY OF CALIFORNIA

Santa Barbara

Diverse Global Entryways: How Young Men and Women from China, India, and the United States Make the Decision to Enter Computer Science

A Thesis submitted in partial satisfaction of the

requirements for the degree Master of Arts

in Sociology

by

Yan Ling Anne Wong

Committee in charge:

Professor Maria Charles, Chair

Professor Sarah Thébaud

Professor Lisa S. Park

June 2018

The thesis of Yan Ling Anne Wong is approved.

_____

Sarah Thébaud

_____

Lisa S. Park

_____

Maria Charles, Committee Chair

June 2018

ACKNOWLEDGEMENTS

I would like to thank my Master's committee chair, Prof. Maria Charles, for her guidance and support throughout the past three years. Her expertise and unyielding support has not only made this project possible, but also helped me grow as a sociologist. I would also like to thank Prof. Sarah Thebaud and Prof. Lisa Park for their valuable feedback on my thesis. In addition, I would like to acknowledge Corrie Grosse and Annie Hikido, who shared with me their experience in qualitative research. Their advice on interview coding helped me get through a difficult stage in my research.

My heartfelt thanks goes to the 29 graduate students in Computer Science, Electrical and Computer Engineering, and Media Arts and Technology, who generously shared with me their time and lived experiences in the field of CS. They have helped me learn so much about a field that was unfamiliar to me, and without their participation, this study would not have been successful. I wish them all the best in their career endeavors.

Lastly, I would like to express my deep gratitude to my family: to my father, who has always believed in me and encouraged me to pursue my goals; my mother, who has never failed to show her love and care even when I am away from home; and my brother, who has shared precious memories of growing up even though we are now miles apart. Their love has sustained me, and I count them as the greatest blessings in my life.

ABSTRACT

Diverse Global Entryways: How Young Men and Women from China, India, and the United States Make the Decision to Enter Computer Science

by

Yan Ling Anne Wong

Most sociological research on STEM focuses on the experiences of racial-ethnic and gender minorities and point to the unfriendly culture of STEM as a main factor for their underrepresentation. This study explores the segregation of STEM from a different vantage point by comparing the motivations that graduate students from different ethnic and immigrant backgrounds ascribe to their decisions to study and work in computer science (CS)-related fields. Interviews with twenty-nine CS graduate students from China, India, and the United States reveal differences by gender and country of origin in motivations for entering the field of CS in three areas: ideas about the purposes of work, perceptions of the CS field, and perceptions of self. This study illustrates how individual decision-making may be conditioned by larger cultural and structural forces to produce complex patterns of gender and racial segregation in the US and beyond. Results suggest that an expressive orientation to work and the masculine framing of the field may account for the higher levels of sex segregation in CS in the United States than in China and India.

TABLE OF CONTENTS

INTRODUCTION

Despite increases in women's attainment of higher education and labor force participation since the 1950s, fields of study and occupations continue to be highly sex-segregated in the United States. Some of the most segregated occupations are in STEM (Science, Technology, Engineering, and Mathematics). In 2015, 28.4% of employed scientists and engineers were women, when the percentage of women in the general US labor force was 47% (NSF 2017). In the fast-growing field of computer science, the proportion of women awarded computer science bachelor's degrees peaked at above 35% in the 1980s, and has decreased since then. In 2014, women made up around 18.1% of those awarded bachelor's degrees in computer science (NSF 2017).

An examination of statistics in other countries yields somewhat surprising results. Globally, women's share in science and engineering in 2010 was highest in the Middle East and North Africa (40%), followed by Latin America/Caribbean and Eastern Europe (just over 30%), "The West" – Western Europe, North America, and Australia (around 30%), and Sub-Saharan Africa (just above 20%) (Ramirez and Kwak 2015:16). It was also found that women were underrepresented with varying degrees in computer science in all 21 OECD countries, showing that women continue to be underrepresented in affluent economies (Charles and Bradley 2006:189). Contrastingly, the percentages of women in CS in some developing and emerging societies are higher: in India, for example, 42% of undergraduate students in CS and computer engineering were women in 2011, more than two times the proportion of women awarded CS bachelor's degrees in the US in the same year (18%) (Varma and Kapur 2015:56); and in Malaysia, women constituted more than 60% of the CS student population at two main universities in 2001-02 (Mellström 2009:889). The high

levels of sex segregation in STEM in highly affluent countries compared to developing societies (Charles 2011) continue to puzzle researchers, not least because this phenomenon is inconsistent with structural-functional theories of modernization, which predict that the importance of ascriptive characteristics, such as gender, decreases within public sphere domains as economic development advances.

This study aims to contribute to a better understanding of cross-national differences in female representation in CS by understanding individual motivations and choices in relation to social and cultural structures. By interviewing graduate students in CS-related fields from Asian and European countries of origin and cultural heritages in the US, I explore the interconnectedness between broad-based societal affluence, cultural belief systems, and individual career aspirations. In doing so, this study demonstrates the interplay between macro-level structures and cultures and micro-level decision-making processes, and challenges the division between traditional supply- and demand-side accounts of occupational segregation.

To explain women's underrepresentation in fields such as science and engineering in the United States, some scholars look at the role of taken-for-granted cultural gender beliefs in individual cognition, especially beliefs about individual competencies and affinities. Gender stereotypes appear to be internalized by individuals in the form of career aspirations: American college students who described themselves in stereotypically feminine traits were more likely to prefer female-dominated occupations (Cech 2013). Other studies have shown the impact of cultural beliefs about gender in biasing individuals' self-assessments of domain-specific ability. For example, it was found that men tended to give higher self-ratings of mathematical ability than women did, controlling for actual ability, and individuals who

gave themselves higher ratings in math ability were more likely to pursue quantitative professions (Correll 2001).

International comparisons of sex segregation of field of study found higher levels of segregation in advanced industrial societies than in developing/transitional societies. Charles and Bradley (2009) suggest that this is related to cultural norms of self-expression in affluent countries, or the narrative of following one's passion as a career. Modernization theory argues that advanced economic development leads to a transition from material values to post-materialist values, hence giving cultural approval for self-fulfillment as a career goal, despite possible economic costs (Inglehart and Welzel 2005). In the process of looking for one's true self and passion, Charles argues that cultural beliefs in gender essentialism affect individual perceptions of ability and interests and inform individual occupational choice (2011). As a result, following one's dream and passion may in part reflect societal beliefs about appropriate work for men and women. Self-expression thereby becomes gendered self-expression. This theoretical approach demonstrates the interactions between societal level beliefs about gender and work and individual career preferences and aspirations. However, most studies conducted in this area are based on large-scale survey and statistical data; little is known about how individuals process cultural cues about appropriate work for men and women when they are making decisions about their career.

The gendered culture of CS is another explanation for women's low levels of participation in the field. Popular culture depicts computer engineers as "geeks", typically men who sit in front of the computer all day without interacting with other people. In a study of software engineers, Faulkner (2000) has found that the field emphasizes the technical/social distinction, which frames technical competence and social skills as mutually

exclusive categories. This framing is strongly gendered as it maps on to masculine instrumentalism and feminine expressiveness (Faulkner 2000:759). Since CS is understood as a technical field, the masculine "geek" who is highly competent in technical skills but incompetent in social skills became a frame of reference for men and women alike, and there is evidence that girls' rejection of the "nerd" image of computer hackers was a central reason for their declining numbers in CS in Norway (Håpnes and Rasmussen 1991). However, this specific type of gendered framing of CS may only apply in certain societies. In Malaysia, for example, CS was constructed as a discipline well suited for women, as it often involves an indoor job that requires little manual labor (Lagesen 2008:18). This suggests that the conception of the CS field as it relates to gender may be differ across national and cultural contexts, and could be a factor for the differences in women's levels of participation in CS between more affluent countries and developing countries. However, existing literature on understandings of the CS field in non-Western countries is limited.

One important, but relatively less studied, factor related to segregation of STEM in the US context is migration. Today's labor force is increasingly globalized. In the US, the percentage of immigrants among scientists in the labor force has increased from 7.2% in 1960 to 27.5% in 2008 (Xie and Killewald 2012:50). Immigrants are overrepresented in STEM even after accounting for the overall increase of immigrants in the same period. Among disciplines in STEM, CS has the highest representation of immigrants (Xie and Killewald 2012:56). Immigrants from India and China make up most of the immigrant scientist population: 16% of all US scientists and engineers are immigrants from India, and 11% are from China (Xie and Killewald 2012:57). This increase is largely a result of the rapid increase of foreign students in the US (Xie and Killewald 2012:51). In most STEM

fields, the proportion of women among immigrant scientists is higher than the proportion of women among native-born scientists (Xie and Shauman 2003:198). Most immigrant scientists in the US come from cultures that are commonly considered less gender egalitarian, yet have higher proportions of women in science. Röder and Mühlau (2014) studied the adoption of gender egalitarian beliefs among immigrants in Europe. They found that immigrants adapted their gender ideology to the standards of their residence country, and the origin context lost force over time and weakened over subsequent generations of children.

Drawing on previous literature on gendered self-conceptions in occupational choice and the gender-typing of technical fields, as well as original data from interviews with twenty-nine graduate students in computer science, I argue that different perceptions of self, of the computer science field, and different ideas about the purpose of work contribute to different motivations to study CS. These perceptions and ideas are formed in different structural and cultural contexts; therefore, the motivations for entering the CS field differ across contexts. With a more in-depth understanding of young people's motivations to enter the CS field under different contexts, we may be able to gain insights into the puzzling variations in women's participation in CS across countries of varying levels of affluence.

In the following sections, I first lay out the theoretical framework of my study. I review and build upon prior literature on cross-national and cross-cultural differences in values about work and occupations and depictions of the CS field, and gender differences in assessment of scientific ability and affinity. Next, I introduce the study sample, the study site, the interview data, and the methods used to gather and analyze the data. I then describe my findings in three subsections: ideas about the purposes of work, perceptions of the field, and perceptions of the self. In each subsection, I address differences observed between

individuals from different countries, cultural backgrounds, and gender identities. Finally, I connect my findings to the larger body of literature on sex segregation of fields of study and suggest insights into the connections between contexts and individuals' choice to enter the field of computer science. I conclude with policy implications and directions for future research.

THEORETICAL FRAMEWORK

Popular understandings regard occupational choice as an individual decision, largely determined by the individual's aptitudes, affinities, and aspirations. Along this vein, classical microeconomic theory explains the distribution of different groups of people (for example, men and women) in occupational fields using supply- and demand-side accounts, both of which focus on the behavior of individual workers and employers. Supply-side explanations suggest that men and women have different interests and abilities, which lead them to invest in training for different fields and eventually land in different occupations. Demand-side explanations focus on discrimination of individual employers, which favor certain groups and discourage other groups to enter the field.

While individuals undoubtedly have a certain degree of autonomy over their occupational choice, patterns of variations across time and space in the representations of women (and other minority groups) in fields like computer science suggest a role of contextual factors in individual major and career choice. Existing social science literature reveals contextual variations in three areas: ideas about the purposes of work, perceptions and understandings of the field, and perceptions of the self. Studies suggest gender and country of origin as important axes of difference in these three domains, along with other factors, such as social class, race, and historical period. These factors are not the focus of this

study, but will be discussed where relevant to gender or country or origin. In this section, I address literature that describe gender and country of origin differences in the three main components of career choice to motivate my research questions.

Values about Education and Work in Different Countries

Inglehart and Welzel (2005) argue that economic development triggers cultural changes which make individual autonomy, gender equality, and democracy increasingly likely. An implication of these cultural changes is that work has also taken on an individualist meaning in postindustrial contexts: work is meant to allow individual expression and bring personal satisfaction. As a result, what one chooses to do as a vocation is expected to reflect one's passion in life. In their analysis of American culture, Bellah et al. (1985) suggest that American individualism may weaken community ties. This may dispose individuals to be more concerned with self-realization than family and community needs when deciding their career goals. Charles and Bradley (2009) build on these findings by adding a gender angle: in advance industrialized countries, "different but equal" gender essentialist ideology fits well with liberal egalitarianism in that occupational choices are believed to be made by equal, but naturally different, men and women. In fact it is very likely that young boys and girls reference same-gender individuals and are influenced by gender stereotypes when thinking about what they would like to do when they grow up. Therefore, societal beliefs about what occupations men and women are suited for may be factored into what seem to be individual choices. In contrast, in developing and emerging economies, material wealth is not taken for granted; pragmatic considerations like job opportunities, job security, salary and benefits, and promotion opportunities may be more influential in individual career choice. This may help explain the higher representations of women in lucrative majors, such as engineering, in

developing economies (Charles and Bradley 2009). The above studies suggest different meanings of work in different economic contexts, which also affect the extent to which education is believed to be a form of vocational training or an intellectual pursuit in itself.

Studies on Asian immigrants in the United States and their children suggest differences in how education and work is viewed in Asian and American cultures. In Cupertino, California, where Asians make up over half of the population, the high academic standards set by Asians exceed those of whites and set the benchmark for the third-plus generation, including whites. Nonacademic activities, on the other hand, are dismissed as indulgences in Asian families (Jimenez and Horowitz 2013). Similarly, Louie (2001) found that Chinese immigrant parents in New York City had high academic expectations for children across social class; however, middle- and working-class parents employ different strategies and resources to help their children achieve good grades and secure good jobs. In another study of the children of immigrants from different racial and ethnic groups in New York City, Kasinitz et al. (2008) found race, class, and immigration background differences in the value attached to education. They found that upper-middle class white families saw education as a means of personal fulfillment, while immigrant parents and native minority parents saw education as a route out of poverty. The authors also found that children of immigrants tended to think about the family as an economic and social unit because they were aware of the sacrifices their parents made to bring their families to the United States, which may suggest a different orientation to work than American individualism.

The above studies suggest great variability in understandings of the purposes and meanings of work and education in different economic and cultural contexts. In some contexts, work is valued as a form of expression of an individual's passion and potential; in

others, work is valued for its promise of upward mobility, not just for the individual, but also for the family and community. These orientations to work are not mutually exclusive, but may be given different emphases in different contexts. As we shall see in the next section, occupational fields carry contextual cultural meanings as well.

Gender and the Field of Computer Science

Bourdieu theorizes the scientific field as a field with its own logic and rules that are not explicit and codified (Bourdieu and Wacquant 1992:98). The scientific field is also the locus of a competitive struggle for symbolic capital – the monopoly of scientific authority and scientific competence (Bourdieu 1975:19). Bourdieu argues that judgments of one's scientific competence are always contaminated by and dependent upon one's position in the instituted hierarchies (Bourdieu 1975:20). This illustrates the presence of a social authority which legitimates itself by presenting itself as pure technical reason (Bourdieu 1975:20). In other words, it appears that one's scientific competence is based on the objective evaluation of performance, when in fact other factors such as academic rank, qualifications, and the reputation of academic institutions affect one's perceived competence in the scientific field.

One of the governing logics of the scientific field is gender. This means that in organizations in the scientific field, "advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine" (Acker 1990). In a study of software developers, Faulkner (2000) found that the culture of engineering favored masculinity by framing itself in the mutually exclusive dichotomous categories of technical vs. social, which maps neatly onto the sociological distinction between masculine instrumentalism and feminine expressiveness (Faulkner 2000:762). The engineering field favors the technical over

the social; therefore, this dichotomy between the technical and the social gave rise to a sense of "gender inauthenticity" among women software engineers, who may feel that they need to reject meaningful engagement in social and emotional relationships in order to work closely with technology (Faulkner 2000:762).

Many other Western scholars have also found a similar stereotype of the antisocial "geeky" programmer that prevails in CS, which may discourage women and girls from entering the field. Among high school students, computer scientists are often thought of as "geeky" guys who are socially awkward and infatuated with technology (Mercier et al. 2016; Rommes et al. 2007; Cheryan et al. 2015). Their work is seen as isolating and cut off from communal goals such as helping society and working with others (Hoh 2009; Diekman et al. 2010; Cheryan et al. 2015). People in the industry share masculine interests like playing video games (Cheryan et al. 2011), and the faculty in CS are more likely to believe that inborn brilliance or genius is required for students to be successful (Leslie et al. 2015). These stereotypes may give girls the impression that they might not fit well in CS. Cheryan et al. (2009) found that simply changing the classroom environment from a stereotypical CS setting (with Star Trek posters and video games) to a neutral setting (nature posters, phone books) increases women's interest in CS to the level of their male peers, which shows the effect of contexts that are shaped by popular understandings of gender and CS on individuals' interest in the subject. These popular understandings of CS also create a culture that women find unwelcoming. A survey of technical employees from seven Silicon Valley firms shows that women rate themselves lower on cultural and skill measures of a successful tech employee (Wynn and Correll 2017). The cultural scale is especially important: because women are less likely than men to believe they match the cultural image of successful tech

workers, they are less likely to identify with the tech profession, less likely to report positive supervisor treatment, and more likely to consider switching career fields (Wynn and Correll 2017). The above studies show that the culture in CS is constructed around the male "geeky" programmer who codes all day in isolation, and women and girls find or expect it difficult to fit in. Therefore, they may be more reluctant to go into the field.

The preceding studies of the culture of science and engineering are conducted in Europe and North America. This raises the question of whether the culture of science described by these studies differ in other parts of the world. More specifically, is the gender-typing of science and computer science universal? Do higher proportions of women in scientific fields reflect and, at the same time, create more woman-friendly science cultures in other countries? I now turn to literature on the culture of computer science in parts of the world where women have a higher presence in CS.

Computer Science Culture in Asia

In India, 42% of undergraduate students in computer science and engineering were women in 2011 (Varma and Kapur 2015:56), compared to 18% in the United States. In their interviews with women CS students in India, Varma and Kapur (2015) found that CS was perceived as woman-friendly by both men and women. Many women interviewed saw CS as having great potential for employment in high-paying jobs, and therefore promising higher social status and greater independence. Some also saw computers as new social tools to help people (Varma and Kapur 2015:58). They saw the CS culture as people-friendly, with dedicated, hard-working, intelligent, meticulous, and smart students who help those needing assistance (Varma 2015:271). Notably, many Indian women students reported that their families described CS as an excellent major for women because it required merely mental

and not physical power, and because they could work indoors, with minimal contact with men, rather than outdoors on a construction site (Varma 2015:270; Varma and Kapur 2015:61). Although women are less likely than men to receive early exposure to computers, their strong mathematical backgrounds provided them a sense of self-efficacy in CS (Varma 2010:257). It is interesting to see that although women make up a larger share of the CS field in India, women explain their choices to enter the field in a somewhat gendered logic; for example, that it is more suitable for women to work indoors, and that they describe the CS culture in gendered terms, such as people-friendly.

In Malaysia, where women almost achieve equal representation in CS with men, similar logics exist. Women in CS compared the field with other fields like civil engineering or geology, and considered CS to be more "feminine" because it meant working indoors in an office, as opposed to working outside, which was considered to be dangerous (Lagesen 2008:18). Also, women interviewees distinguished CS from other STEM fields, drawing on a dichotomy of the physical versus the theoretical: working with electronics and mechanical objects is physical, and therefore masculine; whereas working in software engineering and programming is theoretical, therefore feminine (Lagesen 2008:22).

Like India, China has seen a great expansion in the technology industry, especially in the Internet-related sector (Fung, Aminian, and Tung 2015). However, data about the share of women in engineering or in CS are not available; therefore, we do not know much about the CS culture and whether it is gendered in China.

Studies in countries with higher proportions of women in CS suggest interesting similarities and differences between how women frame the computer science field in these countries and in countries where they are a much smaller minority. Women in CS in India

and Malaysia do not reference the geek stereotype (Lagesen 2008:23), which is common in American culture. They also seem to have high levels of self-confidence in the field of CS, in contrast to women's low levels of confidence in STEM in the US. On the other hand, women in India and Malaysia seem to draw upon the same dualistic understanding of gender suggested by Faulkner (2000) when they explain why they pursue a career in CS. They frame their reasons for entering the field in stereotypically female attributes, such as being people-oriented and wanting to help others. Their framing of the CS field as one that allows women to work inside reflects a belief that resembles the "separate spheres" ideology that relegates women to the private sphere, protected from the dangers out there in the public sphere.

Gendered Perceptions of the Self and Career Choice

Gender scholars such as Risman and Davis (2013) have argued for the interactions between macro-level structures, meso-level interactions, and micro-level individuals in the gender structure. Ridgeway's (2011) theory of the gender frame illustrates the impact of broadly shared cultural gender beliefs on social interactions. She argues that gender beliefs are the cultural beliefs about the distinguishing characteristics and behaviors of typical males and females that not only we ourselves know, but we also assume everyone else knows. These beliefs are not just gender stereotypes, but rules of social interactions: they prescribe the rules for appropriate interactions with other men and women under different social contexts. The impact of gender beliefs is especially strong in contexts where gender is salient, for example, mixed-sex settings or settings culturally linked to the stereotypical skills of one sex, such as nursing, military, and in my study, computer science. These cultural rules, which are often implicit, change material arrangements between men and women, which in turn uphold our beliefs about men and women.

Ridgeway's (2011) theory is supported by Cech's (2013) study of college graduates' self-conceptions and occupational field at career launch. She finds that those who describe themselves as emotional, unsystematic, and people-oriented – stereotypically female traits – are more likely to enter fields with higher proportions of women, net of their explicit beliefs about gender roles, categories and essentialism (Cech 2013:747). This provides powerful evidence that the way people understand their own personalities influences their career choice in gendered ways.

Cech et al. compared men's and women's professional role confidence in engineering and found that women's levels of expertise confidence and career-fit confidence are significantly lower than men's confidence levels (Cech et al. 2011:658). Also, they found that gender is no longer a significant predictor of persistence in engineering once professional role confidence measures are included, which shows that professional role confidence helps account for the gender effect in persistence in engineering (Cech et al. 2011:653).

Apart from professional role confidence, self-assessment of scientific competence differs systematically by gender as well. Correll (2001) found that males assess their own mathematical competence higher than females with the same level of objective achievement in mathematics (Correll 2001:1723). Self-assessments of task competence were found to influence career-relevant decisions, even when controlling for commonly accepted measures of ability (Correll 2001:1724). For males and females, the higher they rate their mathematical competence, the greater the odds that they will continue the path leading to careers in the quantitative professions, such as computer science and engineering (Correll 2001:1724). This study shows that gender beliefs affect how one rates one's own abilities, independent of

one's actual abilities. This is important and relevant to our discussion because such self-assessments have consequences on career choice.

Building on existing literature on gendered perceptions of field-specific abilities and occupational fit, I study how young men and women's understandings of the self in relation to the field of computer science differ by country and culture. I argue that self-perceptions do not exist in a vacuum, but in the context of computer science as an academic and professional field. Therefore, it is worthwhile to study computer science as an academic and professional field and whether the culture of computer science is painted differently in different national contexts; and if so, whether these differences shape young people's expectations and perceptions of their own fit in the CS field.

In my study, I focus on the motivations of young people from the United States and several Asian countries (China, India, and South Korea) to enter CS. I look at whether work carries different meanings in different economic and cultural contexts, and whether individuals from these contexts report prioritizing different factors in occupational choice under these contexts. I also study the framing of the computer science field by students from different countries, and how these frames encourage or discourage men and women to go into the field. I look at how individuals fit their self-conceptions in these frames to explain and justify their choice of going into CS, and whether they experienced contradictions between their self-concepts and the (country-specific) culture of CS.

DATA AND METHODS

The data I collected for this study come from one-on-one interviews I conducted in 2016 and 2017. The first phase of interviews took place in May 2016, while the second phase took place in January to May 2017. I interviewed twenty-nine graduate students pursuing

masters' and doctorate degrees in computer science-related fields including computer science, electrical and computer engineering, and media arts and technology at a research university in California. I recruited interviewees by visiting two graduate-level computer science classes, asking the computer science department to send out recruitment emails, contacting the Women in Computer Science group on campus, and through personal networks. Some respondents referred their friends to me after being interviewed.

My sample includes eleven women and eighteen men. Seventeen of the students I interviewed were international students who finished their undergraduate studies in their home countries before coming to the United States. Fifteen were from Asian countries and regions: nine from China, one from Taiwan, four from India, and one from South Korea; two were from European countries: one from Greece and another from Serbia. The two European students were excluded from my analysis because I would like to focus on comparing Asian and American students. Two thirds of the international students in my sample had lived in the US for less than a year at the time of the interview; therefore, in my analysis, I assume that their experiences in their home countries still maintained a strong influence compared to their experiences in the US. Of the remaining twelve students, six were Asian Americans who were either born in the US or immigrated before age 13. The other six were white American students. To get an idea of the participants' social class backgrounds while they were growing up, I asked them to provide information about their parents' occupations and highest levels of education completed on a short survey they filled out before the interview. All but two of the international students come from middle-class families, which is not surprising because a good number of them were in self-financed master's programs. In contrast, about a third of the American students were from working class backgrounds. At least eight

interviewees have at least one parent working in STEM fields (a significant number of interviewees – seven – indicated "teacher" or "professor" as their parent's occupations without specifying the academic discipline, so I was not able to determine whether their parents were STEM teachers).

I conducted most of the interviews in group study rooms in the university library and some in the common areas of the university graduate student apartments. Each interview lasted between 26 to 74 minutes. I conducted the interviews in English, except for six that were conducted in Mandarin Chinese with international students from China. Using Chinese to interview Chinese students allowed them to express their thoughts more thoroughly and helped me build rapport with them. My identity as a Chinese international graduate student also fostered stronger rapport between Asian students and myself, as we were able to relate to similar experiences of growing up in Asia, leaving home, and pursuing higher education in the US. In addition, my identity as a woman may have made women participants feel more comfortable to talk to me about their experiences in the field. On the flipside, it was possible that men were more cautious and reticent when expressing their views about certain matters, for example, gender diversity in CS, because they did not want to offend a woman.

The interviews were divided into three sections: reasons for choosing computer science as a major, experiences in the academic field of computer science, and future career goals. For international students, I also asked them to compare their experiences in CS in their home countries and in the US. At the end of the interviews, I asked the participants several additional questions about whether they felt their gender or racial/ethnic identity has affected their experiences or opportunities in CS. I did not explicitly explain to the interviewees that gender was a main factor being studied because I wanted to see if they

found gender important enough to mention without being primed. Therefore, a debriefing of the study objectives followed each interview.

During the first stage of coding, I coded the interview transcripts line by line for emerging themes. Then, I grouped the initial codes into larger analytic categories ("families"). In this process, three main categories emerged: ideas about the purposes of work, perceptions of the CS field, and perceptions of the self. The second stage of coding involved recoding the interview transcripts using these three categories. I also coded for factors that influenced these three categories, such as family background, gender roles and expectations, and country-specific structural and cultural factors, for example, national labor market structure and media representations of the tech industry. Throughout the two stages of coding, I wrote analytical memos on possible findings and arguments as they occurred to me, as well as new questions raised by the data.

FINDINGS

My analysis reveals three components of participants' motivations to enter the field of computer science: ideas about the purposes of work, perceptions of the computer science field, and perceptions of the self. Perceptions of the self answer questions like "What do I like?" and "What am I good at?"; perceptions of the field answer questions like "What is the environment like studying or working in this field?" and "What kinds of people are suitable for this profession?"; ideas about the purposes of work are reflected in the answers to questions like "What makes a good career?". Usually, one's choice of major would include an overlap of the three components, which means that one would choose a major that provides satisfactory answers to all the above three groups of questions. The relationship between these three components is represented by three circles in a Venn diagram (see figure

1). However, the relative overlapped area of each circle may differ for each individual, which means that for a given individual, one component may be more important than the other two in their major choice. This individual-level system of major choice is embedded within larger structural and cultural contexts. In my study, a main locus of contextual differences would be countries of origin. Although all the interview participants were pursuing graduate degrees in CS in the United States, their major choice was influenced by the structural and cultural contexts in their home countries. In the following paragraphs, I summarize the differences in participants' ideas about work, perceptions of the CS field, and perceptions of the self based on gender and country of origin, and analyze how these differences are informed by larger societal contexts.

Ideas about the Meanings and Purposes of Work

Inglehart (1997) argues that as industrial societies develop into post-industrial societies, cultural shifts towards postmodern values take place. Inglehart and Welzel (2005) found intergenerational differences in values in postindustrial societies and Western ex-Communist societies: younger generations emphasize postmaterial values such as self-

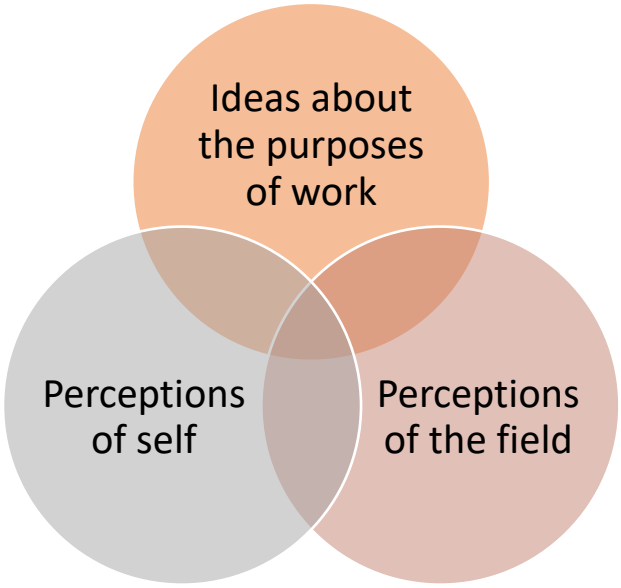

Figure 1

expression, while older generations emphasize material values. An implication of this cultural change is that self-realization and quality of life became legitimate educational and career goals among younger generations in advanced industrial societies, even if it incurs economic costs on the individual (Inglehart 1997).

In my study, I look at a generation of young people who grew up in rapidly developing countries with rapidly developing technology industries. I am interested in whether the processes in which these young people make career decisions reflect the cultural ideals predicted by Inglehart (1997). Another group in my study is the children of immigrants who came from developing countries in the latter half of the 20th century. Since they grew up in a different cultural context than their parents', I wanted to find out whether they inherit cultural meanings of work from their parents or whether their ideas about work approximate those prominent in American culture.

From my interviews, I found that young people from Asia and the US share similar ideals about work. Both groups value personal satisfaction, or "doing what you love", in their career. However, Asians and some Asian Americans are more pessimistic than European Americans about their abilities to achieve these self-expressive ideals while improving or maintaining their quality of life. Therefore, they adopt a more pragmatic approach to major choice and develop practical strategies to create future lives that they will be satisfied with. In some cases, the choice to go into CS is their "fallback strategy" to secure a future that may not be their first choice, but will make them happy nonetheless. I found no apparent gender differences in students' expressive/instrumental orientation towards work among both Asians and Americans.

I found that students from Asia and the US share similar ideals about the value and meaning of work. Ideally, most people want to do something they love and are passionate about as their jobs. Many respondents mentioned that they would like their future jobs to be in their subfields of interest in CS. A man from Taiwan, Chih-Yung, describes what a good occupation means to him:

> A good occupation to me is one that makes you happy when you're doing it. So it is not necessarily computer science, but something that gives you a sense of achievement every day you work and a great work environment for you and your colleagues. To me, that's a good occupation.

He pointed out happiness, sense of achievement, and good working environment as the main factors for a good occupation. He added that this criterion was universal; the definition for a good occupation should be the same in Taiwan, in the US, and anywhere else in the world.

Similarly, when Emily, a European American woman, described the process of exploring and switching between majors in college, she recalled trying multiple things that she "enjoyed", "liked", was "excited about", and considered "cool", before settling on applied math. This highlighted the importance of finding and doing something she loves as a career. When discussing her career goals, she wanted to do something related to research but did not have clearly defined goals. She said, "I feel like I will know it when I find it".

Although the vast majority of interviewees wanted to do something they love as a career, they differ in the expectations of whether they will be able to realize this goal. I found that Asians and some Asian Americans were more likely to emphasize external factors in their major choice. One such external factor that interviewees from China and India stressed was the development of the software industry. In fact, the rapid expansion of the software

industry was the reason why many students who majored in electrical engineering switched to computer engineering and computer science. At least three Chinese students analyzed that the hardware industry had reached a bottleneck, while the software industry was growing quickly, opening up opportunities for students like them. Indian students echoed this observation. Two students were trained in electronic communications in college, but the jobs they got in India after they graduated were CS-related, which led them to further studies in the field. In both the cases of Chinese and Indian students pursuing a CS degree in the US, job opportunities were their main concern. I argue that this is especially true for those who came to the US as international students because of the limited career options that would provide working visas for them. Since there are so many job openings in software engineering that are not filled by native US workers, companies are more likely to hire international students to fill the vacancies. As a result, choosing CS is beneficial to international students who would like to work and stay in the US.

Lindsey is a woman from China who finished a CS bachelor's degree in her home country. Right from the beginning of her undergraduate career, she had had a strategic plan of migrating to the US using CS as an entry point:

> In fact, at first it was mainly the idea of going abroad, the idea that I just did not want to stay in China. And then I was choosing between the United States and Europe, and I thought the United States would be a little better. And then job prospects are better in the United States, because I personally do not care too much about the major – that is, I can study CS, I can also study other things, that is also fine, so my choice was not really driven by interest.

It seems that Lindsey's decision to major in CS was determined solely by her perception of the job prospects of CS. She picked the major that was most favorable to her plan of migrating to the US. When asked if she would want to stay in the CS field for the long run, she answered no, explaining that CS was a way for her as an international student to establish financial stability in the US, so that she could settle and get residence in the US. Since she was not particularly interested in CS, she would rather do something else further down the road.

Asian and Asian American students are more likely to draw clear distinctions between their hobbies and their careers. Jessica, a Chinese American woman, described herself as an artist and a musician, but she felt that she "wasn't good enough at either of those or passionate enough to actually make a profession out of it". This view may reflect that Jessica prioritized other things when she was choosing her major. As she explained later, she was brought up in a "more pragmatic way than some Americans":

> I never heard like, "Follow your dreams." That wasn't like a thing [laughs]… It was just realistic like, "What kind of job you think you could be successful in and enjoy it reasonably," and not like, "Follow your passion."

Jessica explained that her parents (both from China) taught her that interest and passion should be balanced with career success. Enjoyment is important, but only if she could be successful in the job as well. This orientation stands in contrast to the "postmaterialist" idea that career represents one's self-expression. A male student from China, Yingxiu, went further in saying that "what you like" doesn't actually exist, or is insignificant:

> In fact, I think that what you like is to a large extent a pseudo-proposition. For me, I like playing piano and singing more, but I also feel that engineering is quite interesting to learn, not like some disciplines I simply do not want to study.

Here, Yingxiu draws a clear line between what he likes as hobbies (playing piano and singing) and what he likes to study. Earlier, he mentioned that the two important factors in choosing computer engineering was whether he was willing to learn it and whether he could make a living if he graduated with the major. He seems to suggest he cannot do music for a living so it does not matter that he likes it a lot. He needed to be realistic in choosing to do something he does not hate and will enable him to make a living.

One strategy that some Asian students employed to balance pursuing their interest and having a successful career is to combine their passion with a lucrative major (like CS) and look for a middle ground where they can achieve both objectives. Interviewees who were MAT (Media Arts and Technology) seem to do this: they were interested in art, but were convinced that they would not be able to make enough with art, so they decided to combine art with CS and have the best of both worlds. Helen, a woman from China, majored in CS and minored in art for her undergraduate studies. After she graduated college, she was uncertain which way she wanted to go because she felt that she didn't like CS. She considered going to architecture, but her father suggested that instead of starting over, she could combine her strengths in art and CS and do a degree in MAT. A Korean woman, Jae-eun followed a similar path. After completing a bachelor's degree in electrical engineering and a master's degree in medical imaging, she wanted to do something she really liked while utilizing her engineering background, which was why she went into MAT.

These examples stand in contrast with the "passion principle" which scholars argue characterize postindustrial societies. Asian students suggested that liking what they do was important, but it was not the only or even the main consideration in choosing what they do as a career. They saw career choice as a delicate balance between many factors, such as career success defined by earnings, job stability, and promotion opportunities.

On the other hand, American students were more likely to describe their love for computers and fascination with CS. Jacob, a European American PhD student in CS, described with great enthusiasm his passion and wonder for CS when he first discovered the subject:

> When I realized that there were all these people who were applying this type of math that wasn't continuous, I was amazed and I said, "Oh, well. This is what I want to do for the rest of my life." ... Here was this other type of math that was incredibly interesting, so I was like, "Wow, this is what I want to do for the rest of my life."

Jacob was intrigued by the mathematics behind computer science, and described it as "incredibly interesting" and "a lot more enjoyable" than calculus, the other type of math that he didn't like. He seemed to have fallen in love with CS at first exposure, and he aspired to be a CS professor in the future. Later in the interview, he juxtaposed his approach and motivation to study CS with that of more business-minded students. He felt disappointed that some students were just in CS so they could get good jobs in the tech industry, that they did not appreciate the beauty of CS:

> I definitely think that it [students taking CS just to get good tech jobs] makes computer science seem cheap, it makes a lot of this formalism seem useless

> because these kids are going to forget it once they go and just start writing code for Facebook or Google. So I don't know, it's sad to see the field abused because to me in a lot of ways computer science is just a sub-field of mathematics. I think right now computer science is somewhat being abused by its business applications. A lot of smart students are being misled into thinking that a good tech job is sort of the way to study computer science.

To Jacob, "the way to study computer science" is not about getting a good tech job, but appreciating and loving the machines and formalisms that make up the essence of the discipline. He felt sad to see that CS had become a money-making tool for some students; he felt this was an abuse of the academic discipline of CS. Not only did he adopt an intellectual approach to CS, but he saw it as a higher and perhaps more noble goal than using CS to find a high-paying tech job. His approach aligns with the larger culture of self-expression in the US, which upholds that following one's passion and doing what one loves should be the primary driving force in one's career. Pragmatic material considerations come second.

Not all white students share Jacob's approach to studying CS, of course. But one thing that they share was that they were more likely to describe their interest in computers. Some men describe being exposed to and becoming interested in computers from a young age. Brad used to be a hacker who stole video games online and taught himself coding in high school. Then, his hobby turned into his major and later, his career. He described the process as one that happened by chance:

> I think I sort of lucked out that something that started out as a hobby, a pretty niche hobby that no one was really doing like the computer security hacking stuff, turned into a career path.

In contrast to the previous example of Jessica and Yingxiu, the two students of Asian heritage who drew a clear distinction between hobby and job, Brad's hobby *is* his job.

> I very much see it as like, I now get to do my hobby as my job. For eight hours a day, I get to do that hobby, and then that opens me up to other hobbies.

To Brad, it was a nice coincidence that his hobby turned into not just a job, but a nice job with good pay, flexible hours, and plenty of opportunities. It is interesting to note that Brad has many other hobbies in addition to CS, and he saw that by doing one of his hobbies (CS) as a job, he could have more time to explore his other hobbies, which may suggest another purpose of work: to provide the resources to enjoy life. This is different from the Asian students' approach of working to provide basic necessities and ensure the quality of life for themselves and their families.

Why do Asian heritage students have a more pragmatic approach, and white American students a more self-expressive approach to major choice? In Inglehart (1990)'s theory of modernization, two hypotheses for the transition from material to postmaterial values were proposed. The first one was a scarcity hypothesis, which states that everyone wants freedom and autonomy, but individuals' priorities reflect their socioeconomic conditions, placing the highest subjective value on the most pressing needs. For example, in a low-income society, individuals may prioritize job security and income when finding a job. It is important to note that these priorities are based on a subjective sense of security, influenced by the general sense of security in one's social context. As such, an individual from a low-income background in an affluent society is more likely to prioritize self-expression over material needs than his or her counterpart in a developing country, while an

individual from upper-middle-class background in a developing society may prioritize survival values. In both cases, individual priorities are based on the dominant culture of the specific society in addition to individual class background.

My interviews lend support to the scarcity hypothesis. Students from China and India described intense competition for educational resources in their home countries when accounting for their major choice. To survive in this competition, they were strategic in utilizing the limited resources they were able to access. Often, their major choice was not primarily determined by their interest and passion, but by the expected value of the major. For example, Geeta, a woman from India, chose electrical engineering (EE) in college because she got into the best engineering college in India and EE was the best major in that college. Similarly, two other students from China and Taiwan chose the majors that required the highest grades to get into. This approach to major choice seems to imply that students (and their parents, as the students suggested) wanted to make the most out of a college degree, and they figured that choosing the most prestigious and most highly sought-after majors would provide the best value possible. The scarcity of resources is also reflected in the competitive mindset shared by Asian respondents. Students from Asia seemed to be highly cognizant of competitive labor market. Several Chinese students described more intense competition in China than in the US. They also described their expectations for the job search process after graduation using a language of competition. For example, Wuyan, a Chinese man, shared that he thought the competition within his graduate program was fine, but after graduation, he would be competing with a "large army of graduates" in the entire United States. This competitive mindset indicates the perception of the scarcity of resources among Chinese and Indian students, which may predispose them to make choices that they

feel would better equip them for the competition for resources such as jobs and promotions after graduation.

Not only did the scarcity of resources and intense competition foster an emphasis on material goals, it also created social pressure for choice of college major. A common theme in all four interviews with Indian respondents was the limited options of college majors: good students are expected to major in either engineering or medicine. Of course, this does not mean that good students were not allowed to choose other majors, but that job opportunities are the best for these two majors, as described by Advay:

> In India there are only two things: doctor and engineering there. Other than that, they don't care. If you're something else, you're something else. The thing is engineering students will end up easy in jobs… medical students they take a long time to get the job. That's how it is. It depends on jobs, that's it.

The case in China seems to be a bit different. Chinese students had more leeway in choosing their majors. When I asked them what majors were considered good, many of them said that it depended on the person's background and aspirations. Wuyan said that it depended on the situation: "I think both are important, because ... sometimes you have to look at reality, sometimes you have to consider your ideals, so it depends on which side you lean towards when you need to make a decision." Yingxiu added that people from different class backgrounds have different priorities:

> For people from working families who go abroad to study and to find jobs, then of course a good major is one that will make finding a job easier. For rich people who are investment immigrants, of course it's what interests them, what they like to do. It depends on what you want.

Here, Yingxiu suggested that "doing what you like" is a luxury that only people from privileged backgrounds could afford. His comment points to differences in wealth that might have come from the rapid but uneven economic development in China in the past three decades. Those who migrate to the US come from diverse economic backgrounds, which may contribute to different motivations for career choice.

The diverse motivations for career choice may also indicate a gradual change in the culture in China from materialist to postmaterialist values. Abdul's observations suggested a similar cultural change in India, where the previous generation valued doctors and software engineers more than other occupations, but young people from his generation validate the "passion principle" and support each other to do things they love:

> Not in our age group, but the age group previous to that… like if you're a software engineer or a doctor you have more… what do you say, importance... But it has changed a lot for our age group. We think everything is cool, like he's doing something, he's passionate about it, like we're totally cool with that. But… one generation back I don't think that was the case.

The second hypothesis proposed by Inglehart (1990) to explain intergenerational differences in values is the socialization hypothesis, which states that one's basic values reflect the conditions that prevailed during one's preadult years. This explains the more pragmatic approach to career choice among students who grew up in China and India. In addition, older generations in each society tend to transmit their values to their children. An interesting question to ask here is: do children of Asian immigrants inherit their parents' values about work, adopt a cultural orientation more similar to the self-expressive culture of the US, or perhaps combine both cultures?

My results are mixed in this regard. Let us return to the example of Jessica, the Chinese American woman who said that she had been brought up in a more pragmatic manner than some Americans. She mentioned that her mother chose to study engineering even though she was not interested in the subject because she did not have much choice in 1970s China, when colleges just reopened after the Great Leap Forward. Engineering was a major that allowed her to migrate overseas. It seems that Jessica's mother transmitted this practical attitude to her. However, other Asian American students expressed genuine interest and passion in computing. For example, Min Jun (Korean American) and Philip (Chinese American) both mentioned that they liked CS because it gave them the ability to create a reality within a short time. Therefore, it seems that both their immigrant parents' cultural values and values of self-expression are influential in their choice of career.

Social class is another variable related to both the scarcity of resources and the socialization of values. While societal affluence sets a dominant cultural narrative of self-expression and legitimizes nonmaterial goals as part of occupational choice, individual class background involves the particular situation and needs of an individual and their family, which may be at odds with the mantra of "doing what you love" (Ma 2009). A person who grew up in a lower class background in an affluent country may make decisions more similarly with the average person in a developing society, while a person from middle or upper middle class backgrounds in developing countries may make decisions more similarly with the average person in an affluent society. Since everyone I interviewed was in the CS major, my sample could not capture those who chose less lucrative majors. However, my interviews did suggest some influence of social class on occupational choice and career decisions, in general. One example is Brad, the self-taught hacker from a working class

family in West Virginia. He saw people in his neighborhood trapped in a cycle of poverty and decided to take advantage of his skills in computing to get a good career:

> The fact that I had a golden ticket to go see the world and go try these different opportunities, I felt like I would have been slapping everybody in my hometown in the face if I didn't seize that opportunity. I had really good grades and this set of skills that society currently found really valuable, so I really wanted to give it a shot.

Brad also cited his grandfather, who worked three jobs to raise twelve kids, as a motivator for him to give up on his dream job (construction) and focus on CS. However, Brad was also passionate about CS because of his early experience in hacking, so it seemed like the fact that he decided to pursue CS was a fortunate coincidence instead of a calculated move based on the economic needs of himself and his family.

My interview data are consistent with Inglehart and Welzel (2005)'s theory that economic development is accompanied by a growing emphasis on self-expressive values, at least in biographical narratives – whether individuals are as self-expressive in their major choice as they claim is another question that cannot be answered easily with interviews. Although all students wanted to do what they loved, students from developing countries such as India and China were more likely to emphasize external practical constraints in the process of choosing their majors, while European American students were more likely to describe their passion in CS as the main reason for choosing the major. However, there are signs of change in the cultural values towards work in Asian cultures among younger generations. As countries continue to develop economically, whether young people will increasingly

prioritize self-expression over economic survival is an interesting direction for future research.

Perceptions of the CS field

Studies have shown that in Western societies, the field of computer science is numerically and culturally dominated by white men (Ensmenger 2015). In particular, the nerd or geek stereotype prominent in the field often describes a white man immersed in coding and technology. As a result, studies describe women and racial and ethnic minorities experiencing feelings of exclusion in the field. Of the 27 students I interviewed, most described positive overall experiences in the field. Some were especially positive and felt that they fitted in very well, while others, not just women and racial and ethnic minorities, felt that they did not fit in the culture of CS. I suggest that this is related to the fact that the CS culture is narrowly defined in terms of the geek and nerd stereotypes; therefore, anyone who does not match the stereotypes is not considered typical. I found that American and Asian students employed different strategies to deal with the narrow cultural meaning of a computer scientist: American students (including Asian Americans) tend to challenge the dominant culture of CS and try to expand its meaning beyond the stereotypical geek or nerd culture. Asian students also rejected the stereotype, but they rarely critiqued or proposed alternatives to the culture. This difference in strategies may be related to the culture of self-expression in the US: American students try to create a CS culture that allows different ways of self-expression, while Asians may not see such concerns as a high priority. As cultural outsiders in the US, they may also feel less power to expand the cultural meaning of the field.

Consistent with existing literature, my interviews reveal the nerd/geek stereotype, which was mentioned by almost every participant regardless of national origin or gender

when they were asked to describe stereotypes in the field. The definitions of a stereotypical person in CS align with popular descriptions of a nerd/geek[1] who is socially awkward and has a single-minded devotion to computers. As an Indian student, Ayaan, described, they are "geeks wearing spectacles sitting in front of their laptops, coding all day and cups and cups of coffee and going through the night and just come in in the morning". Other students described a typical geek spending most of his time in front of a computer and only hanging out with other geeks. Men and women from the US referenced race and gender when describing a geek, saying that a stereotypical person in the field was male and "probably very Asian and white" (Jessica, Chinese American), later adding that Asian meant Indian and East Asian.

When asked if they thought the geek stereotype was true, most participants thought it only accurately captured a small subset of the population. Some participants considered themselves geeks or nerds. For instance, Faith (Chinese woman) described nerds as people who were not social and preferred playing video games to parties and outdoor activities. She specifically pointed out that the nerd was not just a stereotype, but an impression based on reality. From her experience, this is what computer scientists look like, and she was one of them:

> I feel that this major is a good match for me, because although like I said before, some people in my lab like to chit-chat, I still feel that the whole department is quite nerdy, yeah. And I'm just like that.

[1] There has been some debate on the Internet about the differences between a nerd and a geek, or whether such differences exist. Some Internet sources define a nerd as an industrious, intelligent, and socially awkward person with an extreme interest in academics, and a geek as someone with a specific niche interest that they have become the expert on. I use the two labels interchangeably, because participants in my study did not draw a clear distinction between the two, and they, too, sometimes use the two terms interchangeably.

Similarly, Min Jun, a Korean American man in my sample, saw himself as a "geeky person" after describing geeks as people who have expert knowledge that others do not, and who lack social life. However, contrary to Faith's assertion that nerds populate the whole field, Min Jun believed that only some people in the field were geeks.

Another student, David from China, felt that he fitted well in CS, identified as a geek, but gave a new definition for the commonly used term:

> So geek is someone who's… like me. Geek is, you know, someone who… who could focus on something, you know, for a long time. And really trying to dig into it as deep as possible, you know, no matter what that thing is.

David defined geeks as people who had in-depth knowledge and expertise in anything, but he did not mention negative traits like being socially awkward or having no other interests apart from computers. By redefining geeks, David was able to fit in the field as one of the geeks without embodying the negative image of a socially awkward man coding indoors all day.

Unlike the above examples, other students did not feel that they fitted in CS for a variety of reasons. Although almost every participant recounted positive overall experiences in the field of CS – friendly peers, faculty, and staff, and interesting course material, many of them felt that they did not fit in. This included not only women and racial-ethnic minorities, but also other groups including some white and Asian men, who make up the majority of the CS field. One geek trait that a lot of students thought they did not possess was the singular devotion to CS. Many participants assumed that good computer scientists and engineers spent most, if not all, of their spare time on coding or other technology-related activities, and since they did not do so, they did not consider themselves fit to be good computer scientists

and engineers. An example is Janice (Chinese woman), who said she was not like many "computer science guys" who "code for the whole day" because she thought she was not hardworking enough. Yingxiu (Chinese man) also distanced himself from good computer engineers because he did not spend his spare time researching technology:

> [A good computer engineer] spends his time researching technology after work. I find this very difficult to do. I prefer to communicate with people or get to know different people, learn something different. Yeah, I like it that way. I do not know if this is a disadvantage or an advantage [for myself], I just feel that it conflicts with the vibe that most of the engineers give.

It seems that good computer engineers are expected to devote their time, both at work and after work, to technology. Yingxiu was unwilling to sacrifice his social life to devote his time solely to computers, once again rejecting the antisocial stereotype of nerds. We should note that here, Yingxiu extended the characteristics of nerds to good computer engineers, which means that good computer engineers were expected to possess and display the traits of nerds.

Other students who had broader sets of interests and hobbies do not fit the image of a typical computer scientist. Brad, a white man who enjoys outdoor activities, described his experience with friends in CS who did not share his interests:

> I think I have a good time, but like I said, I'm an outlier. It came up at lunch when I was working at [another institution] that I'd never seen Star Wars… I think it's not a negative thing. I get along with everyone well, and like a lot of my close friends and things are in CS, but there's definitely a differentiator

> that is pointed out quite regularly. "It doesn't make sense. You play sports and like go to the gym, and do all these things, like why are you in CS?"

Brad described positive relationships with his colleagues in CS, but his interest in sports and lack of interest in Star Wars (a typical "nerdy" interest) marked him as an outlier in the field, which shows that just liking CS (evidenced by his rich experience in hacking) is not enough for one to qualify as a typical CS student – liking CS single-mindedly is.

Does a similar geek stereotype exist in China and India? My interviews with Chinese participants revealed a similar but different stereotype in China, the "coding peasant" (碼農). Coding peasants are similar to nerds in that both spend long hours coding, but what differentiates between the two is that nerds are driven by a strong passion, or even obsession, in technology, while coding peasants are driven by work demands. One of my Chinese participants, Jack, explained that the differences between the two were related to the history and structure of both the higher education systems in the two countries and the global technology industry. He thought that "nerds" in America were more diverse in terms of appearance, and they were more passionate about technology than "coding peasants" in China because they studied CS out of their own interest and designed their own products. On the other hand, some Chinese students became coding peasants because they were assigned the CS major in college. Historically, these students ended up doing coding jobs outsourced by American software companies and did not have their own product; therefore, they were not as interested in coding, and they appeared duller and not as passionate about their job. Jack's comment indicates that he thought there was a connection between people's motivations for doing CS and their presentation: American nerds exemplify a passion and even an obsession with technology because they freely chose to be in the field, while Chinese

coding peasants appear dull and uninterested because they just did programming for a living. The differences between nerds in the US and coding peasants in China reflect different orientations towards work – the former motivated by passion, the latter motivated by necessity – which relate to the broader cultural values of self-expression and survival in the two societies.

While stereotypes like the nerd and the coding peasant pervade CS culture in the US and China respectively, my interviews with Indian students suggest that no such stereotypes exist in India. Ayaan, an Indian man, tries to explain this by tracing the origins of the geek stereotype:

> I would say it's [geek stereotype's] like a first-world thing, like all the developed countries have this kind of notion… I would say it's mostly because of the Internet, because you see people over here you wouldn't see people like that just consuming coffee, coding hours and hours together and just like people have made it look like that on the Internet.

It is interesting that Ayaan pointed out that the geek stereotype was a "first-world thing", meaning that it only existed in developed countries, like the US, and not in developing countries, like India. Other Indian participants echoed Ayaan's observation that the geek was a product of popular culture, like the Internet or movies, and therefore lacked credibility. The fictional roots of the stereotype may explain why so many participants felt that they did not fit the descriptions of a geek, and therefore are not typical computer scientists. Indeed, only few, if any, could devote all their spare time to coding or hacking after doing it for a day at work or at school. The specificity of the geek stereotype, coupled

with exclusionary social dynamics due to one's minority status, created the feeling of being out of place.

The above examples showed how individuals experience the CS culture. However, individuals are not only recipients of culture; they are also producers of culture. Citizens of foreign countries present in the US for immigration or other purposes do not just assimilate into mainstream American culture; they change and become part of the culture. In the graduate programs of CS-related departments in the university where I conducted this study, there is a sizeable population of international students. In my sample of 27 participants, over half (15) are international. International students can be considered a "majority-minority" in this context, and they created an interesting dynamic in the culture of the department. For one, the traditional majority in CS, white American and Asian American men, felt that they were the minority. Brad, a white American man, described cultural differences with students from Europe on things like getting lunch at different times. Andrew, an Asian American man, also described cultural differences with international students, and because international students made up the majority of students in his department, he found it difficult to fit in:

> The graduate student community is very different [from the undergraduate student community]. It's largely made up of international students, and most people are from a very, very diverse set of backgrounds, I guess – have different hobbies, and grew up on different things, so – and some even prefer to speak their own native language instead, for instance, so it's very, very difficult to fit in and find the right group of colleagues, I guess, as a graduate student.

The cultural differences between American students and international students in CS (many of whom are from Asia) created unique gender dynamics in the field, as experienced by a Chinese American woman, Jessica:

> First of all, there is the cultural difference and then second of all, there is the gender difference. Especially when most people in my department come from cultures that are more conservative and more gender segregated, then they don't feel like they can be my friend or they don't want to generally. I tend to try to find other Americans to be friends with and they are not in my field.

Jessica found it difficult to make friends with the international students in her department, most of whom were male and came from more gender-conservative cultures. She preferred making friends with other Americans, and because Americans were the minority in EE, she ended up making friends outside her department. This example shows a possible interactive effect between culture and gender that isolates American women in CS-related fields, and suggests a similar effect for women from other cultural backgrounds as well if it was true that the separation was caused by more gender-segregated cultures.

We have seen that students felt that they did not fit in the CS field because they did not measure up to the geek stereotype or because they did not fit in with other people in the field. How did they cope with the mismatch between themselves and the field? I found that American students were more likely than Asian students to critique the geek stereotype, define themselves in new different ways, and imagine a new culture in CS. This may be explained by the more self-expressive culture in the US.

Several American students offered criticisms about the CS culture. Brad commented that the culture of the field was childish and unprofessional. Job descriptions were written in

Comic Sans, and workplaces boasted nerf guns. He further stated that there was an arrogance in the field, especially in the hacker community, where he was involved:

> A lot of humongous egos in the hacker community where people think they're awesome… It still has this sort of 16-year-old immature feel to it. I think because we're like the new kids on the block that are now making all of the money, right? Like computer securities is a hot field, yet for some reason, people don't seem to be socially maturing… All of our conferences have booze and you're getting wasted while giving your talk and things like that. Not many other sciences do that, right?

When asked why he thought the hacker culture came to be this way, Brad said that a rebel mentality might be the reason. Hackers are experts who have knowledge about the tech world that others don't, and by definition, they break rules and "hack every aspect of life", which may contribute to the tendency to also challenge conventional workplace cultures. As Brad also pointed out, this was a distinctly masculine culture: the arrogance, the rebel mentality, and the prominence of alcohol at conferences might make women feel uncomfortable and discourage women from staying in the field. Brad further suggested that this masculine culture was a reason for the underrepresentation of women in the field:

> A lot of the things that come up, like in the past decade, like why women don't go into CS? I think because it's been such a male-dominated field for a while. It has this sort of bro-ey kind of feel. A lot of the jokes are not very gender-neutral [or] appropriate.

According to his description, male domination is not just in numbers, but in the culture of CS. The “bro-ey” feel, exemplified by the “not very gender-neutral [or] appropriate” jokes, is ingrained in the culture of the field.

Women participants in my study experienced both overt and covert forms of sexism. An example of an overt form was when Erika, a Czech American woman who went to a conference while pregnant, got an unsolicited comment from a stranger, that she “just made graduating a lot harder” on herself. More subtle examples included a time when a professor tried to help Erika with a problem in class when she had already written the solution on the board, which might have been well-intentioned but suggested implicit gender bias (although Erika did mention that it could also be a bias against athletes, as she wore her college soccer gear to class).

Some women participants attributed their experiences in the field to their token status. A token group is one that only makes up up to 15% of the whole group. Jae-un (Korean) did not see her disadvantages in the field as a problem with the culture of the field, but an effect of being a numerical minority:

> It's not discrimination; it's not that they are trying to discriminate. It's just you know if there is minority, you just get more attention and also because of that, you are not very courageous to talk because the boy beside me talking, and me talking is the way is different. And that’s natural; it's not that they want to discriminate.

In this quote, Jae-un repeated that she didn’t think she was discriminated against in the field, but that she experienced difficulties because she was a numerical minority. She did not link the underrepresentation of women with the culture of engineering. Jessica also

attributed her uncomfortable experiences, such as feelings of loneliness and isolation, in the field to her status as a minority:

> I am the only girl in my lab and I'm the only girl in the class I'm taking and it's usually how it is. Sometimes there's maybe a couple more girls but it feels very lonely sometimes. It's hard to make friends because you are like the weird one.

Later, she described an experience when she was teased by her male colleagues when they were traveling to a conference together:

> When I first joined my lab we went to this conference last summer. There was a computer vision conference and all the guys in the lab were going to get a room together, save money and they were like, "You are going to get your own room, right?" I'm like, "I can't afford that". We worked it out and I ended up staying in the room with the guys but they teased me nonstop about it. They were like, "What happened to the room?" I was like, "Why don't you ask any of those guys?" [laughs]. It gets weird sometimes but I think I am thick-skinned enough that it doesn't really bother me for the most part.

Jessica thought her male labmates were not malicious and were just being silly. Her response to these uncomfortable experiences was to be “thick-skinned” and stop caring about what other people thought. This may be an additional labor that members of token groups need to put in to survive in the field, and the additional labor may affect their performance in the field.

Students who are not members of minority groups in CS are aware of and concerned about minorities’ experiences. Several criticized the CS culture for its lack of awareness of

social and diversity issues. Andrew, a Chinese/Vietnamese-American student, compared the CS field to a factory that produces workers who are apathetic to issues related to diversity:

> I do think that part of the culture is a lack of understanding of issues relating to diversity and issues related to minorities and things like that. It's a field that funnels all of its – that treats students a certain way, and then expects a certain output out of them, and never really thinks about anything else. For the most part you go in, and then you get a degree, and then you go work at a company, and you produce a product. So it's definitely a place where you probably never have time to look around and think, "Well, maybe this field would be better or different, if it was more diverse". You never really think about diversity. You never really think that there is a need for it or anything like that. I think that's part of our culture.

Andrew did not consider the lack of social awareness to be merely a problem with individuals, but with the culture of the field of computer science. He saw the field as one that trained students for the workforce and did not prioritize issues like diversity. This shows that concerns about diversity are not limited to members of minority groups. A similar criticism about the lack of social awareness was given by Sean, a white American PhD student in CS, who described a culture of "white tech bros" in CS:

> I feel like there's this dominant culture of like white tech bros who feel like they weren't dominant culture of computer science. Like, they are alienating… It's just like dominant culture driven towards profit, oblivious to what's going on with the rest of the world, sort of, I guess, self-centered.

Sean brought up another character, “white tech bros” here. According to Sean, “white tech bros” are people who dominate the technology industry and who only cared about making profit, for example, some people in CS wanted to solve problems in the most efficient way possible, which was often at odds with other concerns like social issues (he gave an example of a start-up incubator that wanted to automate fast food ordering system and did not care about fast food workers losing their jobs). Two other American men, Andrew (Asian American) and Jacob (white American) also made similar observations: there is a fast-growing group of computer scientists who are also businessmen interested in making a fortune out of technology. It is interesting that this aspect of the CS culture was only mentioned by Americans – more precisely, American men – and the reason why they brought it up was to criticize it. Chinese and Indian participants were more likely to consider the profit-making potential of CS as a positive aspect, especially for their own careers. They may even aspire to be one of the “tech bros” – to rise in the ranks of big tech companies or start their own software company. Therefore, they did not see the need to criticize the profit-oriented aspect of CS. In contrast, Sean had another vision for what he wanted to do with computer science, one that is not profit-oriented but more socially minded:

> I don’t want to work in like software company. I don’t want to spend ten hours a day programming. I’m not interested in making $150,000 and be like some crazy database administrator or something... I want to teach students and do that kind of thing.

His teaching philosophy is focused on social responsibility as well:

> Like teach people how to do Computer Science but also emphasize like social responsibility while teaching it. Hopefully, encourage those people to not go out in the world and be these like money-grabbing start-up people.

Sean seemed to draw a dichotomy between doing CS for profit and for other social goals. Sean is from a working class background, but the result of his background is not that he wanted to make more money with his CS degree; instead, he wanted to promote social equality with technology. Being from an affluent society such as the US, he and the other American men who criticized the money-making culture might have been influenced by the culture of self-expression and emphasized non-material goals.

I have described students' individual experiences of the CS field, which reflect the culture of the field. One thing that was surprising was the diverse backgrounds of students who felt that they did not fit in the field. I argued that this is because students hold themselves to the standards of a geek, and the geek stereotype is so narrowly defined that very few fitted the description. Of course, the question that remains is whether the consequences of feeling out of place differ for men and women, or for individuals from different countries. Does the sense of being an outsider affect individuals' self-confidence equally across gender and racial/ethnic groups? Does it affect the extent to which individuals want to stay in the field? These questions point to the interactions between CS culture and individuals' self-perceptions and will be answered in the next section.

Perceptions of the Self

Previous studies have shown that boys are more likely than girls to develop a geek identity early in life through exploring and playing, or "tinkering", with computers (Margolis and Fisher 2002). Boys' early exposure to computers gives them a head start on

programming, and helps them develop a sense of belonging and familiarity in the field of CS. As a result, boys and later, men, tend to develop higher confidence and greater perceived fit in CS. This may be especially true in cultures where innate talent and brilliance is believed to be required for success in STEM fields, like the United States (Leslie et al. 2015), as tinkering may serve to confirm the belief that boys are innately better at, and naturally attracted to computers. Consistent with prior research, my study found that men were more likely to have been exposed to computers at an early age. However, this only applies to American men: few Asian men (and none of the women) described similar experiences of tinkering. I suggest that American women may observe a bigger gap in experience between their male counterparts and themselves than Asian women may; therefore, American women may be more negatively affected, for example, they may suffer from low levels of confidence and sense of belonging in the CS field. My interviews with women participants suggest that women employ different coping strategies to counter the disadvantages they face in the field, the most effective of which appears to be forming a strong support network.

Among my interviewees, American men seems to be the only group that tinkered with technology in childhood and adolescence. Asian men and women are almost equally unlikely to have had such experiences. Out of the eight US-born men in my sample (including one who immigrated to the US at age 13), four described early experiences in programming. Their choice to major in CS in college was a natural extension of their interest developed early in life. Jonathan, a white/Asian American student, became interested in programming in junior high school:

> For junior high, one of my friends made a website. I thought it was the coolest thing, so I wanted to make it too. Yeah, pretty much since junior high I started

getting interested in programming.

Other American men took computer science in high school, developed an interest in programming, and decided to continue with CS in college, as Min Jun (Korean-American man) described:

> In high school I took a computer science class and that just opened up a new world for me because I get to – what should I say – control this reality inside the computer and that made me feel powerful and I don't know, fun, too, you know just like to change around things.

And perhaps the most prominent example of having an interest in computers early in life is Brad, the hacker we talked about in previous sections. He said that his programming skills when he started college were "all self-taught in high school" when he got into hacking to steal games and movies online. For these men, the CS major seemed natural because they had already had some experience with programming before college, whether formally, through CS classes in high school, or informally, through hacking and learning from friends. These experiences not only gave them an advantage in actual programming abilities, but also helped form their identity and sense of belonging in CS. Since all the American men in my sample are either white or Asian, and most of them are from middle-class backgrounds, it is possible that early opportunities for tinkering with technology are only associated with white and Asian middle-class boys. Further studies may be able to determine the race and class dimensions, in addition to the gender dimension, of such phenomenon.

In contrast, such early experiences with computers and technology were less common among men who grew up in Asia. Most Chinese and Indian men did not give accounts of coding or building computers in childhood when they explained why they majored in CS.

Instead, some were assigned the CS major after they did not get into the majors of their choice, while others chose a major that they perceived to be able to give them the best jobs upon graduation, which happened to be CS. There were a couple exceptions, however. David from China, a child of two engineers, recalled having his own computer at the age of 6 or 7, and when he entered college, he just "naturally" selected CS. Another example is Ayaan, an Indian man who was exposed to CS in 8th grade, took CS as an option subject in high school and wrote his first program during that time. He said that majoring in CS in college was "just a continuation", and he "didn't even think twice about taking computer science". Nonetheless, such examples are comparatively rare among men from Asia than men from the US.

Women from both Asia and the US are equally unlikely to have had early experiences with computing. Most of the women in my sample developed an interest in math and science, and someone in their lives encouraged them to pursue CS. Helen (from China) said that she did not have a clear interest when it came to choosing a college major, and it was her father, who worked in the IT industry, that suggested CS for her because he thought he could help. Likewise, Erika (Czech American) listed various people who supported her to study CS: her father who had a master's degree in CS, her then-boyfriend who encouraged her to pursue her dreams, and her professors in college who offered her research opportunities and mentorship. In some cases, support from important people in these women's lives proved to be crucial in determining their career path. Violet, an Asian American woman, was originally in a math PhD program and considered quitting the program, but her colleagues suggested her to switch to CS based on her interest in applied math. Similarly, Jessica (Chinese American) majored in bioengineering in undergrad, but soon realized that she did not like it.

She got interested in EE after taking a circuits class, and her boyfriend at the time, who was an electrical engineer, encouraged her to take more classes in that field. She ended up finishing a minor in electrical engineering and computer science, and continued studying EE in graduate school. In all of these cases, women only became interested in CS during their time in college, if not later. They did not develop a geek identity early in life, but acquired an interest in CS later. Because American men were the group most likely to have had early experiences in programming, their female counterparts (American women) may feel that they are behind when they start CS classes in college, and they may feel more alienated because their male classmates seem to know a lot already. A recent report about CS classes at Harvey Mudd College showed that separating students with different levels of prior programming experience fostered women's sense of belonging in CS (Xia 2017). On the other hand, since boys in Asia do not seem to have as many opportunities to play with computers, the gap between men and women in terms of CS skills and knowledge when they get to college may be narrower than in the American case.

Why is it more common for boys in the US to have early experiences with technology than boys in Asian countries? A reason may be that the tech industry is generally more developed in Western industrialized countries, so children – boys more so than girls – have greater access to technology at an early age. Computer science is also not available as a high school subject in some countries such as China, and even if it is offered in other Asian countries, it may not count as much as other science subjects in college entrance requirements. Regardless of why Asian boys are not exposed to computing as much as their American counterparts, the experience may not be that important to Asians anyway. Some scholars as well as popular media observed that East Asian cultures are more likely to

emphasize the growth mindset, or the belief that intelligence can be built upon by effort, rather than the fixed mindset, which states that intelligence is a fixed entity that is unevenly distributed among individuals (Spiegel 2012; see also Dweck 2006). As a result, to Asian students, whether one has natural talent or affinity to computers may not be relevant, because such skills can be acquired through hard work. In contrast, success in STEM fields is attributed to innate talent in the US (Leslie et al. 2015), which may elevate the importance of the display of early interest in computers as a sign of fit in the CS field.

As individuals' assessments of ability and affinity to CS are important in their choice of major, their perceptions of their own personalities are also important factors in the occupations they see fit for themselves. Cech (2013) found that people who describe themselves in conventionally feminine terms (such as being social) are more likely to enter female-dominated occupations. From my interviews, I argue that even in a male-dominated field like CS, women still tend to explain their place in CS by coding their personalities and attributes of a good tech worker in traditional feminine terms. Multiple women said that social skills were important for engineers on the job, and that they themselves possessed such skills. Janice, a Chinese woman, said that a good software engineer should be meticulous and detail-minded, traits commonly attributed to women rather than men. These examples show the fluidity of the image of a successful tech worker and the nature of the job tasks. While the field is still dominated by men, women find their place by identifying and emphasizing tasks that require female-typed skills.

Being the minority in CS, women were found to display lower levels of confidence, both in their ability and their fit in STEM fields (Cech et al. 2011). Women participants in my study show similar lack of confidence. Recall that Erika, the student athlete who

encountered challenges to her ability in college. She referenced the imposter syndrome when talking about her experience in CS:

> I've read about like, you know, women have this imposter syndrome often and feel like they're not as good, not good enough to be there. I felt like in my case it was legit and I just got to deal with it and I was okay with that.

The imposter syndrome is the feeling that usually minorities in a field share, that they are not good enough to be there but somehow got in by mistake. Janice (Chinese) expressed a similar feeling, saying she thought everyone else in CS was all better than her. Jae-un (Korean) reflected on the reason for her failure and realized that her lack of self-confidence contributed to a self-fulfilling prophecy:

> I've not succeeded yet, I've experienced more failure. But now I realized that because I don't have I didn't have a belief that I'd succeed. So I would think negative results first, so it's just repeating.

Jae-un pointed out that she often focused on the negative and predicted negative result, because she didn't believe that she could succeed. This ironically became the reason for her failure.

Women's lack of confidence does not only originate from the individual herself, but also from people close to her. Violet (Asian American), for example, faced opposition from her mother going into college and graduate school, and she attributed her mother's views to male superiority as a part of Asian culture:

> Going into higher education I did have a lot of barriers… I'm Asian so there's a lot of sexism in some Asian families so the first time I approached research for example, my mother told me that woman don't do research, only men do,

> because it's too hard on our brains. So I mean she didn't mean it in a negative manner, it was just sort of - have you heard of cultural hegemony? Yeah, it's just sort of that, it's something that sort of… there, like they don't mean it to put you down or something.

She explained that her mother's views negatively affected her self-esteem, motivation, and her academic performance in college:

> Initially that made me not work as hard, because I felt like what's the point of putting so much effort in? But this was in undergrad. So well after like a quarter of letting myself and my study slump, I just looked at myself and I realized - I was just like, why am I letting this get to me, and I just got over it.

Violet got over her mother's negative comments in college, but other people's comments started to matter more in the stressful environment of graduate school:

> But I mean in graduate school, I felt like it's so much harder that little things like that start taking their toll pretty hard. So yeah, that affected me a lot more in graduate school... In undergrad, people could say whatever they wanted about me and I really didn't care. But I guess I got a little bit more vulnerable because of the stress of graduate school, so I let peer pressure and things like that affect me, but I feel like most of it was myself… If I allowed myself to be more invulnerable then I feel like whatever people said wouldn't have mattered.

I expected women in Asia to not feel as behind or out of place in the CS field as American women do, but I did not find country differences in women's confidence. This is surprising, because given the more instrumental orientation to work, the weaker gender

stereotypes in CS, and the narrower gender gap in coding experience in India, I expected Indian women to display higher levels of perceived fit. This is a possible area of further research, especially since I only had one woman from India in my sample, which may not be representative of the population. Women's lack of confidence across countries of origin in the CS field may be attributed to cross-cultural uniformity of gender stereotypes and status differences: in all large societies, women are perceived as more communal but less agentic than men, and are ascribed lower status than men (Bem 1993; Ridgeway 2011). In the United States, however, women are the minorities regardless of their countries of origin. Their lower levels of confidence relative to men are consistent with Kanter's (1977) findings about tokens, who experience hypervisibility and isolation in the field.

While the lack of self-confidence seems to be a common experience among women, it is not as commonly reported among men. There were only two instances in which men mentioned feeling unconfident, one of which was a man who switched majors from electronics to CS, and felt that people in CS looked down on him. It could be that men are more likely to feel confident in CS and that their belonging in the field is not questioned as often, as shown by various studies (Ong 2005); but it is also possible that men feel uncomfortable expressing weakness or a lack of confidence, especially to a woman interviewer.

Women developed different coping strategies in face of the difficulties they face in CS. For some women, negative comments and expectations from others make them work harder to prove themselves. For example, one of the reasons Jae-eun majored in EE in college was that she wanted to prove that women could do it too. Other women like Violet, tried to deal with it internally, to become emotionally stronger and more invulnerable so that

they would not be affected as much. Still other women reached out to others for support and help. Erika (Czech American) was a member of the Women in Computer Science group on campus, and she described the group being very helpful in giving her opportunities to make friends with other women in the department, and to receive and give support to each other. Emily (white American) described a similar positive experience with the group. Some women chose to reach out to men (especially men from the same ethnic group) for help on classes and projects. Lindsey (Chinese) felt that from her experience, men were willing to help women because women were a minority in the field.

To conclude, the support of important people in women's lives seems to be important in women's entry to CS and their persistence through CS undergraduate and graduate programs. Whether it is suggesting CS as a possible major for girls, or encouraging women to stay in it, or even just giving moral support by going through the process with them, all of these forms of support seem crucial to women, who rarely had early experiences of programming and who defied social norms by entering a male-dominated field.

DISCUSSION

My study has revealed country-of-origin and gender differences in young people's reported motivations for choosing CS in three aspects: ideas about the purposes of work, perceptions of the field, and perceptions of the self. First, in terms of ideas about work, US and Asian participants share similar aspirations about work, but have different expectations for the future: both groups wanted to follow their individual "passions", but Asians are more pessimistic about the practicality of achieving this ideal. Asian students were also more likely to draw a clear distinction between hobbies and careers: they aim to satisfy material needs with their careers, and do what they are passionate about as a hobby. Overall, my results

show that instrumental narratives about work are more common among Asian students, while expressive narratives are more common among American students.

Second, the results suggest that the CS field is narrowly defined by geek culture in the US and to a certain extent, in China, but not India. As a result, many students, not just women and racial-ethnic minorities, felt that they did not fit into the geek or nerd stereotype. However, American students are also more likely to push back against this cultural trope and expand the meaning and purpose of CS.

Third, women generally have lower levels of confidence and sense of belonging in CS than men do. A reason for this gender difference is the higher likelihood for boys (especially American boys) to tinker and develop a sense of belonging in the field early in life. A support network is especially important to help women stay in CS.

My results point to the influence of the culture of self-expression on individual occupational choice on three levels: society, field, and individual. A culture of self-expression emphasizes "doing what you love" as a career, associates an occupational field with certain types of personality, and affects individuals' level of confidence and sense of belonging in an occupational field based on their perceived fit.

On the societal level, in more affluent societies like the United States, career choice is a statement about who one is and an expression of one's identity and passion, rather than merely a way to secure economic stability for oneself and one's family. An occupational field, then, is perceived to be filled with persons of certain personalities and passion for the field. For example, the computer science field in the contemporary United States is associated with two types of people: geeks and nerds who are socially awkward and obsessed with technology, and "white tech bros" who are profit-oriented startup partners. These

stereotypes are gendered because they display stereotypically masculine behavior and interests, such as working with objects rather than people, and socializing over masculine activities like drinking beer and playing video games. As suggested by the "doing gender" perspective (West and Zimmerman 1987), an individual does not need to agree with or endorse these (gendered) stereotypes for them to take effect on the individual; simply knowing or assuming that individuals themselves are held accountable to these standards is enough to alter individual assessment of competence and fit in the field. As a result, women tend to show lower levels of confidence and sense of belonging in the CS field because their self-image does not fit the image of a good computer scientist or a good tech worker (Cheryan et al. 2009).

This study reveals the importance of economic and cultural contexts in shaping occupational choice. By comparing young adults from the United States and Asian countries (China, India, and South Korea), I was able to explore how individual career choice is understood by persons with different cultural and socioeconomic heritages. My findings about young people's motivations to enter CS are consistent with Charles and Bradley (2009)'s argument that a culture of self-expression may reinforce occupational sex segregation by increasing the salience of gender stereotypes and presumed gender-specific talents and passions. These individual decisions may aggregate into distributions of men and women in male-dominated and female-dominated occupational fields. Therefore, the study findings provide an insight into why there are lower proportions of women in male-dominated fields like STEM in post-industrial societies than in developing societies.

My results are consistent with the interpretation that in Chinese and Indian cultures, a more instrumental and pragmatic orientation to work may translate into a weaker influence of

gender into career choice, and therefore, weaker gender segregation in fields of study and occupations in those countries. Also, different gendered understandings of the CS field, especially between Indian and American students, may further reinforce gender segregation in the field in the US. Women's underrepresentation in CS in the US may lead to low levels of self-confidence and sense of belonging, further discouraging their participation in the field.

Limitations and Future Directions for Research

There are a few limitations of this study, particularly with the sample of international students. First of all, I interviewed students who came from India and China to the US, who represented a select group of young people from their home countries. Most of them were from middle class backgrounds, and they have chosen to come to the US for further studies. Therefore, they may not represent the young people in their home countries who are also pursuing studies and work in CS. Second, I did not separate masters and doctorate students in my analysis. Since the masters and doctoral programs in CS are designed differently with different career goals and motivations in mind, my analysis might have missed this distinction. Third, all of the participants in my study were graduate students in CS-related fields, which means that they had persisted through the "leaky pipeline" of CS through high school and college. By just looking at this population, I was not able to study those who left the CS field before they graduated college. Therefore, I was not able to investigate the factors that cause certain groups of individuals to be more likely than others to leave the field.

For future research, the effect of immigration can be studied in greater depth, comparing Asian American students who are of first-, second-, and third-plus-generation immigrant background to look for differences in their ideas about the purposes of work. The

Asian American participants in my study expressed a wide range of work values, and the differences in values are worth studying with regard to their family's immigration history. It is of theoretical and empirical value to distinguish the effects of cultural heritage and immigration status on ideas about the purposes of work. For example, is a more pragmatic approach to occupational choice a result of one's cultural background or one's status as an immigrant or a child of immigrants? A second direction for research can be interviewing Asian students in Asia to compare if they perceive work, the CS field, and their fit differently than their co-nationals in the US. This can reveal the change in values and perceptions associated with international migration. Finally, an interesting question to investigate is: as countries like China and India continue to develop economically, are self-expression values going to replace survival values as important determinants for career choice? Are young men and women in China and India in twenty years' time going to choose occupations differently than their parents? Or, do traditional values like communal concern remain influential in these societies? As cultures increasingly value self-expression in developing societies, are women's representations in CS going to remain high, or are they going to approximate the rates in post-industrialized societies? These are all questions that would keep researchers in sociology, education, and global studies busy for years to come.

REFERENCES

Acker, Joan. 1990. “Hierarchies, Jobs, Bodies: A Theory of Gendered Organizations.” *Gender & Society* 4 (2): 139–58.

Bellah, Robert N., Richard Madsen, William M. Sullivan, Ann Swidler, and Steven M. Tipton. 1985. *Habits of the Heart: Individualism and Commitment in American Life*. Berkeley, CA: University of California Press.

Bem, Sandra Lipsitz. 1993. *The Lenses of Gender: Transforming the Debate on Sexual Inequality*. New Haven, CT: Yale University Press.

Bourdieu, Pierre. 1975. “The Specificity of the Scientific Field and the Social Conditions of the Progress of Reason.” *Sociology of Science* 14 (6): 19–47.

Bourdieu, Pierre, and Loïc J. D. Wacquant. 1992. *An Invitation to Reflexive Sociology*. Chicago: University of Chicago Press.

Cech, Erin. 2013. “The Self-Expressive Edge of Occupational Sex Segregation.” *American Journal of Sociology* 119 (3): 747–89. https://doi.org/10.1086/673969.

Cech, Erin, Brian Rubineau, Susan Silbey, and Carroll Seron. 2011. “Professional Role Confidence and Gendered Persistence in Engineering.” *American Sociological Review* 76: 641–66.

Charles, Maria. 2011. “What Gender Is Science?” *Contexts* 10 (2): 22–28. https://doi.org/10.1177/1536504211408795.

Charles, Maria, and Karen Bradley. 2006. “A Matter of Degrees: Female Underrepresentation in Computer Science Programs Cross-Nationally.” In *Women and Information Technology: Research on the Reasons for Underrepresentation*, edited by Joanne McGrath Cohoon and Bill Aspray, 183–203. Cambridge, MA: MIT Press.

———. 2009. “Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries.” *American Journal of Sociology* 114 (4): 924–76.

Cheryan, Sapna, Allison Master, and Andrew M. Meltzoff. 2015. “Cultural Stereotypes as Gatekeepers: Increasing Girls’ Interest in Computer Science and Engineering by Diversifying Stereotypes.” *Frontiers in Psychology* 6: 1–8.

Cheryan, Sapna, Victoria C. Plaut, Paul G. Davies, and Claude M. Steele. 2009. “Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science.” *Journal of Personality and Social Psychology* 97 (6): 1045–60.

Cheryan, Sapna, John Oliver Siy, Marissa Vichayapai, Benjamin J. Drury, and Saenam Kim. 2011. “Do Female and Male Role Models Who Embody STEM Stereotypes Hinder Women’s Anticipated Success in STEM?” *Social Psychological and Personality Science* 2 (6): 656–64.

Correll, Shelley J. 2001. “Gender and Career Choice Processes: The Role of Biased Self-Assessments.” *American Journal of Sociology* 106: 1691–1730.

Diekman, Amanda B., Elizabeth R. Brown, Amanda M. Johnston, and Emily K. Clark. 2010. “Seeking Congruity Between Goals and Roles: A New Look at Why Women Opt Out of Science, Technology, Engineering, and Mathematics Careers.” *Psychological Science* 21 (8): 1051–57.

Dweck, Carol S. 2006. *Mindset: The New Psychology of Success*. New York: Random House.

Ensmenger, Nathan. 2015. “‘Beards, Sandals, and Other Signs and Rugged Individualism’: Masculine Culture within the Computing Professions.” *OSIRIS* 30: 38–65.

Faulkner. 2000. “Dualisms, Hierarchies, and Gender in Engineering.” *Social Studies of Science* 30: 759–92.
Fung, K. C., Nathalie Aminian, Chris Y. Tung. 2016. “Some Characteristics of Innovation Activities: Silicon Valley, California, China and Taiwan.” *Economic Change and Restructuring* 49 (2-3): 221-40.
Håpnes, Tove, and Bente Rasmussen. 1991. “Excluding Women from the Technologies of the Future?” *Futures* 23 (December): 1107–19.
Hoh, Yin Kiong. 2009. “Using Notable Women in Environmental Engineering to Dispel Misperceptions of Engineers.” *International Journal of Environmental & Science Education* 4 (2): 117–31.
Inglehart, Ronald. 1990. *Culture Shift in Advanced Industrial Societies*. Princeton: Princeton University Press.
———. 1997. *Modernization and Postmodernization: Cultural, Economic, and Political Change in 43 Societies*. Princeton: Princeton University Press.
Inglehart, Ronald F., and Christian Welzel. 2005. *Modernization, Cultural Change, and Democracy: The Human Development Sequence*. New York: Cambridge University Press.
Jiménez, Tomás R., and Adam L. Horowitz. 2013. “When White Is Just Alright: How Immigrants Redefine Achievement and Reconfigure the Ethnoracial Hierarchy.” *American Sociological Review* 78 (5): 849–71.
Kanter, Rosabeth Moss. 1977. *Men and Women of the Corporation*. New York: Basic Books.
Kasinitz, Philip, John H. Mollenkopf, Mary C. Waters, and Jennifer Holdaway. 2008. *Inheriting the City: The Children of Immigrants Come of Age*. New York: Russell Sage Foundation.
Lagesen, Vivian Annette. 2008. “A Cyberfeminist Utopia? Perceptions of Gender and Computer Science among Malaysian Women Computer Science Students and Faculty.” *Science, Technology, & Human Values* 33: 5–27. https://doi.org/10.1177/0162243907306192.
Leslie, Sarah-Jane, Andrei Cimpian, Meredith Meyer, and Edward Freeland. 2015. “Expectations of Brilliance Underlie Gender Distributions across Academic Disciplines.” *Science* 347 (6219): 262–65. https://doi.org/10.1126/science.1261375.
Louie, Vivian. 2001. “Parents’ Aspirations and Investment: The Role of Social Class in the Educational Experiences of 1.5- and Second-Generation Chinese Americans.” *Harvard Educational Review* 71 (3): 438–74.
Ma, Yingyi. 2009. “Family Socioeconomic Status, Parental Involvement, and College Major Choices – Gender, Race/Ethnic, and Nativity Patterns.” *Sociological Perspectives* 52 (2): 211–34.
Margolis, Jane, and Allan Fisher. 2002. *Unlocking the Clubhouse: Women in Computing*. Cambridge, MA: The MIT Press.
Mellström, Ulf. 2009. “The Intersection of Gender, Race and Cultural Boundaries, or Why Is Computer Science in Malaysia Dominated by Women?” *Social Studies of Science* 39 (6): 885–907.
Mercier, E. M., B. Barrom, and K. M. O’Connor. 2006. “Images of Self and Others as Computer Users: The Role of Gender and Experience.” *Journal of Computer Assisted Learning* 22: 335–48.

NSF (National Science Foundation). 2017. “Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017.” NSF 17-310. Arlington, VA. https://www.nsf.gov/statistics/2017/nsf17310/.

Ong, Maria. 2005. “Body Projects of Young Women of Color in Physics: Intersections of Gender, Race, and Science.” *Social Problems* 52 (4): 593–617.

Ramirez, Francisco O., and Naejin Kwak. 2015. “Women’s Enrollments in STEM in Higher Education: Cross-National Trends, 1970-2010.” In *Advancing Women in Science: An International Perspective*, edited by Willie Pearson, Jr., Lisa M. Frehill, and Connie L. McNeely, 9–25. Switzerland: Springer International Publishing.

Ridgeway, Cecilia L. 2011. *Framed by Gender: How Gender Inequality Persists in the Modern World*. New York: Oxford University Press.

Risman, Barbara J., and Georgiann Davis. 2013. “From Sex Roles to Gender Structure.” *Current Sociology Review* 61 (5–6): 733–55.

Röder, Antje, and Peter Mühlau. 2014. “Are They Acculturating? Europe’s Immigrants and Gender Egalitarianism.” *Social Forces* 92 (3): 899–928.

Rommes, Els, Geertjan Overbeek, Ron Scholte, Rutger Engels, and Raymond De Kemp. 2007. “‘I’m Not Interested in Computers’: Gender-Based Occupational Choices of Adolescents.” *Information, Community and Society* 10 (3): 299–319.

Spiegel, Alix. 2012. “Struggle For Smarts? How Eastern And Western Cultures Tackle Learning.” *Morning Edition*. National Public Radio. https://www.npr.org/sections/health-shots/2012/11/12/164793058/.

Varma, Roli. 2010. “Computing Self-Efficacy among Women in India.” *Journal of Women and Minorities* 16: 257–74.

———. 2015. “Making a Meaningful Choice: Women’s Selection of Computer Science in India.” In *Advancing Women in Science: International Perspectives*, edited by Willie Pearson, Lisa M. Frehill, and Connie L. McNeely, 269–72. New York: Springer.

Varma, Roli, and Deepak Kapur. 2015. “Decoding Femininity in Computer Science in India.” *Communications of the Association for Computing Machinery* 58 (5): 56–62. https://doi.org/10.1145/2663339.

West, Candace, and Don H. Zimmerman. 1987. “Doing Gender.” *Gender & Society* 1: 121–51.

Wynn, Alison T., and Shelley J. Correll. 2017. “Gendered Perceptions of Cultural and Skill Alignment in Technology Companies.” *Social Sciences* 6 (45).

Xia, Rosanna. 2017. “Most Computer Science Majors in the U.S. Are Men. Not So at Harvey Mudd.” *Los Angeles Times*, January 4, 2017, sec. Local. http://www.latimes.com/local/lanow/la-me-ln-harvey-mudd-tech-women-adv-snap-story.html.

Xie, Yu, and Alexandra A. Killewald. 2012. *Is American Science in Decline?* Cambridge, MA: Harvard University Press.

Xie, Yu, and Kimberlee Shauman. 2003. *Women in Science: Career Processes and Outcomes*. Cambridge, MA: Harvard University Press.