STEM Experiences among Latinos and Asian Americans in the U.S.: Generational Change and Access to STEM among the Two Largest U.S. Immigrant Groups

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ABSTRACT-- *This research examines Science, Technology, Engineering, and Mathematics (STEM) attitudes and experiences for the two most recent U.S. immigrant groups – Asian Americans and Latinos. The special focus is on generations. Emerging literature suggests that younger Asian American generations may be trying to avoid the model minority stereotype at the same time that younger Latino generations may be trying to use science as a ladder to mobility. Using recent GSS data on several measures of STEM attitudes and experience, we find considerable support for unique generational effects. Results show virtually no differences between generations on STEM attitudes and experiences among Latinos. In contrast, we find that generation has a significant influence on a majority of the STEM attitudes and experiences among Asian Americans with the second (plus) generation having fewer experiences and less positive attitudes. Findings support the increasingly distinct STEM attitudes and experiences of younger generations of Asian Americans relative to first generation Asian Americans. The experiences of second (or higher) generation Asian Americans are converging with those of second (or higher) generation Latinos. Differences between the first generation Asian Americans and Latinos are quite large with Asian Americans having more STEM experiences and positive attitudes in STEM. Implications of these findings for research and policy on STEM in the context of race/ethnicity and generations are discussed.*

Keywords-- STEM, race/ethnicity, generation, Latinos, Asian Americans

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1. INTRODUCTION

This research uses data from the General Social Survey (GSS) and a conceptual framework that stresses generational processes in mobility systems. More specifically, the research explores generational differences in STEM (Science, Technology, Engineering, and Math) experiences within the two (currently) largest immigrant groups in the U.S. – Latinos and Asian Americans[1]. Asian Americans and Latinos make up approximately 70% of current immigrants and about 50% of second generation Americans (Pew, 2013). Asian Americans have passed Latinos as the largest group of new immigrants to the U.S. (Taylor and Cohn, 2013). Current immigration trends and birth rates suggest that most of the growth of the U.S. working-age population through 2050 will come from immigrants and their U.S. born children (Pew, 2013).

2. A CONCEPTUAL FRAMEWORK: RACE/ETHNICITY, GENERATIONS, AND MOBILITY

Mobility theory and research (and research on success in STEM) show the importance of parent's socioeconomic status on mobility opportunities (Mare, 2011). Similarly, status attainment research shows the import of family resources for success in the educational system (Walberg, 1984). Thus, generation is a critical concept in research on opportunity systems (Mare, 2011). Most racial/ethnic minorities do not necessarily have the advantage of parent's socio-economic resources. Asian Americans (overall) are an exception on this trend (Schmid, 2001; Pew, April 2013; U.S. Department of Labor, 2011). However, the American Dream about opportunity for mobility has historically been a Dream *of* and *for* immigrants. There is considerable evidence that both Latinos and Asian Americans have hopes for this mobility (Hanson

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[1] The terms "Hispanic" or "Latino" refer to persons who trace their origin or descent to Mexico, Puerto Rico, Cuba, Spanish-speaking Central and South American countries, and other Spanish cultures. Origin involves the heritage, nationality group, lineage, or country of the person or the person's parents (or ancestors) before their immigration to the United States. People who identify their origin as Hispanic or Latino may be of any race (US Bureau of the Census, 2008). In this article, we use both terms "Hispanic" and "Latino." A majority of Hispanics/Latinos do not have a preference for the term "Hispanic" or "Latino" (Taylor et al. 2012). Some researchers use the term "Latino/a". Unless otherwise noted, all terms used here refer to both men and women.

&White, 2016). In fact, Latinos are more positive than other racial/ethnic minority groups on their chances of success and getting ahead (Tuch, 2016).

A report by Pew (2013) on generational differences among the two new immigrant groups found positive attitudes about success and mobility among both Asian Americans and Latinos even though Latinos have less objective economic status. Additionally, both first and second-generation Asian American and Latino respondents in the Pew study often agreed on opportunities for mobility in the U.S. On some items, second generation respondents were more positive than first generation. It was not always the Asian American 2nd generation that was most positive relative to the Latino second generation. For example, the Pew study found that two-thirds of second generation Latinos, but only 48% of second generation Asian Americans believe their own children will surpass their own standard of living (Pew, 2013).

In spite of these generally positive attitudes about potential for success and mobility among Asian Americans and Latinos, actual education and income data show considerable disparity (Pew, 2013) and research on the elite STEM education and occupation systems shows significantly greater success for Asian Americans than for Latinos (National Journal, 2013; Flores, 2011). Although much of the literature on generational effects assumes an advantage to later generations, some research (e.g., Lilley, 2012) suggests the opposite in STEM. Indeed, Lilley found that children that immigrated to the U.S. do better in STEM (over time) than native-born children. When socio-economic background was controlled, the finding held for both Asian American and Latinos.

Sociologists studying social change argue that generations are a critical factor in understanding change. There is a small but growing body of work on new generations of Latinos and Asian Americans in the U.S achievement (and STEM achievement) system. Preliminary work on children of Latino immigrants suggests a rising level of achievement and opportunity for mobility in the context of ongoing barriers. Preliminary work on children of Asian immigrants shows considerable success but also diversity and a desire to be more Americanized and break from Asian traditions and family control. In spite of these generally positive attitudes about potential for success and mobility among Asian Americans and Latinos, actual education and income data show considerable disparity (Pew, 2013) and research on the elite STEM education and occupation systems shows significantly great success for Asian Americans than for Latinos (National Journal, 2013; Flores, 2011).

STEM education and occupations are among the most elite positions in the U.S. system. Studies of experiences in STEM are an important element in mobility research. Some researchers have examined generational differences in levels of education, mobility attitudes and other socio-economic indicators for these two immigrant groups. We know little, however, about the experiences across generations in the STEM portion of education and occupation systems. Analyses of Latino and Asian American groups who have distinct reputations (e.g., "English as second language users" vs. 'the model minority") will provide important information on mobility opportunities and access in the elite area of STEM across race/ethnic groups and generations.

3. LITERATURE

3.1 Latinos, STEM, and Generations

Latinos are the largest racial/ethnic group in the U.S. They earn fewer degrees in STEM than almost any other racial/ethnic group and are under-represented in STEM occupations as well (Landivar, 2013; National Science Foundation, 2013). The pathway in STEM is particularly difficult for an ethnic group that has a higher level of poverty and lower level of education and income than many other racial/ethnic groups (Tienda, 2009). Latinos show interest in STEM but have lower rates of entry and persistence in STEM education than Asian Americans and most other race/ethnic groups (Anderson & Kim, 2006; Espiritu, 2001; Cole & Espinoza, 2008; National Journal, January 2013; Zeiser & Berger, 2012). Language, socioeconomic status, school factors, academic achievement, and stereotypes are some of the barriers faced by Latinos in STEM (Swenson, 2012; Rivas-Drake, 2008; Taningco et al., 2008). In spite of these barriers, reports show a rising interest and success in STEM among Latinos especially in the second generation (Lilley, 2012; Mello & Rochin, 2007; Toldson & Esters, 2012). Research on achievement across generations of Latinos often shows higher success for later generations (Allen, 2011). In general, there is evidence that new generations of Latinos are multicultural, bilingual, and focused on the same elements of the American Dream as other groups: homeownership, education for themselves and their children, and occupational opportunities (Humire & Menendez, 2013). The increasing levels of education among second generation Latinos is a major step toward upward mobility (Fry, 2002). The growing shortages of scientists and need for competitiveness in STEM is at odds with the under-representation of one of our largest youth talent bases – Latino youth. Education is a key solution to resolving inequality in the U.S. In spite of progress, racial/ethnic differences in educational and occupational opportunity in the U.S. persist.

3.2 Asian Americans, STEM, and Generations

Like the Latino population, the U.S. Asian American population is increasing at a rapid rate. Unlike the Latino population, their high levels of educational attainment and socio-economic status have earned them the reputation as "model" minority (Hanson, 2014; Varma, 2004). Success in STEM is included in the high success rate of Asian Americans. Asian Americans are over-represented in STEM education and occupations (Finamore et al., 2013; National Science Foundation, 2013). Education researchers have suggested that factors associated with Asian (and Asian American) cultures and families are important in understanding this success in STEM (Hanson, 2014; Hanson & Gilbert,

2012). To some extent, the success of Asian Americans in STEM is associated with high socio-economic resources. Cultural beliefs about factors such as work, achievement, academic performance, and value on STEM degrees also provide cultural capital for Asian Americans in STEM (Hanson & Gilbert, 2012; Sue & Okasaki, 2009). However, it is important to note the diversity in this racial minority group and the fact that not all Asian Americans are interested in or excel in STEM education and occupations (Hanson & Gilbert, 2012 ; Lewin & Tamar, 2008; Trytten et al., 2012). In fact, pressures to succeed in STEM as the "model minority" may have negative consequences with young Asian Americans feeling they are pressured or forced to go into STEM and to succeed there (Hanson & Gilbert, 2012). Additionally, although Asian Americans are thought of as a model minority there is considerable discrimination against Asian Americans in all areas (Purkayastha, 2005; Hanson; 2014).

Park and Myers (2010) look at the post 1965 immigration era in the U.S. and find considerable evidence of intergenerational mobility for multiple groups including Asian Americans and Latinos. Similarly, research on achievement in STEM suggests that there has been evidence of generational advance in both Latino and Asian American groups (e.g. Stalkis & Horn, 2012; Toldson & Esters, 2012; National Journal, 2013). However, research on the experiences of the two newest sets of immigrant Americans suggests that Asian Americans are in post-secondary STEM courses at a much higher rate relative to Latinos regardless of generation (Stalkis & Horn, 2012). Interestingly, some argue for a "third generation decline" among Asian Americans in the sciences (Yang, 2004).

4. METHODS

4.1 Data and Sample

This research uses data from the 2010, 2012, 2014, and 2016 GSS to study generational differences in STEM attitudes and experiences for Latinos and Asian Americans. The GSS is a survey used to collect data on demographic characteristics and attitudes of residents of the United States. The survey is conducted face-to-face with an in-person interview by the National Opinion Research Center at the University of Chicago, of adults (18+) in randomly selected households. The survey has been conducted every year from 1972 to 1994 (except in 1979, 1981, and 1992). Since 1994, it is collected every other year. The data set allows an examination of STEM attitudes and experiences by generation for the two race/ethnic groups of interest. The GSS data include measures of race/ethnicity and other socio-economic variables. Information is also provided which allows one to create generational variables (e.g. first, second generation for the Latino and Asian American subgroups). Additionally the GSS data include a series of variables that measure STEM attitudes and achievement. Thus, the GSS data allow considerable insight into the role of race/ethnicity and generation in the area of STEM across the two race/ethnic groups of interest.

The sample used for this analysis includes those identifying as Hispanic or Asian American in the 2010, 2012, or 2014, and 2016 surveys (N=1,558). Given the size of these race/ethnic groups and their rate of representation in the GSS, multiple survey years were used in order to increase the size of the sample analyzed. Analyses are based on a sample of 1,251 Latinos and 307 Asian Americans.

4.2 Measures

A *race/ethnicity variable* comparing Latinos to Asian Americans was created by combining information from a race question (identification as Asian American) and an ethnicity question (identification as Hispanic). A *generation variable* was created by contrasting those who were not born in the U.S. (first generation) to later generations. Given the sample size, we could not make further comparisons between later generations.

Four *measures of STEM attitudes and experiences* were examined (see note below for further clarification on availability of STEM measures in the GSS). STEM occupation and science major were used to measure STEM experiences. Coding here was similar to that used by the National Science Foundation. Occupations coded as STEM include general and subcategories of computer scientists, architects, chemists, statisticians, mathematicians, biologists, surveyors, engineers, science technicians, medical scientists, astronomers, physicists, and scientists. Majors coded as STEM include architecture, biology, chemistry, computer science, engineering, mathematics, medicine, physics, statistics, and general science. In order to look at means in the ANOVA analyses, these STEM experience variables were coded as 1 if STEM and 0 if non-STEM.

Two measures of STEM attitudes were also examined. One looked at the importance of STEM and asked the respondent to agree or disagree with the statement "Science research is necessary and should be supported by the federal government". Another question asked about science and generations. The respondent was asked to agree or disagree with the statement, "Science and technology give more opportunity to the next generation." Respondents were allowed to respond "strongly agree" "agree" "disagree" or "strongly disagree" to the statements. Given our small sample we compared those who "strongly agreed" to all others. In order to examine means on these variables in the ANOVA analyses those who "strongly agreed" were coded 1 and all others were coded 0.

We were limited to these four measures of STEM experience and attitudes given the questions in the GSS and the response rates to certain questions. Even some of the questions that were included had somewhat low response rates for the race/ethnic minorities and questions examined here. For example, although there were 1,558 Asian Americans and Latinos in the sample used, the N for the science research question was 698 and the N for the science for the next generation question was 707. The sample size was particularly low on the science major question (360) given the

conditions of the question (college attendance). The sample size for the science occupation question was 1,417. Although some of these sample sizes are low relative to the original N of 1,558, they are still sufficient for statistical analyses and the assumptions of the ANOVA model regarding error distributions and random sampling.

4.3 Analyses

Given the categorical nature of the generation variable and the 0,1 coding on STEM attitudes and experiences (probabilities), ANOVA (MCA) is an appropriate statistical technique for our analyses. The ANOVA tests whether there are significant differences between generations on the probability of having positive STEM attitudes or experiences with and without the presence of controls. The MCA provides means on the outcome variables for each generation thus allowing insight into the nature of the generational effect. Research on achievement in STEM suggests that factors such as age, socio economic status, and sex are relevant for all minority groups in their STEM experiences, including Asian Americans and Latinos (Cole & Espinoza, 2008; Hanson, 2014; Hanson & Gilbert, 2012; Hanson & Meng, 2008; Hanson, 2013). Hence, we include controls for sex, age, education, and parent's education in our model of science experiences for Asian Americans and Latinos.

4.4 Limitations

It is important to point out the limitations of the study. Although we use multiple years from recent GSS probability surveys representing U.S. adults, the sample size for the Asian Americans and Latino groups remains somewhat small (although large enough for stable statistical estimates). Additionally, although the GSS includes more measures of STEM attitudes than were considered here, the sample size for the race/ethnic groups of interest was even smaller on those items thus excluding them from our analysis. Other data sets on Asian Americans and Latinos exist (e.g. collected by Pew) but none include both of the race/ethnic groups as well as generational and STEM variables. Given these limitations, our results should be considered preliminary. It is hoped that future data sets will have larger representation of race/ethnic minority groups as well as measures of the important generational and STEM experiences examined here.

5. RESULTS

Findings from the ANOVA analyses of generational effects on STEM attitudes and experiences by race/ethnic group are presented in Appendix Table 1. Generational effects are shown for the combined sample of Asian Americans and Latinos as well as for the separate Asian American and Latino samples. The first row in the table shows the effect of generation without controls and each additional row shows generational effects with some or all of the controls for sex, age, education, mother's education, father's education, and race/ethnicity (for the combined sample). When the F-test shows a significant difference between means for the first generation vs. second generation (or higher) groups the means are starred and shown in bold.

5.1 Combined Sample

Findings for the combined sample of Asian Americans and Latinos show a significant effect of generation on likelihood of having a STEM occupation or STEM major even in the presence of controls. First generation respondents are significantly more likely to report having a STEM occupation or STEM major. Findings for the combined sample also show a generational effect on the attitude about the importance of science for the next generation with first generation respondents being more positive. However, this effect does not remain significant when other factors are controlled.

5.2 Asian Americans

ANOVA results for the Asian American sample show a somewhat similar pattern as for the combined sample. Again, there is a generational effect on the STEM occupation and major outcomes with first generation being more likely to experience both STEM outcomes. This effect persists after controls for other characteristics are taken into account. However, differences between generations are larger in the Asian American sample than in the combined sample on both of these outcomes, especially on the STEM occupation outcome. For example, in the combined sample the first generation is over 3 times more likely than the second generation to have a STEM occupation (10 percent vs. 3 percent). In the Asian American sample, the first generation is over thirty times more likely than the second generation to have a STEM occupation (32 percent vs. 0 percent). As in the combined sample, there is a significant difference between generations of Asian Americans on the attitude about science for the next generation with the first generation being more positive. However, the effect remains significant for Asian Americans even when all controls are in the model.

5.3 Latinos

Findings for the Latino sample show no significant differences between generations on any STEM outcome variable in any model. This lack of generational difference is in stark contrast to the extensive generational differences found in the Asian American sample.

5.4 Race/Ethnic Effects on STEM Outcomes – Overall and Within Generations

Although our major research question concerned the effect of generation on STEM outcomes within the Asian American and Latino groups, it is interesting to examine race/ethnic effects overall and within generations. With regard to general race/ethnicity effects, a crosstab analysis of STEM outcome by race/ethnicity (not shown here) shows the higher representation of Asian Americans on STEM outcomes is especially the case for occupations. Asian Americans are 6 times more likely to be in STEM occupations than are Latinos. As the broader literature suggests, Latinos are making more headway in STEM education. In our sample we find that Asian Americans are 3 times more likely to have had a STEM major than are Latinos.

An examination of differences between Asian Americans and Latinos on STEM outcomes within generations (not shown here) reveals significant differences on all outcomes for first generation respondents in the sample. First generation Asian Americans have significantly higher STEM attitudes and experiences relative to first generation Latinos. However, a look at race/ethnic differences within the second (plus) generation in the sample shows no differences on 3 of the outcomes with Asian Americans only scoring higher than Latinos on the item measuring attitudes on importance of science research.

6. CONCLUSIONS

This research examined the question of differing generational effects on STEM experiences and attitudes in the two most recent U.S. immigrant groups – Asian Americans and Latinos. Our results show that generation has significant influence on STEM attitudes and experiences among Asian Americans but no influence among Latinos. Second generation (plus) Asian Americans have less positive attitudes about STEM and are less likely to have STEM majors or occupations relative to first generation Asian Americans. Although our general results show consistent advantages to the Asian Americans over Latinos on STEM attitudes and experiences, differences between Asian Americans and Latinos are primarily limited to differences within first generation respondents suggesting a converging of STEM experiences and attitudes among later generations.

7. DISCUSSION

Advances in STEM have been key in revolutionizing life as we know it in a post-modern global society (Committee on Science, Engineering, and Public Policy, 2011). In the past century, STEM was critical in expanding knowledge in almost every area of life (e.g., medical, transportation, environment, communications, security, and space exploration). These advances have contributed to massive improvements in our standard of living and way of life (National Academy of Engineer, 2008; Committee on Science, Engineering and Public Policy, 2011). Remaining competitive in a global economy requires a supply of workers across all areas of STEM training. Given all of this, it is our responsibility to make certain that all talented youth can enter science.

STEM degrees and occupations are associated with greater prestige and rewards than any other field of study. In a technologically advanced society the status and power of those in STEM makes them the new elite. Race/ethnicity continues to be a major factor in who is doing science. Equality of opportunity and access has not been realized (Hanson, 2012). It can be argued that science itself will suffer if we are not using all of our science talent (Hanson, 2012).

There is considerable evidence that young people across race/ethnic groups are interested in STEM but the culture of science works to promote some more than others (Hanson, 2012). The desire for mobility and hopes for opportunity exist across race/ethnic groups and are often even more pronounced in new immigrant populations with Latinos scoring particularly high on these desires and hopes (Hanson & White, 2016; Tuch, 2016). Our research argues for a look at generational change and advance in the elite area of STEM for the newest and largest U.S. immigrant groups – Latinos and Asian Americans. Although some of the general mobility literature on generational effects assumes an advantage to later generations, there is also evidence of a lack of generational difference (Pew, 2013). Additionally, some research in the area of STEM (e.g., Lilley, 2012) suggests advantage to earlier generations. In fact, Lilley found that children that immigrated to the U.S. do better in STEM (over time) than native born children. Our findings on Asian Americans support the arguments (e.g. Lilley, 2012) for advantage to earlier generations. However, we find no generational differences among Latinos. Recent research on attitudes about general opportunities and chances for success among different generations in the two new immigrant groups (Latinos and Asian Americans) shows few generational differences and largely positive attitudes (Pew, 2013). We find a similar lack of generational difference among Latinos. The fact that later generations of Latinos are not finding their way into science at a greater rate than earlier generations could reflect processes that create barriers for some young Latinos in STEM. These barriers include stereotypes about Latinos as marginalized populations, poor preparation for STEM early in the education system, low educational achievement, and families with few socio-economic resources (Swenson, 2012; Rivas-Drake, 2008; Taningco et al., 2008). Processes that could be at work to create barriers for some young Asian Americans in STEM include a desire to become more Americanized and avoid fitting in to the "model minority" stereotype about Asian Americans. Some have shown a drop in achievement among Asian American generations over time (Kibria, 2002; Hanson, 2014). Further

research is needed to explore the details and mechanisms of generational differences in STEM experiences in these two minority groups.

Populations in the U.S. are changing at a rapid rate. Some of the 2nd (and higher) generation respondents in our sample (especially the Latino respondents) have just recently entered adulthood. Thus, it is difficult to provide a definitive statement about the eventual opportunities and success for these new Americans in the elite STEM system and the generational changes that will occur. It is important that future researchers follow these new generations and observe their STEM attitudes and experiences as they continue into adulthood.

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APPENDIX Table I: ANOVA Multiple Classification Results Showing Means on STEM Outcomes for Asian American and Latino Adults by Generation (General Social Survey Years 2010, 2012, 2014, and 2016)

Race/ Ethnicity and STEM Outcome

Generation	Combined Sample				Asian Americans				Latinos			
	STEM Occ.	STEM Major	Importance Science Research	Science Next Generation	STEM Occ.	STEM Major	Importance Science Research	Science Next Generation	STEM Occ.	STEM Major	Importance Science Research	Science Next Generation
1st 2nd (No Controls)	*.08* .03*	*.38* .16*	.27 .26	*.39* .32*	*.26* .04*	*.50* .24*	.42 .39	*.61* .39*	.02 .03	.17 .14	.22 .24	.31 .31
1st 2nd (Control for Race/ Ethnicity)	.07* .04*	*.33* .22*	.26 .27	.38 .34	- -	- -	- -	- -	- -	- -	- -	- -
1st 2nd (Control for Sex --and Race/ Ethnicity in Combined)	.08* .04*	*.34* .21*	.26 .27	.38 .34	*.27* .03*	*.50* .23*	.42 .38	*.61* .38*	.02 .03	.18 .13	.22 .24	.31 .31
1st 2nd (Control for Sex and Age—and Race/Ethnicity in combined)	.08* .04*	*.34* .20*	.26 .28	.38 .34	*.28* .01*	*.52* .18*	.42 .37	*.62* .36*	.02 .03	.18 .13	.21 .25	.31 .31
1st 2nd (Control for Sex, Age, Mother's Education, Father's Education-- and Race/ Ethnicity in Combined)	*.10* .03*	*.36* .24*	.28 .29	.41 .33	*.32* .00*	*.53* .19*	.49 .40	*.62* .37*	.03 .03	.18 .15	.21 .25	.34 .29

* F is significant at the .05 level