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CONDITIONS THAT ENCOURAGE PARTICIPATION IN COMPUTER SCIENCE

Draft

Report contains:

1. Factor analysis for **Career** items 1-17
    a. Gender comparison
    b. Race comparison
2. Factor analysis for **Encouragement and Support** items 8-19
    a. Gender comparison
    b. Race Comparison
3. 10 Reasons for Choosing Computing (college items 11a-11j)
    a. Gender comparison
    b. Race comparison
    c. Note: factor analysis was disorganized and failed to reveal reliable factors
4. **Ability** "How would you rate your programming skills?" (ability item 1)
    a. Gender comparison
    b. Race Comparison
5. **Regression and meditational analyses**

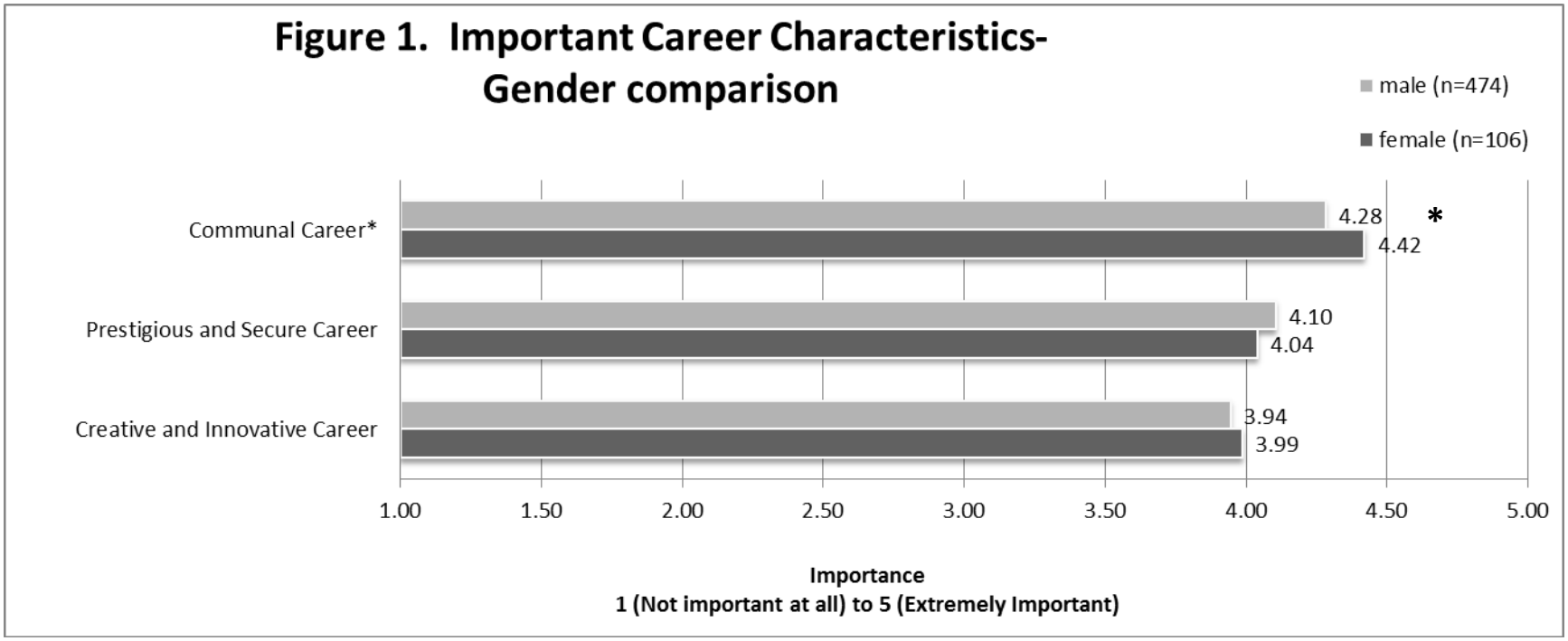
I. Career

A. Factor analysis of career items (n=1434) (career items 1-17)

3 factors emerged: accounting for 59.736% of total variance
Principal axis factoring/ varimax rotation

	Factor		
	Creative and Innovative Career Alpha=.88	Prestigious and Secure Career Alpha=.80	Communal Career Alpha= .69
career_11, Being able to sue your creativity to solve problems	.793		
career_10. Having the power to create and discover new things.	.792		
career_14. Having a career that allows you to work on a wide variety of projects.	.671		
career_16. Doing work that you find challenging.	.646		
career_9. Having the opportunity to express yourself creatively.	.646		
career_15, Working in a cutting edge field.	.639		
career_12. Working with people in an interconnected, social and innovative way	.523		
career_7. Earning a higher salary.		.690	
career_5 . having job security.		.660	
career_8. Working in a field with lots of job opportunities.		.637	
career_13. Working in a prestigious and respect field.		.533	
career_6. Having the power to make things happen.		.463	
career_2. Being passionate about your job			.745
career_3. Being able to spend time with your family.			.565
career_4. Having the power to do good and doing work that makes a difference.			.516
career1. Doing work that you find interesting.			.455

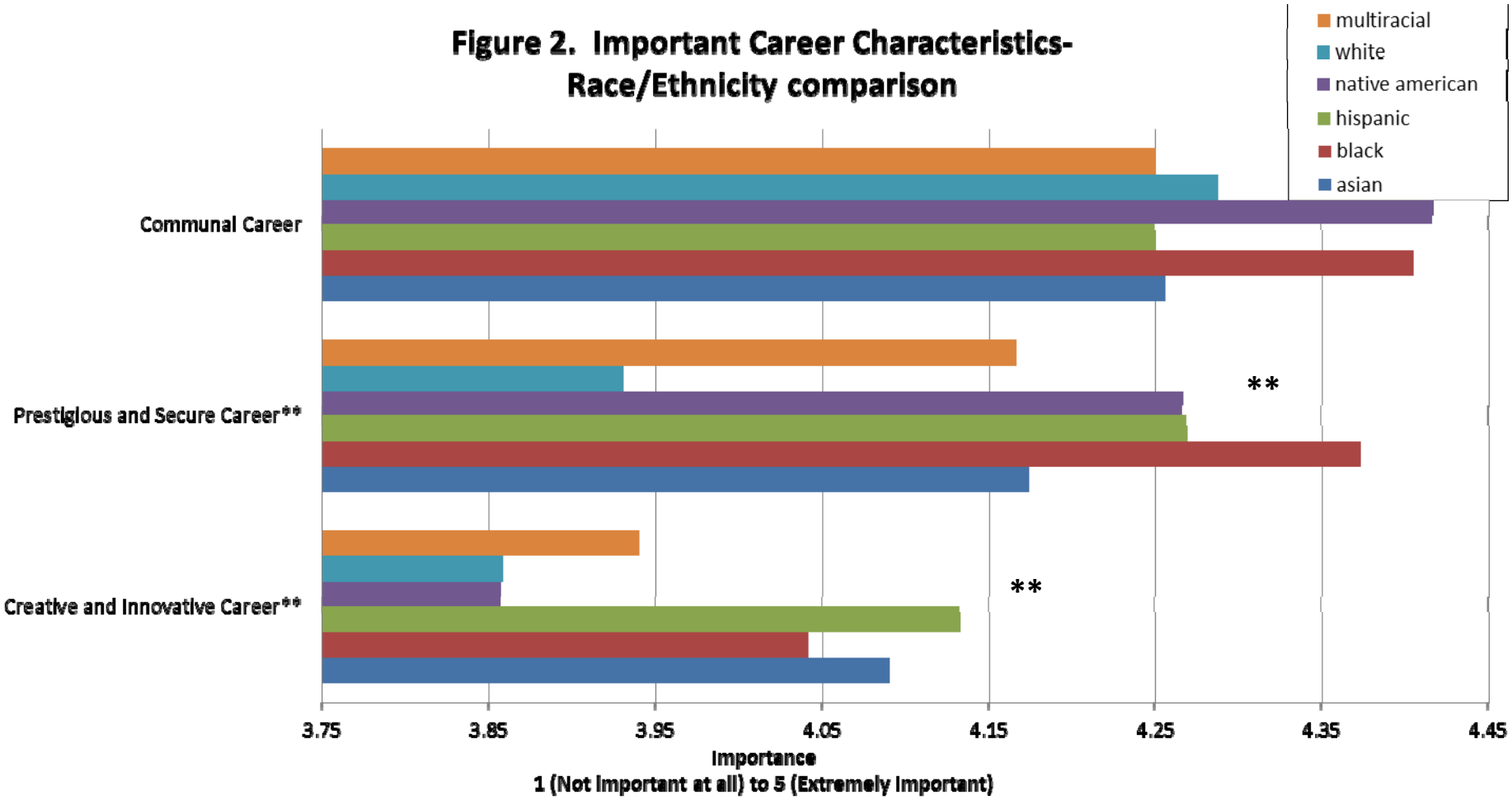
B. Gender Differences in Important Career Characteristics



*p<.05 **p<.01 Note. Participants who declared computing as their majorwere computing majors/minors/other fields were included in the analysis

Female respondents are significantly more likely than male respondents to place importance on communal career characteristics. That is, females are more likely to place importance on "being able to spend time with your family" and "having the power to do good and doing work that makes a difference" than males.

C. Race Differences in Importance Career Characteristics



Asian, Black, and Hispanic respondents are significantly more likely than White respondents to place importance on having a creative and innovative career and for achieving job security and prestige in their chosen professions.

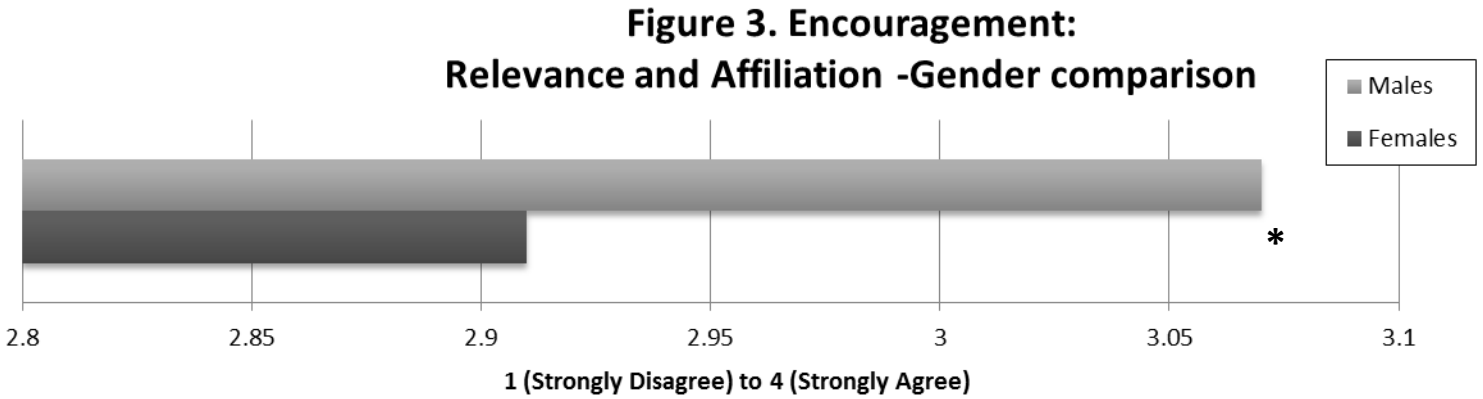
II. Encouragement and Support

A. Factor analysis of encouragement items (n=1434); encouragement items 8-19.

2 factor emerged: accounting for 48.910% of total variance
Principal axis factoring/ varimax rotation

	Factor		
	Relevance and Affiliation=.86	Professor Support Alpha=.61	3 *Poorly loaded items*
encouragment_17. Computing assignments show me how useful knowledge of computing can be.	.774		
encouragment_16 computing assignments increase my interest in computing.	.761		
encouragment_14. My college/university computing assignments relate to my career goals.	.742		
encouragment_11. I feel like I belong in my college/university's computing department	.684		
encouragment_15. The materials covered in my college/university courses relate to solving problems important to society.	.643		
encouragment_13. Computing is an important life skill.	.628		
encouragment_9. Computing professors have offered me personal advice on how to succeed in computing.		.706	
encouragment_8. I am comfortable talking to computing professors one on one.		.628	
encouragment_12. I feel comfortable asking questions in my college/ university computing classes.			
encouragment_10. My college/university computing department offers me information on work and research opportunities.			
encouragment_19. My parents/guardians encouraged me to take computing courses.			
encouragment_18. My parents/guardians are better than average at using computers.			

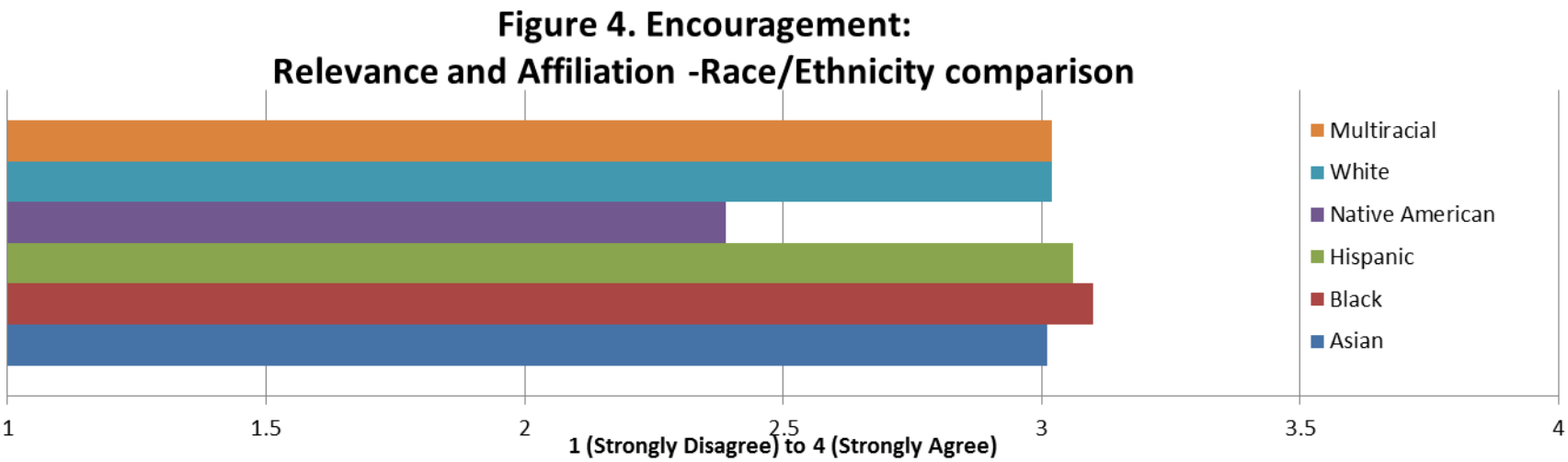
B. Gender Differences in Encouragement: Relevance and Affiliation



Female respondents are significantly less likely than male respondents to report feeling affiliated with the computing department and seeing the relevance of their course work with their career goals. In particular, females are significantly less likely than males to say that they feel like they belong in their college's computing department, perceive computing assignments as relating to their career goals," view computing assignments as increasing their interest in computing, and perceiving their computing assignments as showing them useful knowledge of computing.

Gender comparison by Encouragement: Relevance and Affiliation items			
	Females	Males	p-value
1. I feel like I belong in my college's/university's computing department.	2.71	2.89	.04*
2. Computing is an important life skill.	3.22	3.31	.22
3. My college/university computing assignments relate to my career goals.	2.87	3.04	.05*
4. The materials covered in my college/university courses relate to solving problems important to society.	2.67	2.80	.12
5. Computing assignments increase my interest in computing.	2.93	3.09	.05*
6. Computing assignments show me how useful knowledge of computing can be.	3.10	3.25	.04*

C. Race/Ethnicity Differences in Encouragement: Relevance and Affiliation

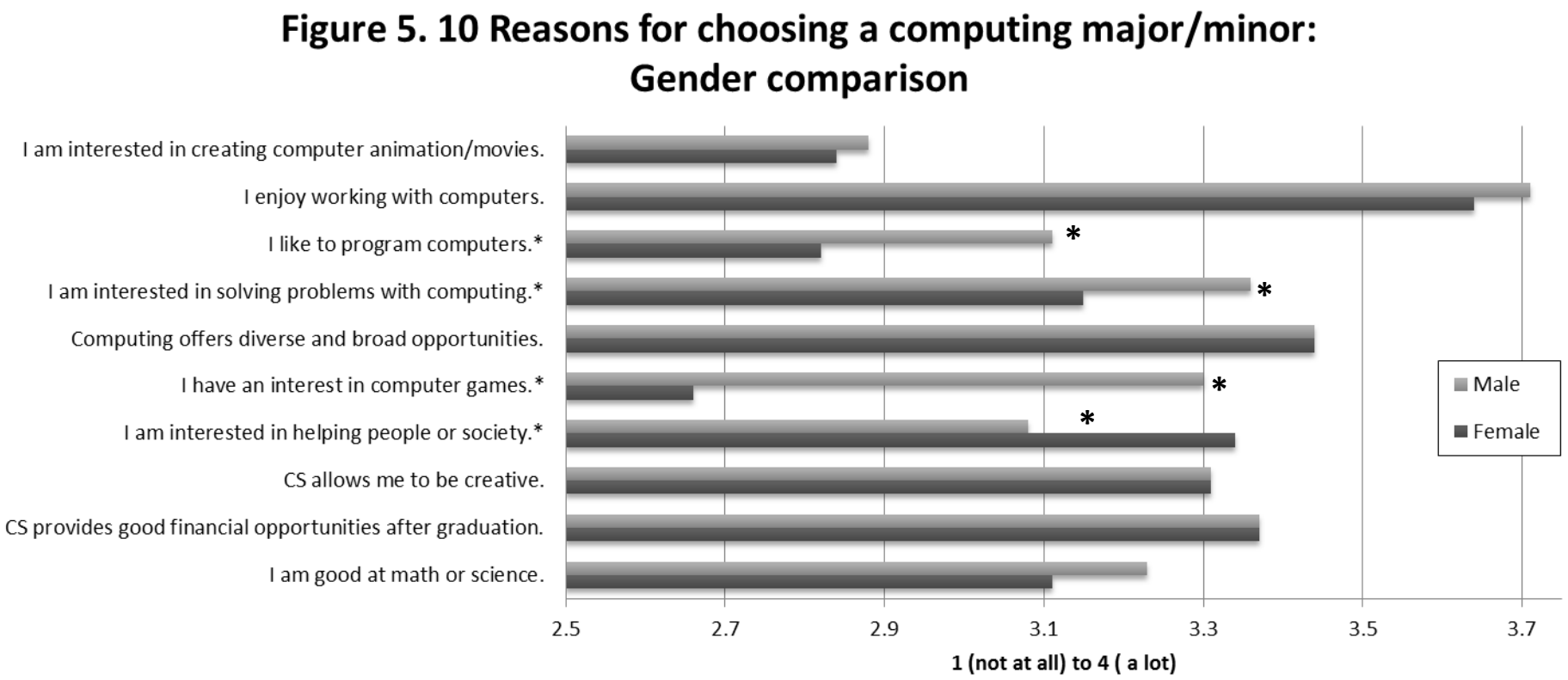


No significant differences were found for race/ethnicity for the factor of Relevance and Affiliation.

Likewise, no significant differences were found for gender and race/ethnicity for the Encouragement factor: Professor Support

III. Reasons for Choosing Computing.

A. Gender Comparison



Female respondents were more likely than male respondents to say that they chose a computing major/minor because of their "interest in helping people or society." Male respondents were significantly more likely than female respondents to cite "interest in computer games," "interest in solving problems with computing," and "liking to program computers" as reasons for choosing a computing major/minor.

B. Race/Ethnicity Comparison

10 Reasons for choosing a computing major/minor: Race/Ethnicity Comparison										
	I am good at math or science.	CS provides good financial opportunities after graduation.	CS allows me to be creative.	**I am interested in helping people or society.***	I have an interest in computer games.	Computing offers diverse and broad opportunities.	I am interested in solving problems with computing.	I like to program computers.	I enjoy working with computers.	**I am interested in creating computer animation/movies.***
Asian (n=83)	3.18	3.33	3.22	3.18	3.23	3.43	3.27	3.04	3.53	3.07*
Black (n=124)	3.3	3.49	3.35	3.39*	3.15	3.52	3.3	2.93	3.74	3.04*
Hispanic (n=27)	3.37	3.56	3.46	3.12	3.26	3.63	3.52	3.11	3.78	2.77
Native American (n=2)	4.00	3.50	3.00	3.50	2.5	3.00	4.00	3.50	4.00	2.79
White (n=295)	3.17	3.31	3.31	3.00*	3.18	3.38	3.33	3.12	3.71	2.79*
Multiracial (n=24)	3.17	3.46	3.38	3.04	3.42	3.5	3.38	3.08	3.83	2.58*

Note. Numbers indicate mean responses. 1(not at all) to 4 (a lot)

Black respondents were more significantly more likely than White respondents to cite “interest in helping people or society’ as a reason for choosing a computing major/minor. Asian and Black respondents were significantly more likely than White respondents (and multiracial respondents) to report “interest in creating computer animation/movies” as a reason for choosing a computing major/minor.

IV. Ability

A. Gender and Race Comparison of Ability: "How would you rate your programming skills?

Ability											
Gender comparison	**n**	**Mean**	**t**	**p- value**		**Poor (1)**	**Below Average (2)**	**Average (3)**	**Above Average (4)**	**Excellent (5)**
Females	104	2.88	-3.75	.000**		10.6%	13.5%	53.8%	22.1%	0.0%
Males	472	3.25				4.0%	13.8%	42.6%	32.6%	7.0%
Race Comparison	**n**	**Mean**	**F**	**p-value**		**Poor (1)**	**Below Average (2)**	**Average (3)**	**Above Average (4)**	**Excellent (5)**
Asian	85	3.14	2.011	.075		3.5%	20.0%	40.0%	31.8%	4.7%
Black*	125	2.99*				6.4%	17.6%	50.4%	21.6%	4.0%
Hispanic	28	3.18				7.1%	10.7%	42.9%	35.7%	3.6%
Native American	3	3.00				0.0%	33.3%	33.3%	33.3%	0.0%
White*	311	3.28*				4.5%	10.6%	44.4%	33.4%	7.1%
Multiracial	23	3.00				13.0%	13.0%	39.1%	30.4%	4.3%

Note. Post-hoc tests (Tukey) reveals a significant difference between Blacks and Whites, p=.003.
Reference lines are at 3 and 2

Female respondents rated their programming skills as significantly lower than male respondents did. On average, females rated their programming skills as average to slightly below average, whereas males rated their skills as average to slightly above average.

Likewise, there was a significant difference between Black and White respondents in self-reported programming skills: Black respondents rated their programming skills as significantly lower than White respondents did.

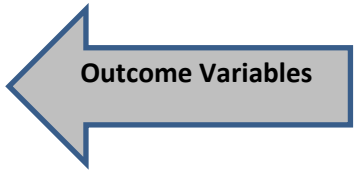
There were no significant interactions between Gender and Race

Regression and Mediation Analyses

Figures 1-4 represent regression analyses (Baron & Kenny, 1986) which assess the nature of the relationship among survey factors.

We hypothesize that self-reported Ability (how students rated their programming skills; ability item #1) will directly predict:

- Satisfaction in choosing to study computing[1]
- Likelihood in completing a computing major/ minor[1]
- Likelihood of pursuing a career in computing[1]



As perceived ability in computing increases, satisfaction and likelihood in completing and pursuing a career in computing will increase. However, we hypothesize that encouragement (whether participants feel affiliated with their computing department and perceive the relevance of their computing course work with their future career) will play a more important role than self-reported ability in predicting female and underrepresented minorities' outcomes. That is, we hypothesize that encouragement will statistically trump ability in predicting outcomes for female and minority respondents

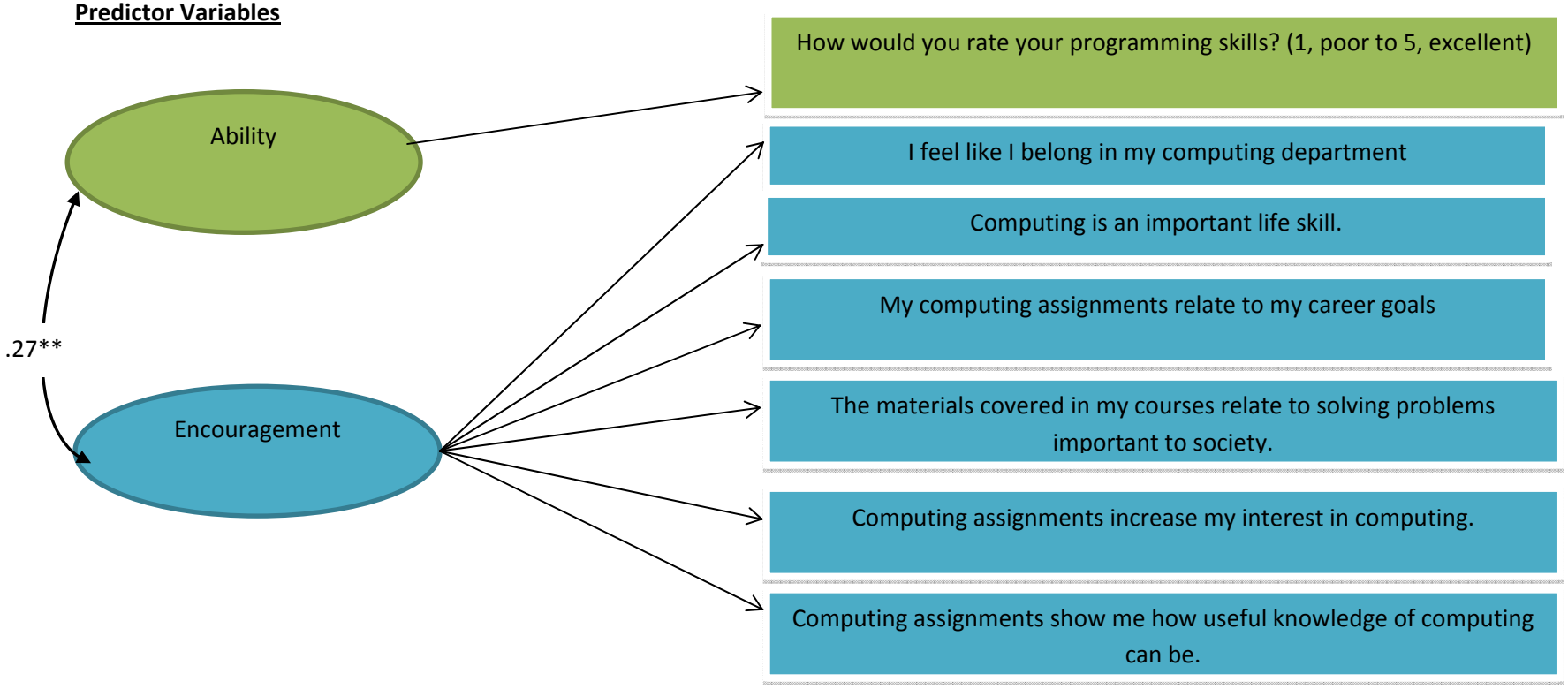
This hypothesis is based on previous research that investigated gender and racial differences in computer science (e.g., Beyer, Rynes, Perrault, Hay, & Haller, 2003). Previous research has repeatedly found that low affiliation and low interest in computer science assignments significantly accounts for the small number of women and underrepresented minorities in computer science majors and careers (Beyer, 1999a; Beyer, Chavez, & Rynes, 2002). In fact, Cohoon and Baylor (2003) contend that increasing affiliation, confidence and interest in computing course work is equally, if not more, important as increasing ability in computing for females. Cohoon and colleagues (2003) find that grades do not adequately explain why women and minorities leave CS at higher rates than men and majority group members. Strenta and colleagues (1994) found that differences in introductory course grades did not adequately explain the effect of gender on willingness to persist in computer science.

To investigate the hypothesized meditational relationship, we conducted a series of regression analyses according to the guidelines stipulated by Baron & Kenny, 1986. The numbers below reflect standardized Beta weights. The standardized Beta value indicates the number of standard deviations that the outcome will change as a result of one standard deviation change in the predictor variable. The standardized Beta-value also provides information regarding the importance of a predictor in the model.

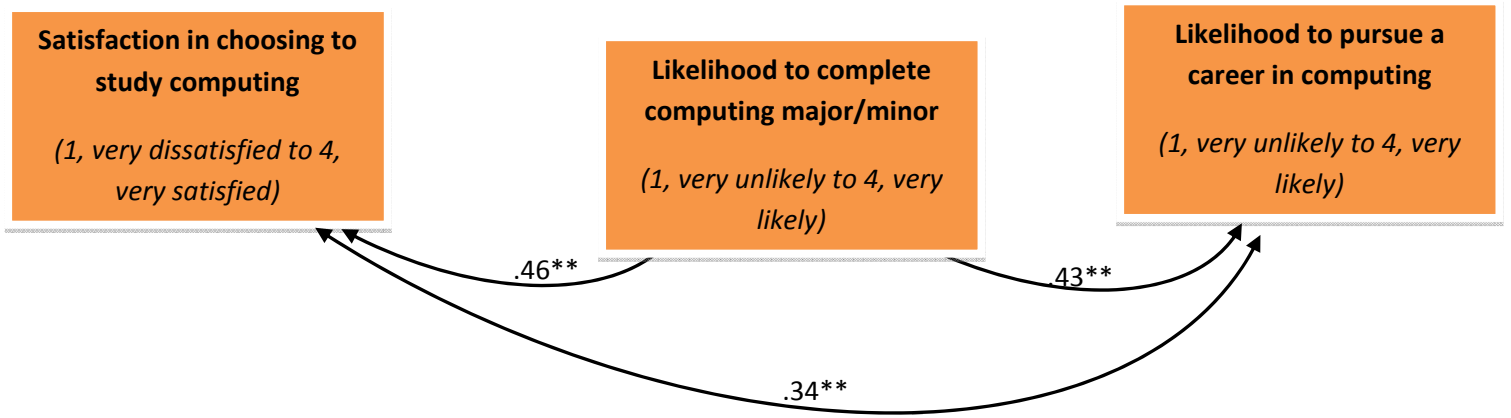
[1]Statistical tests revealed no significant differences by gender or race

For the analyses below, the following constructs were used:

Predictor Variables

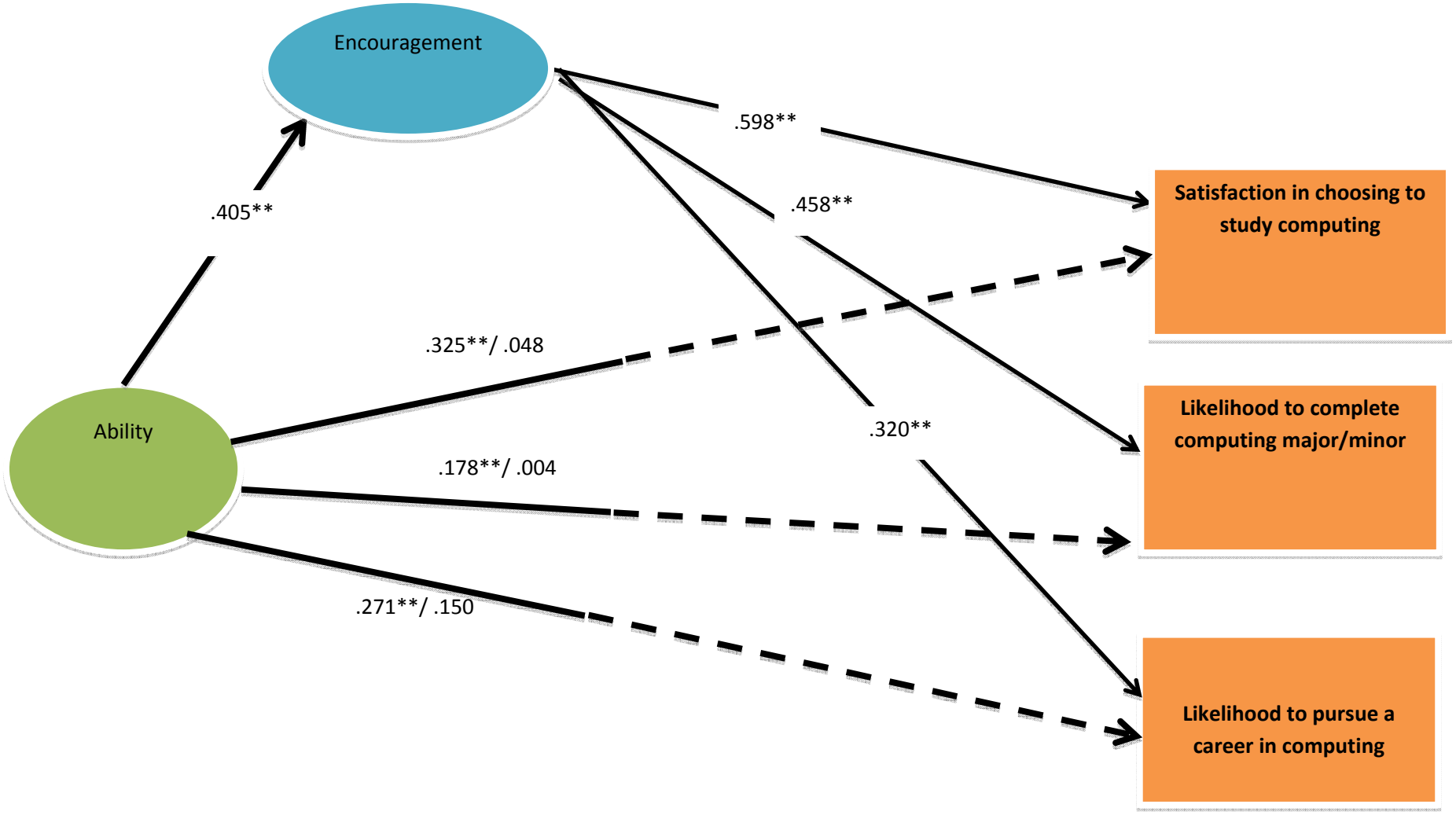


Outcome Variables



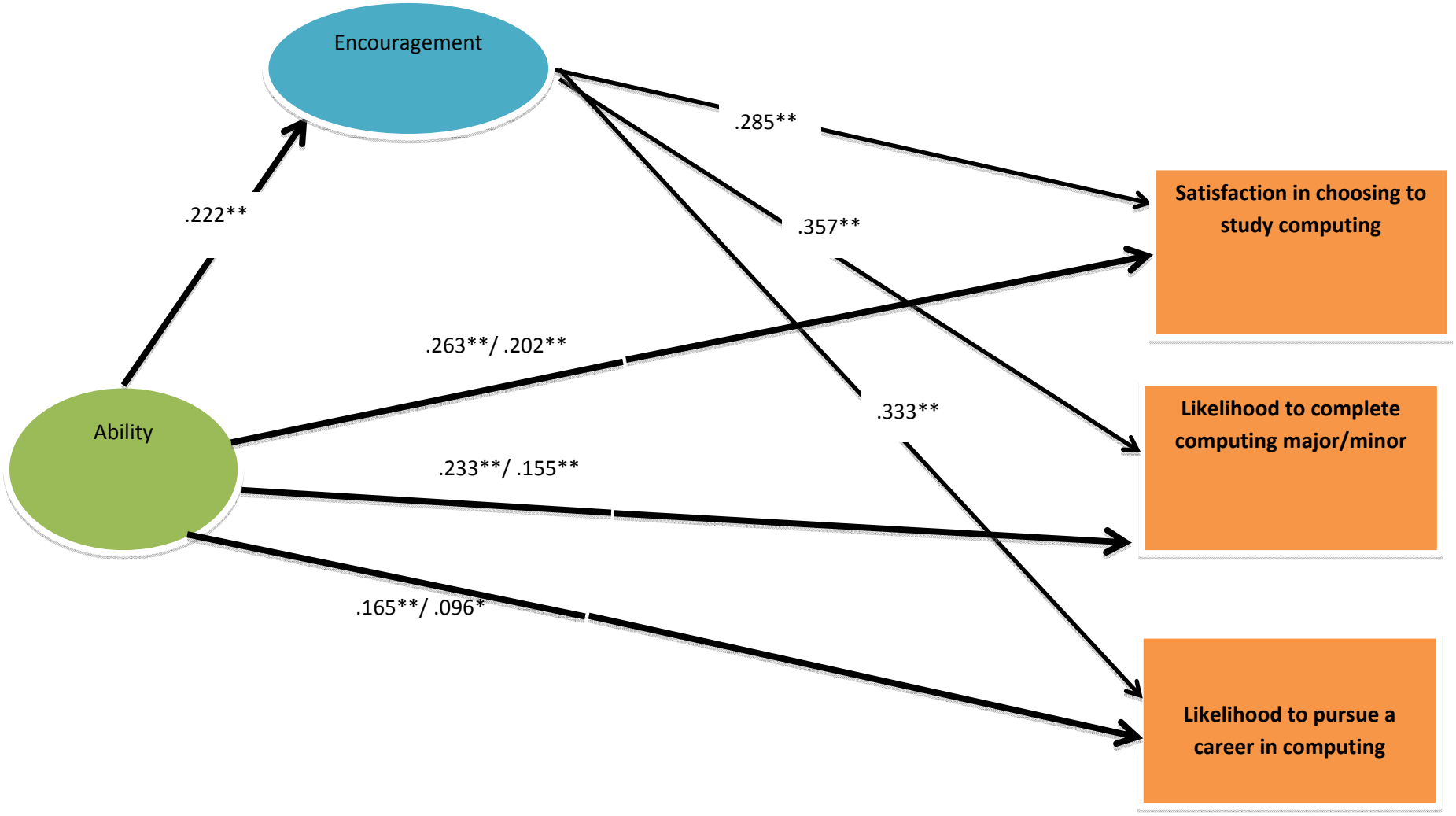
Note. Numbers indicate Pearson's correlations. * significant at $p < .05$ ** significant at $p < .01$

Figure 1. FEMALES -Mediation Analysis



For females, encouragement fully mediates the relationship between ability and satisfaction, likelihood to complete computing major/minor, and likelihood to pursue a career in computing. When the outcome variables are regressed on both encouragement and ability, the direct effect of ability becomes insignificant. This suggests that while ability enhances female's satisfaction and likelihood to pursue computing, encouragement is driving this effect. For every one standard deviation increase in encouragement, there was a .598 standard deviation increase in satisfaction, a .458 standard deviation increase in likelihood to complete computing, and a .320 standard deviation increase in likelihood to pursue a career in computing.

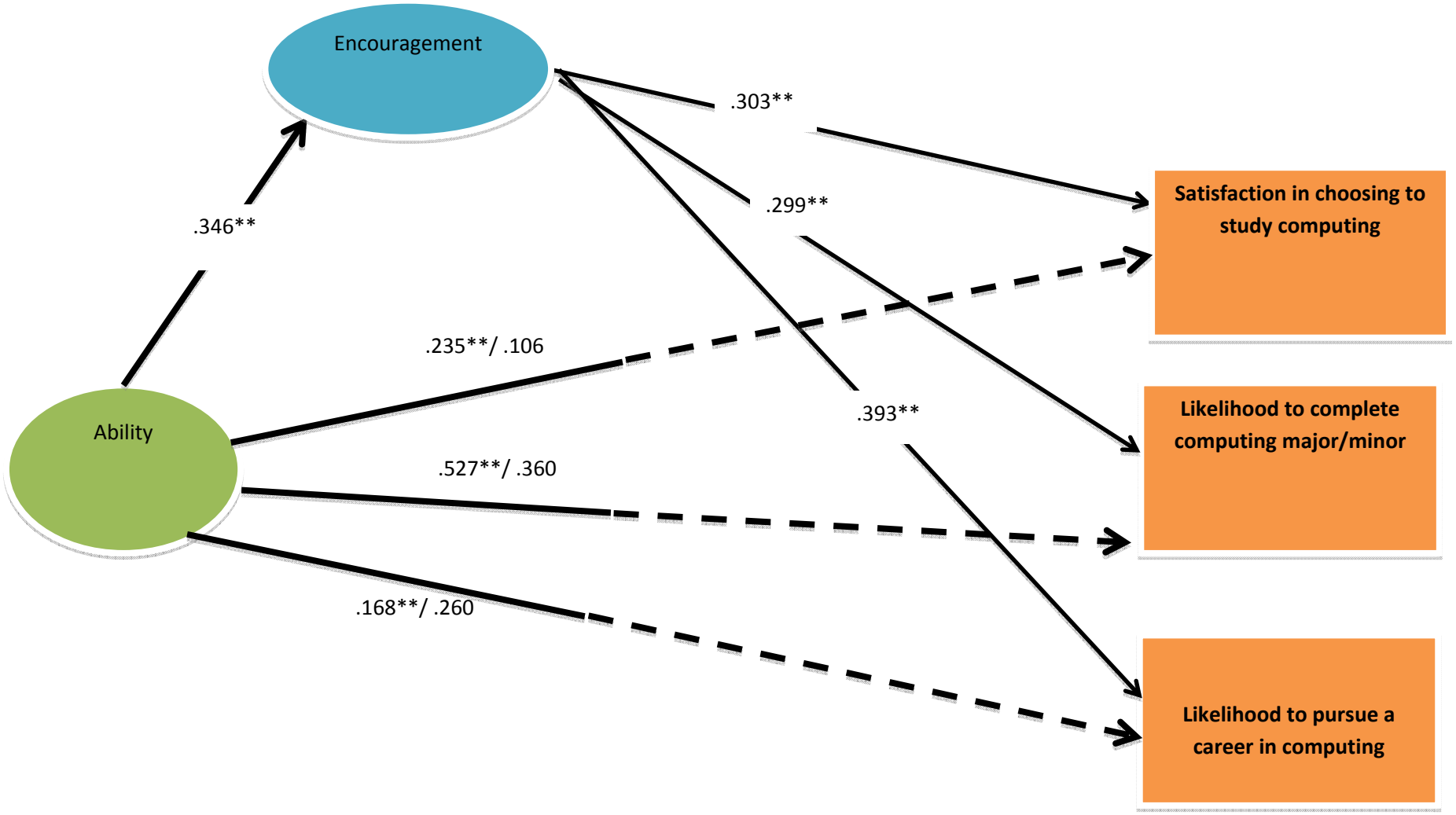
Figure 2. MALES -Mediation Analysis



For males, both ability and encouragement equally predict satisfaction, likelihood to complete a computing major/minor, and likelihood to pursue a career in computing. When the outcome variables are regressed on both encouragement and ability, the direct effect of ability remains significant; thus, encouragement does *not* mediate the relationship between ability and the outcome variables

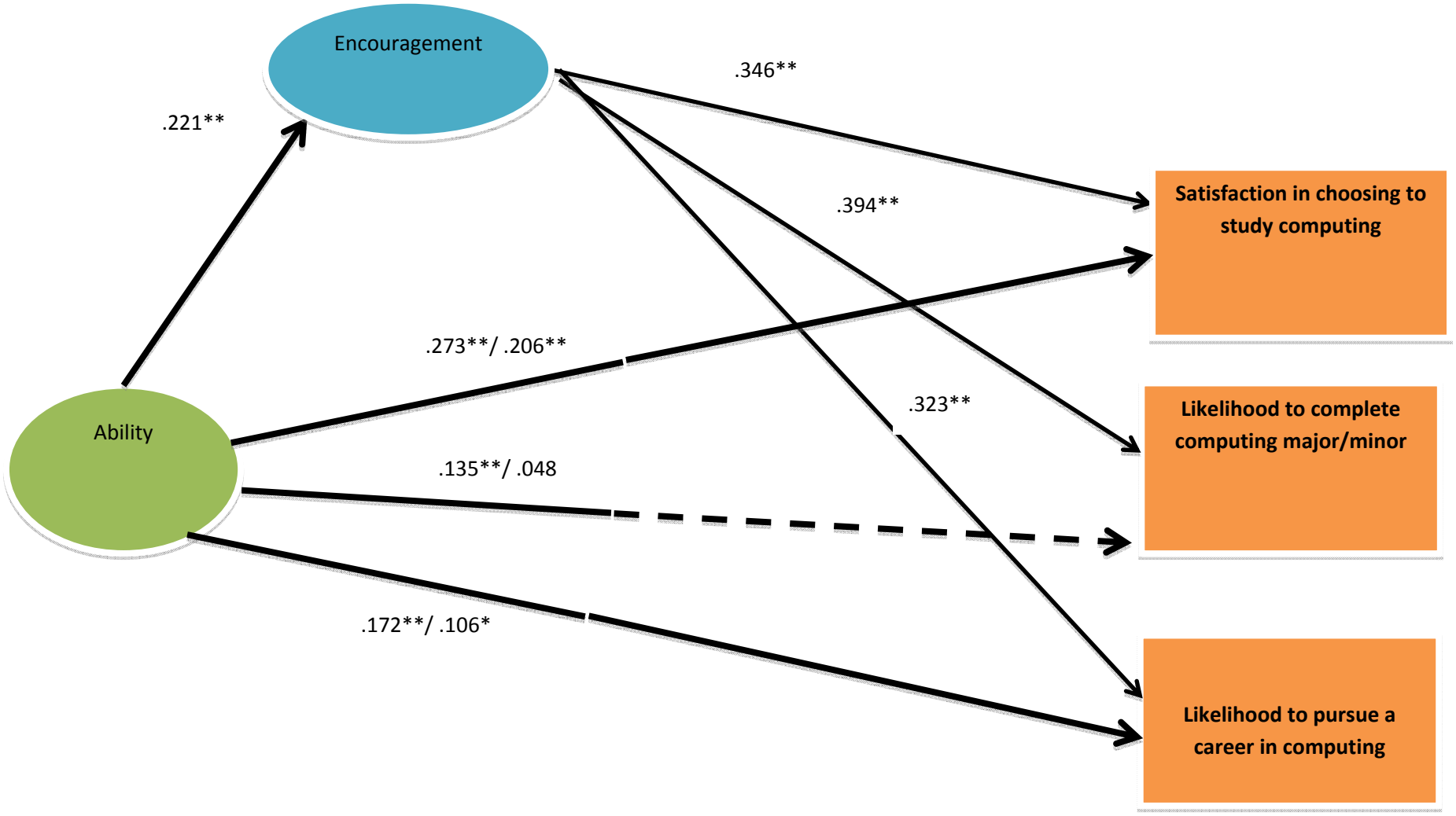
Overall, for females, encouragement matters more than ability in terms of how satisfied they are with computing, how likely they are to complete their computing major/minor, and how likely they are to pursue a career in computing. For males, encouragement and ability were equally important in predicting their outcomes. These results indicate that improving outcomes for females entails improving their affiliation with the computing department and enhancing the relationship between computing assignments and female interests and career goals.

Figure 3. Underrepresented minorities (Blacks, Hispanics, Native American) -Mediation Analysis



For underrepresented minorities (Blacks, Hispanics, native Americans), encouragement, once again, fully mediates the relationship between ability and satisfaction, likelihood to complete computing major/minor, and likelihood to pursue a career in computing. When the outcome variables are regressed on both encouragement and ability, the direct effect of ability becomes insignificant. This suggests that while ability enhances underrepresented minorities'' satisfaction and likelihood to pursue computing, encouragement is driving this effect. For every one standard deviation increase in encouragement, there was a .303 standard deviation increase in satisfaction, a .299 standard deviation increase in likelihood to complete computing, and a .393 standard deviation increase in likelihood to pursue a career in computing.

Figure 4. Whites and Asians -Mediation Analysis



For White and Asian respondents, both ability and encouragement equally predict satisfaction in choosing to study computing and likelihood to pursue a career in computing. When the outcome variables are regressed on both encouragement and ability, the direct effect of ability remains significant; thus, encouragement does *not* mediate the relationship between ability and the outcome variables. However, the relationship between ability and likelihood to complete a computing major/minor was fully mediated by encouragement for White respondents.

Interestingly, there was no difference between White and Asian respondents in their regression analyses, thus, for purposes of parsimony, they were combined.

Overall, for underrepresented minorities, encouragement matters more than ability in terms of how satisfied they are with computing, how likely they are to complete their computing major/minor, and how likely they are to pursue a career in computing. For majority group members in computing, encouragement and ability were equally important in predicting their outcomes.
These results indicate that improving outcomes for underrepresented minorities entails improving their affiliation with the computing department and enhancing the relationship between computing assignments and minority student's interests and career goals.

References

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