INDIVIDUAL AND INSTITUTIONAL FACTORS AFFECTING IDENTITY AMONG MINORITY AND FEMALE SCIENCE STUDENTS.

A thesis submitted
To Kent State University in partial
Fulfillment of the requirements for the
Degree of Master of Arts

By
Jay W. Hays

December 2011
Thesis written by
Jay Warren Hays
B.A., Mount Union College, 1998
M.Ed., Kent State University, 2001
M.A., Kent State University, 2011

Approved by,

___________________________Richard T. Serpe, Advisor
___________________________Richard T. Serpe, Chair, Department of Sociology
___________________________John R. D. Stalvey, Dean, College of Arts and Sciences
# TABLE OF CONTENTS

LIST OF FIGURES .................................................................................................................. iv

LIST OF TABLES .................................................................................................................... v

1 INTRODUCTION .................................................................................................................. 1

2 BACKGROUND ..................................................................................................................... 8

   College Effects ................................................................................................................... 8

   Identity Theory .................................................................................................................. 13

   Constructing a Model for Testing College Effects on Identity ....................................... 18

      Inputs ............................................................................................................................... 20

      Points of Convergence—Inputs ................................................................................... 21

      Environments ............................................................................................................... 22

      Points of Convergence—Environments ....................................................................... 23

      Outputs .......................................................................................................................... 24

      Points of Convergence—Outputs .................................................................................. 25

   Hypotheses ......................................................................................................................... 26

3 METHODS .......................................................................................................................... 29

4 RESULTS ............................................................................................................................ 36

   Race ................................................................................................................................. 42

   Gender ............................................................................................................................... 43

   Future Research ............................................................................................................... 44

5 CONCLUSION ..................................................................................................................... 47

REFERENCES ....................................................................................................................... 50

APPENDIX ............................................................................................................................ 55
LIST OF FIGURES

FIGURE 1:...............................................................14
FIGURE 2:.............................................................30
LIST OF TABLES

TABLE 1: ........................................................................................................... 32
TABLE 2: ........................................................................................................... 32
The purpose of this paper is to determine the factors that influence the development of the scientist identity among women and minority science students. To do so, I will integrate literature on college student development, particularly from the work of Astin (1993), Pascarella (1985), and Chickering and Reisser (1993) and Identity Theory (Stryker [1980]2003) to explain how factors related to student development impact minority students’ sense of self as a scientist. An important extension to Identity Theory is conceptualized in the form of cognitive activity within the context of educational integration.

Education has been seen as the key to enlightenment (Jordan 1896), an important component to socioeconomic status (Stevens and Featherman 1981), occupational prestige (Blau and Duncan 1967), and the ticket to upward mobility (Olneck 1979; Ishida, Müller, and Ridge 1995). A 2002 US Census report by Day and Newburger indicated that a person with a bachelor’s degree will earn nearly $1 million more in their lifetime than a person with only a high school diploma. The report also shows that an individual with a Ph.D will earn $2.5 million more and a professional degree (J.D or M.D.) can earn a person as much as $3.5 million more than someone with only a high school diploma. In addition to advantages in earnings, Pascarella and Terenzini (2005)
summarize a host of other positive outcomes of college attendance including: increased occupational prestige; lower levels of unemployment; greater job/career satisfaction; higher job performance; higher moral, cognitive, and social psychological development; greater sensitivity to issues of diversity and inequality; greater sense of civic responsibility and greater involvement in civic affairs; and overall increased quality of life.

Unfortunately, not all American’s are able to take advantage of this opportunity. Baker and Valez (1996) review access and opportunity issues in higher education and found that college success can be predicted by higher socioeconomic status (SES) backgrounds, higher academic ability, high school performance, and attendance at a private high school. Further, they reviewed that students who more easily integrate into the social aspects of college life (through peer, sub-culture, and faculty interaction) acquire grants, as opposed to loans, and begin their academic careers at a 4-year school, as opposed to a community college, are more likely to complete a bachelor’s degree. Brand and Xie (2010) find that the individuals who have the most to gain (economically and socially) from a college education are less likely to attend than those who have little to gain from a college education:

In the absence of a college education, low propensity men and women have limited human, cultural, and social capital and hence particularly limited labor market prospects. By contrast, in the absence of a college degree, individuals from more advantaged social backgrounds can still rely on their superior resources and abilities. (Brand and Xie 2010: 293)
Minority students, particularly African Americans, Hispanic/Latinos, and Native Americans are consistently on the wrong end of the equation in each of the above factors (Baker and Valez 1996; Brand and Xie 2010).

Minority students lag behind their white counterparts proportionate to the population. Over the last 20 years, only 15% of African Americans, 10% each of Latinos and Native Americans graduated from a 4-year college compared to 31% of whites (Winkleby, Ned, Ahn, Koehler, and Kennedy; 2009). This is especially true in science, technology, engineering, and math (STEM) related fields (Lewis, Menzies, Najera, and Page 2009; Mulvey and Nicholson 2008). A number of studies have demonstrated that underrepresented minority science training programs that include undergraduate research experience (Jones, Barlow, Villarejo 2010; Vilarejo, Barlow, Kogan, Veazey, Sweeney 2008), mentorship (Winkleby, Ned, Ahn, Koehler, & Kennedy 2009), academic adjustment, and sense of belonging (Hurtado, Han, Saenz, Espinosa, Cabrera, & Cerna 2007) positively impact minority students persistence in science majors (Schultz, Hernandez, Woodcock, Estrada, Chance, Aguilar, Serpe 2011).

Female students have been the majority of students attending part time since at least 1980 and have been in the majority of full time attendees since 1990 (NCES 2009). As of 2008, women account for more than 64% of all undergraduate students. Although women outnumber men on college campuses, there are fewer women in STEM majors: in 2006 only 24% of first year Master’s students in Physics were women (Mulvey and Nicholson 2008); and according to a National Science Foundation report, in 2008 women earned only 41% of bachelor’s degrees awarded in physical sciences, less than 19% of
engineering degrees, 25% of math and computer science degrees, and 58% of biological science degrees.

According to a 1997 US Department of Education study, the gap in math and science proficiency scores begins to appear by age 13 and by the age of 17, boys score much higher in math and science on both the SAT and AP exams (NCES 1997). Lee (2002) summarizes a number of issues related to the lack of females in the sciences that go beyond academic tracking and preparedness and found that traditional gender role explanations dominated the findings. In particular the competitive nature of these majors and the objective nature of experimental design rather than the social contexts of meaning tend to be seen as male ways of knowing and discourages females. Lee also noted that successful female science students, consistent with traditional female gender roles, often develop strong relationships with faculty and peers.

The result of this underrepresentedness by females and minorities is a system of structured inequality in the sciences. As noted above, people with a PhD or MD will earn significantly more over their lifetime than those with less educational attainment. Greater inclusion of minorities and females in the high status groups will facilitate the long term decline of structural inequality. Curry (1997) explains that many minority serving institutions are not aware of, do not have experienced researchers who know about, or do not know how to take advantage of federal research grant programs sponsored by the National Institutes of Health or the National Science Foundation. They are thus structurally at a disadvantage to primarily white major research institutions. Inclusion of
underrepresented groups in biomedical sciences helps to break down the structural
inequalities that have kept minority populations in lower socioeconomic brackets.

Curry (1997) also notes that exclusion not only affects who becomes a biomedical
scientist, but who is studied. Sprague and Zimmerman (2004) have noted that historically
white men have dominated the field as both researcher and research subjects. A study
(whether biomedical or social) that only utilizes white men lacks validity due to selection
bias and results could not be generalized to females and non-whites. Krieger (2001) also
noted that dominant paradigms in biomedical research claim that racial differences in
disease (e.g. hypertension) rates are due to genetic causes; however, she demonstrates
that ecological factors such as economic and social deprivation, exposure to toxic
substances and hazardous conditions, social trauma and inadequate healthcare
experienced by minorities (due to their lower economic status) are the causes of higher
rates of hypertension in African Americans than in whites. Further complicating the
matter is a level of distrust by minorities towards biomedical researchers as evidenced by
the Tuskegee syphilis study (Gamble 1997).

Government agencies and institutions of higher education (e.g. the Standford
Medical Youth Science Program; Massachusetts Institute of Technology’s Minority
Introduction to Engineering and Science program; Outreach, Research Training and
Minority Science Programs at UC Irvine) have implemented programs and policies over
the last half century to increase the enrollment and graduation of underrepresented
groups, primarily females, ethnic minorities and persons of lower SES. Chief among the
federal government programs are the GI Bill, the Federal Pell Grant, and Trio programs
such as Upward Bound. The National Institute of Health\(^1\) and the National Science Foundation (2008) have also financially contributed towards efforts to increase minority participation.

Whether or not any change in underrepresented student enrollment is due to these programs is difficult to ascertain; however, according to the National Center for Educational Statistics (2004), the percentage of minority students (black, Hispanic, Asian/Pacific Islander, American Indian/Alaskan Native) enrolled in 2- and 4-years schools nearly doubled in the past 35 years from less than 16% in 1976 (black 9.6%, Hispanic 3.6%, Asian/Pacific Islander 1.8%, American Indian/Alaskan Native .7%) to more than 30% in 2002 (black 12.4%, Hispanic 10.4%, Asian/Pacific Islander 6.7%, American Indian/Alaskan Native 1.0%).

The present study highlights Identity Theory as one understudied factor in explaining how specific individual and environmental characteristics affect female and minority science students’ sense of self. More specifically, what individual and environmental factors affect female and minority science students’ identity? Identity Theory is well positioned to answer this question; the goal of identity salience is to explain behavior by examining the salience of a given identity. Merolla, Stryker, and Serpe (In progress), using the same data set as the present study, find that the salience of an identity increases the likelihood that the same identity will be enacted in the future. As institutions attempt to increase participation of minority students in science occupations,

\(^1\) A full listing of NIH programs can be found at [http://www.scepscoridea.org/inbre/PUIWorkshop/INBREPUIWorkshop_NIHMinorityServingPrograms.pdf](http://www.scepscoridea.org/inbre/PUIWorkshop/INBREPUIWorkshop_NIHMinorityServingPrograms.pdf) retrieved July 15, 2011.
understanding the factors that influence such an identity provides direction for policy and intervention. Furthermore, increasing student retention has received a great deal of attention in higher education (Noel, Levitz, Saluri 1987). Merolla et al’s linkage of identity salience to student retention was an important contribution of Identity Theory to the study of higher education outcomes. The present study extends this connection by identifying the individual and institutional elements of the educational experience that predict identity salience. With the goal of showing how great salience of the “scientist” identity leads to retention in STEM disciplines and higher representation of minorities and women in these fields of study.

To answer this research question, I begin with Pascarella’s (1985) model developed to examine college effects on individual outcomes. The model conceptualizes the study of student development by individual, environmental, and outcome variables. This model is adapted to include Identity Theory. Chickering and Reisser’s (1993) work is used as a bridge to connect the literature on college effects and Identity Theory. In the next section, the theoretical development of Pascarella’s model is examined followed by a discussion of identity theory. A new model of examining college effects on identity is proposed and then tested.
Astin (1993) identified a number of problems in researching college effects. He developed a model around three types of variables that attempt to address these problems (outlined below). His model is simply I-E-O, or inputs – environment – outputs. The study of the effects of higher education is a difficult undertaking because of the vast number of potential inputs (academic preparedness, standardized test scores, motivation, individual student behavior, etc.); environmental variables (size of the institution, level of education of the faculty, quality of programming, student life, opportunity for research, racial tensions on campus, etc.); and outcomes (degree attainment, level of income after graduation, graduate school attendance, job placement, cognitive change/development, identity, citizenship, etc.). Time of exposure to higher education (as a traditional 18 year-old student, or a non-traditional 30 year-old student) and when the outcome is measured across the lifespan (immediately following graduation or 20 years later) also complicate any analysis of educational outcomes. A third problem identified by Astin is the attempt to demonstrate that any social psychological outcome is a result of college attendance and
not some spurious variable such as maturation. That is, do non-college attendees have similar levels of growth on such measures as cognitive development or citizenship?

Pascarella (1985) further identifies two different types of studies that examine two separate units of analysis. The first type of study examines the institutions themselves as the unit of analysis. In these studies organizations are compared to one another on a variety of measures including graduation rate, attrition, research funding, diversity, etc. The second type of study examines students as the unit of analysis. These studies attempt to show that college attendance affects student learning, growth, and development.

Astin proposed a two-by-two taxonomy of student outcomes to organize educational outcomes by type of outcome and type of data. Outcomes can either be cognitive or affective and data can be either psychological or behavioral. Cognitive outcomes are measures of intellect and mental processes whereas affective outcomes pertain to “attitudes, values, self-concept, aspirations and everyday behavior” (Astin 1993:9). Psychological data are often latent variables (self-esteem, depression) while behavior data is more directly observed (degree attained, job acquired).

Pascarella (1985) building off of Astin’s taxonomy and I-E-O format constructed a causal model to test the cognitive-psychological dimension. The Pascarella model begins with two exogenous sets of input variables: student background/pre-college traits (aptitude, achievement, personality, aspiration, ethnicity, socioeconomic status, parents’ level of education) and structural/organizational characteristics of the institution (enrollment, faculty-student ration, selectivity, percent residential). Three separate variables constitute the institutional environment: interaction with agents of socialization
(faculty and peers); quality of student effort; and institutional environment. The final output variable is a measure of cognitive development and learning.

Chickering and Reisser (1993) developed a psycho-social model of college student development that can serve as a bridge, linking Pascarella’s model for assessing the effects of the college environment on student learning and outcomes, to Stryker’s ([1980]2003) theory of the effects of society on the self. Chickering and Reiser’s (1993) theory maintains that students grow along seven vectors of development during the college experience: developing competence; managing emotions; moving through autonomy toward interdependence; developing mature interpersonal relationships; establishing identity; developing purpose; and, developing integrity. Their model avoids the stage based developmental models common among other social psychologists such as Piaget, Erikson, Perry and others (see Chickering and Reisser chapter 1 for a summary of these models). Their model suggests that each individual starts at different points on each of the seven vectors, and “advance” on each vector according to the experiences of the individual rather than sequentially,

We propose that while each person will drive differently, with varying vehicles and self-chosen detours, eventually all will move down these major routes. They may have different ways of thinking, learning, and deciding, and those differences will affect the way the journey unfolds, but for all the different stories about turning points and valuable lessons, college students live out recurring themes: gaining competence and self-awareness, learning control and flexibility, balancing intimacy with freedom, finding one’s voice or vocation, refining beliefs, and making commitments. (Chickering and Reisser 1993:35)

The first vector, developing competence, includes three types of competencies: intellectual, physical, interpersonal. Intellectual competencies include acquiring knowledge and developing the ability to think, analyze, and synthesis information.
Interpersonal competencies involve developing communication skills and learning empathy. Physical skills not only include physical prowess and artistic abilities, but it also sets the stage for another vector: managing emotions.

*Managing emotions* is an important step in the maturation process for students. Students must learn to deal with stress, anxiety, depression and myriad of other emotions that confront students daily as they interact with faculty, other students, families whom they may be separated from for the first time, and development of new romantic and/or sexual relationships.

The third vector is *moving through autonomy toward interdependence*. Chickering and Reisser argue that many college students revel in their new found independence. Creating their own schedules, freedom from parental curfews and developing a sense of efficacy are common experiences. However, students soon learn that they are not truly independent, but rather are interdependent, developing mutually beneficial support structures. Students find they are not islands onto themselves.

Developing a sense of interdependence leads naturally to the *development of mature interpersonal relationships*. Mature relationships occur when the individual develops a capacity for healthy intimacy and learns tolerance and respect for others. This vector does not speak only to close intimate relationships, but includes an appreciation for diversity and one’s place in society.

The fifth vector is *establishing identity*. They believe that establishing identity is a process of being comfortable with who one is physically, emotionally, culturally, sexually, includes a sense of acceptance, stability, integration, and self-esteem, as well as
clarification of roles. The more comfortable, consistent, and accepting of who one is the more established the identity.

An important aspect of the college experience, according to Chickering and Reisser, is to *develop a sense of purpose*. College students are often encouraged by academic and career counselors to develop goals both vocational and personal for themselves. Students should develop a sense of meaningfulness and direction in order to live more intentionally.

Finally, *developing integrity* is the seventh vector. Establishing a value system consistent with personal and societal values and living life congruently is the highest level of development for Chickering and Reisser. They recognize that a level of self-actualization is required and that not all students, or even older adults, achieve the upper limits of this vector.

At first reading, it may seem as though these vectors are all outcomes, but a closer read suggests that they build off of one another. Some are reciprocal and others require a level of attainment in one vector before reaching a higher level in another vector. For example, managing emotions is likely reciprocal with developing mature relationships; and developing identity logically precedes developing purpose. In Astin’s terminology, vectors may be inputs, environments, or outputs depending on how they are measured, when they are measured, and the interests of the researcher. Pascarella (1985) attributes Chickering’s earlier work as a significant influence on his model. As a social psychological model, there are several key elements in Chickering’s model that are
common to Identity Theory and are discussed in detail in the section below with the goal of integrating them into a more comprehensive perspective on educational attainment.

**IDENTITY THEORY**

Identity Theory is the product of a social-structural interpretation of symbolic interactionism (Stryker [1980]2003). Identity Theory links social structure and interaction (social behavior) through the organization of the self. The goal of identity theory is to understand how society affects the self, and how the self shapes society through social behavior (Stryker and Burke 2000). The social structure largely defines the opportunities that an individual has for social interaction by setting the boundaries (class, sex, race, roles, etc.) within which the self operates. From an Identity Theory perspective, the self is fundamentally a product of society (Stryker and Serpe 1982).

Individuals engage in society through the roles that they occupy. Roles both define the relationship one has with role alters (e.g., student to teacher) and provides the self with a script of societal expectations (Weinstein and Deutschberger 1963). The self is hierarchically organized into identities, which are reflexively identified and internalized roles. When one states “I am a student,” they are identifying themselves according to a role and indicating an internalization of role-behavioral expectations. The internalization of roles is a cognitive process that implies choice among alternative role behaviors. Identity relevant behavior is subjective, active, and therefore recreates society suggesting that individuals are not only products of society but are agents as well. Figure 1 depicts the self-society relationship.
Fig. 1: Structural Symbolic Interactionist frame

- The bold line represents the primary direction of influence as specified by Identity Theory.

As noted previously, Identity Theory accounts for both the social structure and the self in role-choice behaviors. The social structure is relatively organized and stable. The self, as a reflection of society is also organized and stable (Serpe 1987). The organization of the self is grounded in the cognitive processes behind behavior and is consistent with Mead’s (1934) conceptualization of the self which begins with the mind.

Identity Theory attempts to understand how this dichotomy of product and agent works through the concepts of commitment and identity salience. According to Serpe (1987), commitment represents the social structure in the equation by connecting the self to others in role relevant ways and takes two forms: interactional commitment and affective commitment. Interactional commitment refers to the number of relevant others associated with a particular identity. Affective commitment refers to the intensity of those connections. Commitment to an identity (student) depends on the number of role partners (other students and faculty) and how important those relationships are to the stability of the self. One’s place in society is thus partially dependent upon their network of relations, their role-position, in the social structure.
Commitment leads to the hierarchical ranking of identities within the self, or, *identity salience*. Identity salience represents the agentive aspect of self and determines role-choice behavior. Does a student stay in and study, or go out and socialize on the night prior to an exam? In this regard, studying will lead to successful fulfillment of the academic nature of the student identity, while going out (although salient in regards to the social component of the student identity) could result in failure and loss of the student identity. Identity salience is relatively stable and change to the salience hierarchy comes only when significant changes in the social structure (patterns of commitment) cannot be maintained (Serpe 1987; Serpe and Styker 1987, 1993). In such cases, new patterns of commitment are formed which effect the salience hierarchy.

Identity salience is defined as the likelihood that a given identity will be enacted across situations. In contrast to this conceptualization of salience as a probability, Rosenberg’s (1979) theory of the self includes a measure of the importance of some aspect of the self (an identity, attribute, characteristic, etc.). This later concept is referred to as *psychological centrality*, and is one of the four principles of self-concept formation (the other three being reflected appraisals, social comparisons, self-attributes). The principle of psychological centrality states that “the self-concept is not a collection but an organization of parts, pieces, and components and that there are hierarchically organized and interrelated in complex ways” (Rosenberg 1979:73). Both concepts are cognitive schemes that help to organize and stabilize the self, but psychological centrality requires that an individual be aware of their identities and from a measurement standpoint can
rank them in terms of importance; whereas, salience does not require self-awareness for an identity to be highly salient (Stryker and Serpe 1994).

For example, a CEO (chief executive officer) of a large corporation may come home and treat his family members as subordinate employees rather than treating them in role appropriate ways: father to son, husband to spouse. The CEO issues orders, hands down reprimands and praises as if the children and spouse were ‘up for promotion.’ In this case the role of chief executive officer is highly salient as it is enacted outside of the corporate situation. He may not even be aware that the “CEO identity” has trumped the “parent identity” as it relates to role behavior. Stryker and Serpe (1994) examined salience and centrality to determine if they were redundant concepts. Their findings were mixed indicating that in some cases centrality and salience were highly correlated but in other cases were completely independent. They concluded that “both concepts be included in research designed to test identity theory by examining how either salience or centrality mediates the relationship of structural or interactional conditions embodied in the concept of commitment” (Stryker and Serpe 1994:34).

A final component of Identity Theory relevant to the present study is the incorporation of specific measures of cognition. Identity Theory holds that identities are cognitive schemas “internally stored information and meanings serving as frameworks for interpreting experiences” (Stryker and Burke 2000:286). Meanings are both established by the social structure in terms of expectations, performance, and place in the social structure as well as taken by the individual as an active agent in re-creating meaning (role-making; Turner 1962). The social meaning of experiences is thus
personalized as identities. In this regard “identity” is an internalization of some aspect of the self in which the individual asserts “I am” – “I want” – “I feel” (Stryker 1968). This paper will focus on the conative – “I want” – aspect of identity.

In order to develop the meaning of identities, one must spend time thinking about identity and identity relevant activity (Serpe 1991). Serpe (1991) formulated thinking and planning as a variable into Identity Theory, which he termed “cognitive activity.” He demonstrated that commitment and cognitive activity effect identity salience and that these cognitive structures of the self are easier to change than the social structure as represented by patterns of commitment. As noted previously, choice is a fundamental element of identity salience. Choice implies cognitive activity and therefore precedes identity salience. His results indicated that cognitive activity does have a direct effect on identity salience that do not require strong commitment and has an indirect effect on salience for identities that require more social interaction.

The basic model for testing identity theory includes commitment preceding identity salience preceding some behavior. Additional variables, such as cognitive activity (Serpe 1991), self-esteem (Owens and Serpe 2003), structural overlap (Stryker, Serpe, Hunt 2005) and a host of control variables are often added to test specific hypotheses related to the basic model. These additions usually test for effects on commitment, salience, or some behavioral outcome. In the present study, the point of

---

2 Stryker (2008) classifies identities in terms of roles, while others use a broader definition. Owens (2003) characterizes three types of identities: person, social, and collective. Burke and Stets (2009) uses identity to refer to roles, group memberships, or a characteristic of the individual that makes them unique. This paper will use identities as tied to roles in the same sense as Stryker.
interest is not on a behavioral outcome but on those factors that influence commitment, cognitive activity, identity salience and psychological centrality.

**CONSTRUCTING A MODEL FOR TESTING COLLEGE EFFECTS ON IDENTITY**

In constructing a new model of college effects on identity, it is important to first consider how the model will address the problems of examining college effects identified by Astin (1993) and Pascarella (1985). The second step is to consider the three elements Astin proposed as important for the study of college outcomes: the input, environmental, and outcome variables. Third is to locate the points of convergence between Pascarella’s model and Identity Theory, which allow for the marriage of the two perspectives. Chickering and Reiser’s theory is used to bridge the two perspectives.

Astin’s identified the vast number of possible variables as the first challenge of conducting research in higher education. No study can consider all variables and research is often limited by the funding, response rates, access to subjects, and in the case of secondary analysis (as is the present study) research is limited to available data. This paper analyzes six exogenous variables (black, Latino, female, research, mentoring, and educational rank) and four endogenous variables (cognitive activity, commitment, identity salience, and psychological centrality). Pascarella’s model suggests the inclusion of additional exogenous variables: measures of academic preparedness (age, first generation student, standardized test scores, high school grade point average, parents

---

3 see Rea and Parker 2005 for a full discussion of the limitations of survey research.
level of education) and institutional characteristics (faculty-to-student ratio, size of the institution, Carnegie classification, percentage of students by race and gender, and percentage of faculty by race and gender). However, in final analysis they were not significant and were dropped from the model.

The second challenge deals with time of exposure, which includes both length of time in higher education as well as the point during the life course in which the student is enrolled. Educational Status (freshmen, sophomores, etc.) at time 1 serves as a measure of time in education throughout data collection. Further treatment of time associated with the educational status variable appears in the methods section. The present study is longitudinal in design which satisfies the time ordering requirement of causality.

Third, Astin expressed concern over spuriousness. Do college students experience gains in various outcomes as a result of college or some other variable such as maturation? Astin suggests a strong study of college outcomes would include a cohort of non-college attending cases to serve as the counterfactual. Fortunately, a non-college attending counterfactual is of little concern because the identity under investigation – scientist – is a highly specialized identity requiring years of higher education and training. The time required to not only identify as a scientist but to be recognized as a scientist by others can take a minimum of twelve to fifteen years (from Bachelors to graduate school to a postdoctoral or residency) often culminating in a terminal degree: PhD or MD (Wagner 2006).

Finally, Pascarella indicated that the level of analysis was an important element in studies of higher education. Studies are divided into those that study the institution of
higher education as the level of analysis or the student as the level of analysis. The model presented here examines the student as the level of analysis, but includes institutional variables such as faculty mentoring, participate in undergraduate research, and commitment, as social structural variables that measure the environment.

*Inputs*  

Pascarella suggested that input variables are those that are unique to the student, such as demographics and ability. An extension of Identity Theory in this paper is the inclusion of a cognitive activity variable that is different from that specified by Serpe (1991) and warrants additional discussion. The behavior expectations of scientist include the development of scientific reasoning, theoretical knowledge, laboratory skills, and writing (Wagner 2006). Therefore, not only is time spent thinking about the identity important; but time spent developing the cognitive skills necessary for such a specialized identity are extremely important.

Like Serpe (1991), I suggest that such activity precedes identity salience for three reasons. First, cognitive activity in the form of scientific reasoning is a requirement for the role of scientist, that is, it is a role expectation. Second, consistent with identity theory and its symbolic interactionist roots (Stryker[1980]2003), identities are the internalization of a role. Developing an understanding of the expectations and requirements – the *meanings* -- of the role is an important requisite to role performance. Third, the role of scientist often requires a specific level of credential in order to be recognized as such. An

---

4 This section of the paper provides the theoretical argument for constructing the model. A full description of the variables is presented in Table 1 and are discussed in the Methods section of the paper.
important premise of symbolic interactionism is the naming and recognition of others as an occupant of a role position: “persons who acting the context of organized patterns of behavior, i.e., in the context of social structure, name one another in the sense of recognizing one another as occupants of positions. When they name one another, they invoke expectations with regard to each other’s behavior” (Stryker [1980]2003: 54).

*Points of Convergence – Inputs.*

Race (Owens and Serpe 2003; Stryker, Serpe, and Hunt 2005) and gender (Serpe 1987) have been shown to be important predictors of commitment and identity salience as well as college outcomes (Pascarella and Terenzini 2005). The other two input variables – educational status and cognitive activity – also represent important point of convergence. Developing Competence is Chickering and Rieser’s (1993) first vector of student development. An obvious outcome of education is the acquisition of knowledge and development of the intellect. It holds than that as a student progresses from freshman, to upper classman, to graduate student, that they have in fact acquired knowledge and developed their ability to think (for if not what is the purpose of education!). It has also been pointed out that the identity of scientist is a very specialized identity that requires knowledge acquisition and scientific reasoning. Developing competencies is thus not only a basic element of higher education; it is an important element of developing an identity of scientist. Developing competencies is represented in the new model as *educational status* and more directly as *cognitive activity.*
Environments

The environmental variables include the exogenous variables mentoring and participation undergraduate research, and the endogenous variable for commitment. The mentoring variable specifically pertains to the student having a faculty mentor in their science major. The faculty mentor is one who gives “guidance, assistance, and encouragement on professional and academic issues” (The Science Study Guidebook 2010). Minority students, who have a low propensity for attending college, lack the cultural capital to be successful in higher education (Brand and Xie 2010). Having a mentor who can act as a socializing agent can have a profound effect on student outcomes (Pascarella 1985). Participation in undergraduate research work can have similar effects, “working on an independent research project has its strongest positive correlations with attainment of a bachelor’s degree, commitment to the goal of making a theoretical contribution to science, and self-reported growth in preparation for graduate or professional school. . . . and virtually every self-reported growth measure” (Astin 1993:381).

Ones place in the social network, as measured by commitment to role others, is also conceptualized here as an environmental variable. Commitment has long been held by Identity Theory to represent the social structure. In this case the social structure is represented by the college or university of attendance. The relationships therein are comprised of faculty members and the student’s peers. Participating in undergraduate research and having a mentor increase the students’ interaction and affect with agents of socialization and should thus increase commitment and ultimately identity.
Points of Convergence – Environments.

These three variables all have one thing in common: interaction between the student and faculty, as well as interaction between the student and his/her peers, which consistently shows a positive influence on retention and other educational outcomes (Astin 1993; Tinto 1975). Tinto’s (1975) work is paramount to this discussion. His theory argued that “it is the individual’s integration into the academic and social systems of the college that most directly relates to his continuance in that college” (Tinto 1975:96). This definition is similar to Identity Theory’s definition of commitment as the extensiveness and intensiveness to others in patterns or role relationships. It would hold that if the student is engaged in research, which is typically part of a registered course guided by a faculty member (mentor?) and has a strong commitment to this relationship, that commitment could be tied to student retention. Or, adversely, student commitments as well as academic and social integration would be tied to higher identity salience.

A number of Chickering and Reisser’s vectors are applicable to this set of variables. Chief among these would be developing mature interpersonal relationships. Greater commitment to science faculty members and fellow students in their major goes hand-in-hand with the development of mature relationships. The traditional faculty-student role relationship is vertical with the faculty member lecturing and the student writing down every word as gospel in a classroom setting. The mentoring relationship between faculty and student, and the relationship developed during the research guidance process will typically take place outside of the classroom and has a less formal
relationship between faculty and student. Chickering and Reisser note that it is outside-of-class interactions, which can be more social in nature, are what is most important in the faculty-student relationship as it effects student development. The faculty member becomes more than just lecturer and adopts roles of mentor and advisor. Stryker, Serpe, and Hunt (2005) refer to this process as structural overlap: interactions with the same persons in different settings in different patterns of role relationships.

**Outputs**

The output variables are *identity salience* and *psychological centrality*. In terms of Astin’s taxonomy of outcomes, both identity salience and psychological centrality fall within the *psychological-affective* domain. First, they are both psychological in nature as opposed to behavior. Astin is clear that psychological outcomes are typically latent constructs as opposed to some directly observable action. Both salience and centrality are latent constructs. A full discussion of the constructs and the measurable variables to which they infer is discussed later in this paper.

Astin characterizes affective outcomes as the individuals’ attitudes, values, beliefs, motivations, and self-concept. Centrality is component of the self-concept (Rosenberg 1979) and is therefore considered affective-psychological. Salience is more difficult to classify as it is a cognitive schema, but not in the sense in which Astin uses the term (academic achievement, knowledge, critical thinking). The concept of identity salience is constructed as a predictor role choice behavior; therefore identities can be a motivation for behavior (Stryker 2008:28). Highly salient identities have more
motivational power than do low salient identities. For these reasons I also classify identity salience as an affective-psychological outcome.

Points of Convergence – Outputs.

Chickering and Reisser’s establishing identity vector is perhaps the most obvious point of convergence with both Stryker’s structural symbolic interactionism and Rosenberg’s self-concept theory. Rosenberg (1979) defines the self-concept as comprised of two motives: “The first is the self-esteem motive – the wish to think well of oneself. The second is the self-consistency motive – the wish to protect the self-concept against change or to maintain one’s self-picture (Rosenberg 1979:53). Aspects of one’s self that are central to the self-concept are protected in order to maintain a consistent and positive self-image. Identity Theory also maintains that stability of the self is an important motivator (Serpe 1987; Stryker 2008) and global self-esteem has been shown to influence the salience hierarchy (Owens and Serpe 2003).

Chickering and Reisser include self-esteem, stability, and integration of different aspects of the self (sexual orientation, gender, race, roles, etc.) in the establishing identity vector. Self-awareness is an important aspect of their definition of identity:

Students high on this dimension [personal stability and integration] knew the kind of person they wanted to be and had a sense of balance and perspective. They tended to see things whole, with a well-ordered set of values. They had sorted out what was important to them and were aware of their own strengths and weaknesses. (Chickering and Reisser 1993:201)

They further found that as students progressed in college their measures of stability and integration spiked during the transition from high school to college and in their final
Hypotheses

The hypotheses are arranged according to direction of effect so that each of the four endogenous variables is represented by their own set of hypotheses. Although race is of key concern in this analysis, no predictions are made as to direction or influence. Likewise, no predictions are made in relation to gender.

Cognitive Activity. Participation in undergraduate research develops the intellectual skills necessary for the scientist identity, therefore, it is expected that participation in undergraduate research will positively affect cognitive activity. Upper classman and students who attend graduate school are more likely than freshman or sophomores to participate, or have participated in undergraduate research, furthermore, more advanced students should have more developed intellectual skills; therefore educational status will positively affect cognitive activity.

Hypothesis 1a: Engaging in undergraduate research will have a positive effect on cognitive activity.

Hypothesis 1b: Greater educational status will have a positive effect on cognitive activity.

Commitment. The more time that students spend in role relationships with peers and their faculty members the stronger those relationships become; therefore, educational
status will positively affect commitment. Similarly, participation in undergraduate research increases the time the science student spends in the laboratory with faculty and other students; therefore, participation in undergraduate research will positively affect commitment. Students with a faculty mentor will spend more time with their mentor in multiple role relationships (structural overlap); therefore mentoring will have a positive effect on overall commitment through the influence of faculty affective commitment.

Hypothesis 2a: Engaging in undergraduate research will have a positive effect on commitment.

Hypothesis 2b: Greater educational status will have a positive effect on commitment.

Hypothesis 2c: Mentoring will positively affect commitment.

*Psychological Centrality.* Activities that strengthen the students sense of self as a scientist will positively influence the importance of the scientist role, or psychological centrality: participation in undergraduate research (learning the ‘work’ of scientist); educational status (committing more of ones resources to achieving the role of scientist); cognitive activity (learning to intellectual skills of the scientist); commitment (building the social structural to support the role of scientist).

Hypothesis 3a: Engaging in undergraduate research will have a positive effect on psychological centrality.

Hypothesis 3b: Greater educational status will have a positive effect on psychological centrality.
Hypothesis 3c: Cognitive activity will have a positive effect on psychological centrality.

Hypothesis 3d: Commitment will have a positive effect on psychological centrality.

Identity Salience. The same activities that affect psychological centrality will affect identity salience for the same reasons.

Hypothesis 4a: Engaging in undergraduate research will have a positive effect on identity salience.

Hypothesis 4b: Greater educational status will have a positive effect on identity salience.

Hypothesis 4c: Cognitive activity will have a positive effect on identity salience.

Hypothesis 4d: Commitment will have a positive effect on identity salience.
CHAPTER 3

METHODS

Structural equation modeling (SEM) is used to demonstrate the relationship between the input, environment, and output variables. The model that is presented in this analysis is represented as Figure 2. The model follows the classic Identity Theory design with commitment preceding identity salience and psychological centrality (Serpe 1987; Stryker & Sepe 1994). The model also follows the approach outlined by Pascarella (1985) by including individual, environmental, and outcome variables.

The data come from The Science Study, a nationwide, longitudinal study of minority science students. A panel of 1420 minority science undergraduate and graduate students were recruited from over 48 colleges and universities in the United States. The study currently has eight waves of data. Wave one data was collected in the spring semester 2006 with each wave constituting subsequent fall and spring semesters (data were not collected fall 2008 or spring 2009). Data for the present student were analyzed from waves two (fall 2006), five (Spring 2008) and six (Fall 2009). For the sake of simplicity, these three waves will simply be referred to as Time 1 through Time 3 respectively.

These particular waves were chosen for several reasons. First, causal inference requires temporal ordering of cause-effect. The longitudinal design meets this condition. Second, two important components of identity theory are also established through the
Figure 2: Structural Model: including standardized regression coefficients and fit statistic

Time 1          Time 2          Time 3

Female          
Black           
Latino          
Education status 
Mentor          
Research        

Commitment

Psychological Centrality

Identity Salience

Cognitive Activity

Fit Statistics:
N = 1420
Chi-sq. = 390.91
Df = 264
Chi-sq/df=1.48
RMSEA: = .031
passage of time – role choice and stability of the self (Serpe 1987). Students who continue to choose the science student identity will establish greater stability of self by ensuring academic advancement. Freshmen at Time 1 should be juniors by Time 3 if they progress at the expected rate. Students who began time one as upper classmen may have advanced to graduate school and graduate students will have further acclimated into the life of a scientist. The third, and perhaps the most practical reason for selecting these waves, is that the data of interest were collected during those waves.

Due to the longitudinal nature of the study there is missing data. After listwise deletion there are only 307 cases with information on each variable for each of the waves of data. Using AMOS graphics 19, stochastic regression was utilized to impute missing data (Little and Rubin 2002). Stochastic regression is a multiple imputations method in which missing values are imputed with randomly drawn known values and unknown parameter values are set equal to the maximum likelihood estimates. This procedure was completed 10 times creating 10 new complete data sets. Each data set was then merged so that one data set of 1420 cases was created. Unknown model parameters were set using maximum-likelihood estimates.

Table 1 displays the descriptive statistics for all variables utilized in this study and Table 2 provides the coefficients. Data collected during Time 1 (T1) constitutes the exogenous variables in study: demographic information (race and gender), the students’ current educational standing (sophomore, junior etc.), whether or not the student has a faculty mentor, and participation in research. Time 2 (T2) variables include cognitive
Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>.74</td>
<td>.44</td>
</tr>
<tr>
<td>Black</td>
<td>.45</td>
<td>.50</td>
</tr>
<tr>
<td>Latino</td>
<td>.43</td>
<td>.49</td>
</tr>
<tr>
<td>Faculty mentor (q32_2)</td>
<td>.59</td>
<td>.49</td>
</tr>
<tr>
<td>Undergrad Research (erexp_2)</td>
<td>.67</td>
<td>.48</td>
</tr>
<tr>
<td>Current Educational Status (q17-2)</td>
<td>3.64</td>
<td>1.34</td>
</tr>
</tbody>
</table>

Table 2: Unstandardized path coefficients with standard errors and standardized coefficients for SEM

<table>
<thead>
<tr>
<th></th>
<th>Commitment</th>
<th>Cognitive Activity</th>
<th>Psychological Centrality</th>
<th>Identity Salience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.130**(.042)</td>
<td>-.122*** (.010)</td>
<td>-.135*** (.019)</td>
<td>-.054(.044)</td>
</tr>
<tr>
<td>Standardized</td>
<td>.029</td>
<td>-.107</td>
<td>-.054</td>
<td>-.010</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.299***(.061)</td>
<td>.020 (.015)</td>
<td>.029 (.027)</td>
<td>.160* (.064)</td>
</tr>
<tr>
<td>Standardized</td>
<td>.074</td>
<td>.020</td>
<td>.022</td>
<td>.032</td>
</tr>
<tr>
<td>Latino</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.309***(.062)</td>
<td>.103*** (.015)</td>
<td>.235*** (.027)</td>
<td>.509*** (.065)</td>
</tr>
<tr>
<td>Standardized</td>
<td>.075</td>
<td>.098</td>
<td>.102</td>
<td>.098</td>
</tr>
<tr>
<td>Mentor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.868***(.040)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized</td>
<td>.214</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.237***(.040)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized</td>
<td>.058</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td>.095***(.015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized</td>
<td>.016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commitment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstandard. (SE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
activity and commitment. Time 3 (T3) constitutes the outcome variables identity salience and psychological centrality.

Race is included as both Latino and Black, each is a dichotomous variable in which 1 represents Latino or Black respectively. Female is also dichotomous with females being 1 and male being zero. Research is a dichotomous measure of whether or not the student has participated in undergraduate research. Educational status at Time 1 is coded 1 for freshmen, 2 for sophomore, 3 for junior, 4 for senior, 5 for master’s level, 6 for PhD level, and 7 for MD. Eighty percent of the respondents were undergraduates with more than two-thirds of all respondents being upper classmen (juniors or seniors). The average age of the students in this study is 22 suggesting that the majority of students in the study are of traditional age (18-22 years old as undergraduates)\(^5\). Therefore, educational status also serves as a proxy for life course stage. The following sets of variables are each latent constructs. Appendix A lists all of the measured variables that are explained by each latent construct.

Cognitive activity is a latent construct including four items from the Deep Processing scale and a single item from the Task Goal Orientation Scale. Cronbach’s alpha for these items is .822. Each of the five items asks the student to relate their feelings about themselves as a student with 1 being strongly disagree and 5 being strongly agree. The task goal orientation question states “I like school work best when it

\(^5\) A cross tab analysis of age and current educational status demonstrated that the majority of students were traditional aged: 56% of freshmen were 18 years of age; 77% of sophomores were 18 or 19 years of age; 60% of juniors were 19 or 20 years of age; 63% of seniors were 20-22 years of age. The age distribution for graduate students had greater variance: 76% of master’s level students were 21-27 years of age; and nearly half of doctoral students and medical students were 24-27 years of age. The oldest student at time 1 was 46 years of age and the youngest person was 15 years old.
really makes me think.” The four Deep Procession items state “When a theoretical point or conclusion is presented in lecture or in the text, I try to decide if there is good supporting evidence.” “I treat the course material as a starting point and try to develop my own ideas about it.” “Whenever I read or hear a theoretical point in a course, I think about possible alternatives.” “I try to think through topics and decide what I’m supposed to learn from them, rather than studying topics by just reading them over.”

*Commitment* is a latent construct that includes two measures of affective commitment. Affective commitment is the depth or closeness of relationships associated with a particular identity and is measured by the feelings associated with the loss of these relationships. In the case of the student identity, there are two different groups of role alters that are important: other students and faculty. Therefore, the commitment variables are comprised of a measure of affective commitment to other science students and affective commitment to science faculty. The affective commitment measures are both scaled items combining three items on a likert-type scale with 1 indicating no effect of loss to 10 being a great effect at the loss of the relationships. The items ask “how much would you miss other (science students/faculty) if you were not able to spend time or communicate with them?” “How close are you (in personal and emotional terms) to other (science students of faculty)?” and finally “How important are other (science students/faculty) to you?” Cronbach’s alpha for affective commitment - faculty is .845 and .894 for other science students.

*Identity Salience* is a latent construct comprised of four variables that seek to know how the respondent feels about themselves as a scientist. Each of the four identity
Salience questions ask “how certain is it that you would tell [a coworker, friend of a friend, person of the opposite sex, friend of a family member] about your desire to be a scientist?” Each question uses an 11 point scale with zero being “certainly would not” to 10 “certainly I would.” The Cronbach’s alpha for identity salience is .972.

*Psychological Centrality* is the final endogenous variable in the model and along with *Identity Salience* are the dependent variables of interest. Psychological Centrality addresses how the respondent thinks about themselves and their scientist identity. There are nine items to which Psychological Centrality is the latent construct and each item is scored on a five-point scale with 1 being “strongly disagree” and 5 being “strongly agree.” A few examples of items are “Being a scientist is an important reflection of who I am;” “The daily work of a scientist is appealing to me;” and “In general, being a scientist is an important part of my self-image.” Psychological Centrality has a Cronbach’s alpha of .952. The scaled versions of psychological centrality and identity salience correlate at .689. Thus the error terms are correlated in the model.
CHAPTER 4

RESULTS

The model under review is an over-identified model with 377 sample moments and 113 parameters to be estimated. The chi-squared is 390.91 (264 df). The goodness of fit statistics generally show that the model fits the data well. The chi-squared/df ratio is 1.48. Key goodness of fit statistics are included in Figure 1.

The Root Mean Square Estimate of Approximation (RMSEA) addresses how well the data fit the population being analyzed. RMSEA values of less than .5 indicate that the data fit the population well (Byrne 2010). In the present study, the RMSEA is .31 and falls within the 90% confidence interval.

Hoelter’s Critical N indicates whether or not the sample is of adequate size for the model. The results suggest that for the model to be significant at the .05 level, the sample size should be 1101, and at the .01 level the sample size should be 1164. Given the present sample size of 1420, the present sample is more than adequate.

The first set of hypotheses are related to cognitive activity are supported for educational status, Latino, and research, each were positively associated and statistically significant at the .001 level. Female was also significant at .001 level, but was negative, suggesting that men engage in cognitive activity more than women. Being black did not contribute to level of cognitive activity. These findings suggest that as Latino and male
students advance (from freshman, to sophomore, etc.) their level of cognitive activity increases. Recalling the individual items of the Cognitive Activity factor, (see Appendix A) it is clear that as students advance in level, so does their commitment to learning and to thinking about knowledge: seeking supportive evidence, developing their own theories, and looking at alternatives.

A common explanation for this pattern is often associated with involvement in undergraduate research. The bivariate correlation between educational status and research is positive and significant (.138). The model covariance for these two variables is .086 and although small is greater than any of the other covariances among the independent variables. The standardized regression coefficients for involvement in undergraduate research (.129) and educational status (.118) on cognitive activity are also both high in relation to the other variables: Latino (.098) and female (-.107). I also examined the total standardized direct effects of educational status (.118) on cognitive activity, and research on cognitive activity (.129). These direct effects were greater than all of the other Time 1 variables except for the effects of mentoring on commitment (see below). In sum, the longer the student remains in the sciences -- increased educational status – the more likely they are to participate in research and to increase their levels of cognitive activity related to their scientist identity.

The second set of hypotheses is related to the variables contributing to Commitment. All six of the exogenous variables are positive and significantly contribute to commitment. Both Blacks and Latinos demonstrated a desire to spend time with, were personally close to, and considered faculty and other students related to their student-
scientist identity as important. Females also shared closer affection towards their faculty and peers in the sciences than did males. Educational status and undergraduate research also contributed to commitment but were not as strongly associated as they were with cognitive activity. The influences of the latter two variables on commitment are likely due to time in role. Serpe and Stryker (1987) demonstrated that “a stable self is the product of stable commitments” (46). The self seeks stability by fostering social relationships that support the self. Upper classman, who are also more likely to participate in research, have had more opportunities to spend time with peers and faculty in role related activities (in the classroom, in the lab, or during office hours) to strengthen commitment, thus stabilizing the self.

As further evidence of the importance of strong social ties, the most important contributor to affective commitment was having a faculty mentor (.868). Mentoring often involves multiple one-on-one interactions between the student and a faculty member. Mentoring is most effective when the mentee comes to see the mentor as a role model. Such figures certainly can become an important figure for the student as they develop their identity as a scientist. It is also very likely that mentors also encourage and guide a student’s research. The bivariate correlation between mentoring and undergraduate research is .278 and model covariance is .068, both are significant.

Mentoring, educational status and research have such a strong influence on commitment because of the structural overlap present in these three activities (Stryker, Serpe, Hunt 2005). In addition to the traditional faculty-student relationship, the mentor-mentee and the researcher-research assistant relationships represent two additional
contact points between the student and faculty member. Each relationship carries slightly different role expectations. Stryker, et al. (2005) contends that these structural overlaps build trust between the participants, thereby increasing the affective commitment of the relationship. In sum, for minority science students, affective commitment is influenced most heavily by having a science faculty mentor, being a more advanced student, and participating in research.

The third set of hypotheses involved the influences on psychological centrality. Being Black was the only variable examined that did not have an effect on psychological centrality. Being female, Latino, educational status, research, commitment, and cognitive activity were all statistically significant. Consistent with the above findings, being female was negatively related to centrality, indicating that men hold their scientist identities more central to their self-concept than do women. Later in the discussion I will examine the gender differences more fully.

The effects of commitment on centrality are consistent with previous research (Stryker and Serpe 1994). In the present study, I find that holding a self-concept of scientist is tied to the affective commitment associated with peers and professors. One of the items in the psychological centrality scale includes “my social network includes a lot of scientists and/or science students” demonstrates the importance of role others. In fact, the regression coefficient from commitment to centrality was the single greatest effect in the structural model (.551). The effect of commitment on identity salience was slightly less at .428.
The relationship between cognitive activity and psychological centrality is not surprising for this population. Students, who engage in higher education, expending vast resources in the process, and are highly committed to achieving a self-concept and identity of scientist, would naturally engage in the type of cognitive activity required of the identity. I hypothesized that cognitive activity, developing the necessary intellectual skills necessary for the identity, occurs prior to the adoption of a self-concept of scientist (psychological centrality). It could be argued that these two variables occur simultaneously, or in the inverse order. However, one could not honestly answer the question “I have come to think of myself as a scientist” from the psychological centrality scale, if one has not first developed the prerequisite scientific reasoning. This also explains both the direct and indirect effects of research and educational status on centrality. The self-concept is solidified through participating in role relevant activity (research) and successful execution of the student-scientist role (advancing in educational status), both of which have already been shown above to effect commitment to role others and to cognitive activity.

The final set of hypotheses pertains to Identity Salience. Both being Black and Latino significantly contribute to the identity salience of scientist. Female was not significant indicating gender does not influence identity salience. Research and educational status are both significant predictors of identity salience. As expected, and consistent with Identity Theory (Stryker [1980]2003; Serpe 1987), affective commitment is significantly related to identity salience. However, contrary to expectations, cognitive activity is not a significant predictor of identity salience in this study.
Identity salience, as a measure of the structure of the self, is strongly associated with the social structure and the proximity to role others (Stryker, Serpe, Hunt 2005): other science students and professors. The intimate ties that are created and developed through the educational process (research, educational status, mentoring) and are demonstrated through commitment stabilize one’s identity so that it may be invoked across situations. Commitment’s standardized effect on identity salience (.428) is the second strongest effect in the structural model aside from the effects of commitment on centrality (.551). Research and educational status have both direct and indirect effects on identity salience through commitment.

The previous research linking cognitive activity and identity salience differs from the present study in two important ways and may explain the differing results. First, cognitive activity in the Serpe (1991) study was consistent with Stryker’s (1968) original formulation and conceptualized cognitive activity as thinking and planning about a specific identity; whereas the present study combined measures from a goal orientation scale and a study strategies scale measuring deep processing. In short, the present study conceptualized cognitive activity as scientific reasoning/intellectual skills rather than time spent thinking about being a scientist. Second, identity salience was measured differently in the two studies. The former study used a paired-comparison scaling in which subjects were asked to rank order identities. The later study used a probability measure of invoking an identity across situations to measure salience. The different conceptualizations and measurements for these two variables, in addition to the different samples studied, may account for the discrepancy in the findings.
Although mentoring was not examined for direct effects on either centrality or salience, it does have an indirect effect (.092) on identity salience through commitment. Theoretically, having a faculty mentor would not directly affect one’s choices to invoke an identity in situations in which the faculty mentor would not have an influence. Telling a friend of a friend about being a scientist would not be effected directly by a faculty mentor (unless perhaps the mentor facilitated the meeting). However, as discussed above, having a faculty mentor has a strong association with affective commitment which has a strong effect on salience. Thus, mentoring indirectly affects identity salience.

Race.

Being Latinos or Black contributes to the affective commitment and identity salience of scientist, I believe that the identity of scientist, is a point of pride for these minority groups and they are happy to invoke this identity across situations. As underrepresented populations in higher education in general, and more so in STEM fields, achieving an identity of scientist represents an achievement most of their family and friends will not achieve. Popular culture has long held “scientist” as synonymous with “best and brightest”. Einstein, Newton, Darwin, Edison, and Hawking are all recognizable scientists. Scientists are the space explorers, the curers of disease, creators of knowledge and understanding, and the inventors of technologies that most of the population does not understand. To be considered among this group would bring a tremendous amount of pride. Although this sense of pride and esteem seems to affect identity salience, for blacks it does not affect psychological centrality, an aspect of the self-concept. This line of rationale deserves further attention in future studies.
Mentoring contributed positively to the development of affective commitment, but mentoring correlated negatively with Latinos (-.073) suggesting that it was not helpful; whereas for Blacks, mentoring was more important (.053) and likely contributed to the development of affective commitment. Schultz et al. (2010) found that mentoring was not an important contributor to student persistence and Merolla et al. (in progress) found that identity salience predicted persistence. The exact role that mentoring plays in regards to identity and persistence is still unclear; but it does operate differently for Blacks and Latinos.

**Gender.**

The females in this study had a negative association with psychological centrality and identity salience was not significant. This suggests that women do not hold the scientist identity as a core aspect of their self nor do they carry the scientist identity with them across situations. Females also had a negative association with cognitive activity. This finding indicates that males are more likely to engage in the type of learning and ways of knowing that are consistent with scientific reasoning. Also supporting the literature is the positive relationship with commitment. Females are more likely to develop strong social ties with faculty members and peers, compared to males.

This study supports the traditional gender role bias explanation found in the literature on females in the sciences. Sprague and Zimmerman (2004) argue that positivism, the hallmark of the natural sciences, is grounded in objective, rational, abstract and quantitative ways of thinking and knowing. A feminist epistemology,
“give[s] priority to actors’ own subjective experience and emphasize the emotional aspects of social life grounded in concrete, daily experiences. For them data must be qualitative in order to reveal these aspects” (Sprague and Zimmerman 2004; 39). As evidence of this pattern, females account for 77% of psychology degree recipients and over half of other social science degrees in 2008 (NSF 2008). These fields are less likely to use positivist perspectives and more open to qualitative research designs. Strong mentoring and a more “social” laboratory experience are likely ways to increase the number of women in the natural sciences.

**Future Research**

The design of this study did not allow for a direct comparison of how Blacks and Latinos differed with respect to the exogenous variables. To compare the two races, nested models in which one model consisted of only Blacks and a second model consisting of only Latinos would need to be analyzed. This analysis would also distinguish between Black and Latino females. In the current analysis, females were treated as a single population that did not vary by race.

A second extension of the current project could further analyze the cognitive activity variable and its time-order relationship to identity salience and psychological centrality. It was theorized in this study that cognitive activity precedes the identity measures, however it is likely that a reciprocal relationship exists.

Third, a number of controls should be implemented in the model including: (a) controlling for educational status throughout each wave to distinguish between
continually enrolled students and students who stop-out; (b) similarly controlling for the
students major at each wave will reduce the noise associated with identity salience and
psychological centrality; (c) controlling for participation in science training programs for
minorities will also shed light on mentoring, undergraduate research, and the impact of
financial aid on identity; (d) finally, controlling for type of institution may also produce
important identity based results. For example, Blacks attending historically black colleges
and universities may perform differently than students at predominantly white schools.
The same may be true for Hispanic serving institutions and all-women’s schools.

Fourth, Additional self-concept measures may clarify the roles that identity
salience and psychological centrality play in identity processes and student persistence.
Specifically, why do blacks not hold the scientist identity central to their self-concept, but
do invoke their scientist identity across situations. Other measures of the self-concept
would need to be analyzed including specific and global self-esteem, social comparisons
and self-attributions. Measures of self-efficacy may also shed light into why blacks were
not significantly associated with cognitive activity. The cognitive activity measures
implied a sense of confidence in relation to mastering course materials, theories and
knowledge. A strong sense of efficacy may be required to question professors, text books,
and theories and to develop one’s own ideas and to see them as legitimate.

Fifth, further investigation into the types of mentoring that occurred can shed
more light into this association: was the mentor of the same race or gender? How often
did the pair meet? What was the nature of the relationship? Did the student conduct
research with their mentor? Where there other structural overlaps between mentor-
mentee? Knowing whether a mentor was a faculty or staff (e.g. academic advisor, residence hall director, student activities coordinator), or a peer mentor has important consequences for commitment, cognitive activity, and other identity processes. Faculty members who also guide student’s research and advise them academically, financially, or personally will have important structural overlap effects that a student affairs professional or peer-mentor may not have.
CHAPTER 5

CONCLUSION

This paper set out to determine the factors that influence the self-concept of minority and female science students. To do so, I relied upon the theory and causal modeling of the effects of higher education on students. I further utilized Identity Theory to frame the structure of the self. Identity Theory was perfectly positioned for this analysis because the basic assumptions of its structural symbolic interactionist roots included the assertion that society affects the self, and the self recreates society. By replacing identity salience and psychological centrality with typical student outcomes (gpa, graduation rates, job placement, cognitive development, psychosocial development etc.), I was able to show that the student is both a product and an agent of higher education.

In the present study, societal influences were represented by aspects of higher education known to influence student development outcomes. These included the influence of faculty members and other students, especially those relationships that permitted structural overlap (mentoring). The availability of, and opportunity for, undergraduate research and the general collegiate environment that facilitates intellectual development were also important structural components in this analysis.
Conversely, individuals in this study were not simply products of higher education, but were active agents in creating their social structure and their identities as scientists. The student as agent was achieved through the principle of choice: by participating in undergraduate research projects, expending personal resources and capital to advance their student standing, and engaging with faculty mentors, students were able to develop patterns of relationships in the form of commitments that constructed their proximate social structures. By actively developing their cognitive skills students became agents for building their own identities as scientists.

The study also successfully extended Identity Theory by incorporating a measure of cognition. This measure examined cognition as a necessary component to a highly specialized identity. Identities have role expectations, and highly specialized identities that require years of training and certification (Ph.D.) are especially so. In this longitudinal study, in which educational status was measured, I was able to ascertain the positive influence of intellectual skill development as a necessary component of the identity of scientist. This line of research can further be extended by measuring cognitive activity and salience multiple times. I expect the relationship to be similar to the relationship between commitment and salience, at each measurement a positive gain in each measure.

There were clear patterns of difference between the two minority groups examined in this study and between men and women. Consistent with gender stereotypes, females established stronger relationships with faculty and peers, but did not develop an identity of scientist to the same extent than men did, nor did they develop the cognitive
skills consistent with the scientist identity. Specific interventions for female science students should capitalize on commitment’s influence on salience by encouraging a lab team approach as opposed to the individual researcher approach. By increasing the emphasis on cooperative learning females can better utilize their strengths in order to contribute to scientific investigation and discovery.

It is unclear why being Latino influenced cognitive activity and identity salience, while being Black did not. However, we can state with confidence that interaction with faculty and peers through research projects and mentoring does have an important influence on commitment and centrality for both groups. Future research topics were discussed above and a closer examination of those items will lead to better understanding of how identity processes can increase participation of all minority groups in the sciences. Greater participation in such a high status group can work to erode structural inequalities in our society.
REFERENCES


----- . 2008. “From Mead to a Structural Symbolic Interactionism and Beyond.” Annual Review of Sociology 34:15-31


APPENDIX A

SURVEY ITEMS

Cognitive Activity
Yourself as a Student: The next set of questions also relate to your feelings about yourself as a student. Please select the best answer on the scale from 1(strongly disagree) to 5 (strongly agree).
Q110c: I like school work best when it really makes me think
Q113a: When a theoretical point or conclusion is presented in lecture or in the text, I try to decide if there is good supporting evidence.
Q113b: I treat the course material as a starting point and try to develop my own ideas about it.
Q113c: Whenever I read or hear a theoretical point in a course, I think about possible alternatives.
Q113e: I try to think through topics and decide what I’m supposed to learn from them, rather than studying topics by just reading them over.

Affective Commitment- Other Science Students
Yourself as a Scientist: The following questions relate to how you feel about yourself as a scientist. For the purposes of this study when you see the word scientist it is intended to mean a professional undertaking research activities in your area of study (e.g. a biologist or a research psychologist).
0= miss them not at all, 10= miss them a great deal
Q93a: How much would you miss other science students if you were not able to spend time or communicate with them?
Q94b: How close are you (in personal and emotional terms) to other science students?
Q93c: How important are other science students to you?

Affective Commitment- Science Faculty Members
Q95a: How much would you miss science faculty member if you were not able to spend time or communicate with them?
Q95b: How close are you (in personal and emotional terms) to science faculty members?
Q95c: How important are science faculty members to you?
Psychological Centrality
The following questions ask how you think about yourself and your personal identity. We want to understand how much you think that being a scientist is a part of who you are. For the purposes of this study when you see the word scientist it is intended to mean a professional undertaking research activities in your area of study (e.g. a biologist or a research psychologist).
1= strongly agree, 5= strongly disagree
Q91a: In general, being a scientist is an important part of my self-image.
Q91b: Being a scientist is unimportant to my sense of what kind of person I am.
Q91c: I have a strong sense of belonging to the community of scientists.
Q91d: I derive great personal satisfaction from working on a team that is doing important research.
Q91e: Being a scientist is an important reflection of who I am
Q91g: I have come to think of myself as a “scientist.”
Q91i: I feel like I belong in the field of science.
Q91j: Thinking of myself as a scientist is compatible with other aspects of my background (ethnicity, gender, social class, etc.)
Q91m: The daily work of a scientist is appealing to me.

Science Identity
Yourself as a Scientist: The following questions relate to how you feel about yourself as a scientist. For the purposes of this study when you see the word scientist it is intended to mean a professional undertaking research activities in your area of study (e.g. a biologist or a research psychologist).
0= certain I would not, 10= certain I would, 12= I am no longer considering science as a career
Q90a: Think about meeting a coworker for the first time. How certain is it that you would tell that person about your desire to be a scientist?
Q90b: Think about meeting a person of the opposite sex for the first time. How certain is it that you would tell this person about your desire to be a scientist?
Q90c: Think about meeting a friend of a family member for the first time. How certain is it that you would tell this person about your desire to be a scientist?
Q90d: Think about meeting a friend of a family member for the first time. How certain is it that you would tell this person about your desire to be a scientist?