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On the Cover: McNair Scholar Amber Wiewel Major, Journalism/Photo
My sincere congratulations to all the MU undergraduates who participated in the McNair Scholars Program during the 2005-2006 academic year. Under the careful guidance and support of a faculty mentor, each student was intensely engaged in over a year’s worth of research or scholarly activity. The papers presented here represent the culmination of the hard work, dedication and energy put forth by both the scholars and the mentors. This publication is interdisciplinary; therefore, it reflects a variety of topics and writing styles specific to the scholars’ disciplines which allows for a rich and interesting reading experience. Six were chosen to be presented in their entirety. Many other strong contributions are listed in this publication. All participants are to be commended for their enthusiasm towards discovery and their commitment to pursue an advanced degree.

The McNair Scholars Program is a University wide effort attracting student and faculty from an array of academic departments. Since 1989, students have had the opportunity to learn about the importance and excitement of graduate education and gain the skills and tools needed to successfully apply for and excel in advanced studies. The program strives to mirror the example of high standards and perseverance set in the memory and legacy of astronaut and scientist, Dr. Ronald E. McNair. The participants, faculty mentors and the program staff are united in the intent to begin building the foundation for these emerging scholars to have a strong and flourishing academic future.

Although the papers written by these students truly do reflect the end product of the research and scholarly process, the papers also represent the start of the next phase of their educational journeys. We are proud to highlight the work of these talented young researchers in the fourteenth edition of the MU McNair Journal. Our best wishes as they begin to shift from learners charged with obtaining knowledge to scholars engaged in producing knowledge.

Brian L. Foster
Provost
Background

College students who are considering study beyond the baccalaureate level realize their dreams through the McNair Scholars Program at the University of Missouri-Columbia (MU). MU was one of the original fourteen universities selected to develop a program established by the U.S. Department of Education and named for astronaut and Challenger crew member Ronald E. McNair. The purpose of the program is to provide enriching experiences that prepare eligible students for doctoral study.

Program Elements

One of the most exciting aspects of the McNair Scholars Program is the opportunity for junior or senior undergraduate students to participate in research experiences. McNair Scholars receive stipends to conduct research and engage in other scholarly activities with faculty mentors from the areas in which they hope to pursue graduate study. These research internships are either for the academic year or for the summer session and are under the supervision of faculty mentors. For academic year internships, students work a minimum of ten hours per week during the fall and winter semesters. Summer interns work full-time for eight weeks.

McNair Scholars also attend professional conferences with their mentors, go to graduate school fairs, prepare for graduate school entrance exams, receive guidance through the graduate school application process and obtain information on securing fellowships, graduate assistantships, and loans. Participants learn about graduate school life, advanced library skills, and effective ways to present their work. At the completion of the research internships at MU, McNair Scholars make formal presentations of their research to faculty and peers at the McNair Scholars Conference and submit papers summarizing their work. Students who participated as juniors the previous year continue in the program during their senior year for graduate school placement and to further develop their skills.

Eligibility

Participants must meet grade point average standards; be U.S. citizens or permanent residents; and qualify as either a first generation college student with an income level established by the U.S. Department of Education, or a member of a group that is underrepresented in graduate education.

All students who wish to be involved submit an application to the program. A committee composed of faculty members and representatives from both the graduate dean’s office and the McNair Scholars Program selects participants and approves faculty mentors. Research internships are offered to those students who are juniors or seniors and are identified as having the greatest potential for pursuing doctoral studies.
Background

The United States over the past 24 years has experienced a 400% increase in the prison population. Federal and state prison populations rose from 330,000 in 1980 (Lynch & Sabol, 2001), to over 2 million in 2004 (US Department of Justice, 2005). Having been so successful on the “get tough on crime” agenda, the public’s attention has now turned to the over 600,000 offenders released to our communities each year (Visher & Travis, 2003). Research shows over a three year period 7 of 10 offenders will be rearrested and over 50% will return to prison. President Bush, in his 2004 State of the Union Address proposed a broad new reentry initiative, saying, “We know from long experience that if they [ex-offenders] can’t find work, or a home, or help, they are much more likely to commit crime and return to prison.” The fact is, very little is known about how to manage the enormous number of individuals reentering society, how ex-prisoners can effectively be reabsorbed into our communities (Lynch & Sabol, 2001), on how post-incarceration education impacts the reentry process. Presently lacking effective methods to prepare individuals for society, our nation can expect to continue to pay for re-incarceration costs, be victimized by repeat offenders, and operate without the tax revenue generated by gainfully employed ex-offenders.

One significant factor in the reentry process, and the prison population as a whole, is educational attainment. Prison populations are less educated than the general population. The U.S. Department of Justice reported 41% of state and federal prisoners do not have a high school diploma (or equivalent) compared to 18% of the general population (Wolf Harlow, 2003). Minority rates are highest; blacks (44%) and Hispanics (53%). Correctional education programs have been instituted to help inmates develop the skills necessary to function within the prison industry along with employment after their release. Dating back to 1789 in Philadelphia’s Walnut Street Jail (Gehring, http://www.ibiblio.org/icea/history.htm), correctional education is nothing new. Research has repeatedly shown an inverse relationship between level of education and recidivism (Mace, 1978; Holloway & Moke, 1986) a finding which supports education within correctional institutions. The ultimate goal of correctional education is to help inmates become self-sufficient so they can reenter society as law abiding, productive citizens and family members. Findings from the Three State Recidivism Study in 2001 indicated that participation in correctional education programs reduced the probability of incarceration by 29% (Steurer, Smith, & Tracy, 2001). A study of seven Alabama colleges providing correctional education to prisoners reported even more significant findings with college graduate’s recidivism rates at 5% (Gainous, 1992). College courses however are being cut from educational programs in state prisons. Over 31% of state prisons offered college courses in 1995 compared to 26.7% in 2000. Federal prisons have increased their post secondary educational opportunities from 68.8% to 80.5% over the same period (Wolf Harlow, 2003).

A tremendous gap in the literature exists in the relationship between post-incarceration educational achievement and recidivism. Over 80% of state and federal prisons offer basic adult education (Wolf Harlow, 2003) placing offenders in an opportune position to pursue further education upon their release. Ex-prisoners when they leave prison often demonstrate

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Dan is a junior originally from Rocky Mount, MO. who has recently been awarded the Fortnightly Club scholarship. His campus activities include being a member of National Society of Collegiate Scholars and Golden Key International Honor Society. In addition, to finishing his social work degree this December, Dan plans to continue researching his McNair topic before pursuing a graduate degree in Social Work.

Anne Dannerbeck, PhD, Mentor
School of Social Work

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Daniel Hanneken

Practical Solutions: Understanding and Addressing Offenders Post-Incarceration Educational Opportunities and Challenges

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Dan is a junior originally from Rocky Mount, MO. who has recently been awarded the Fortnightly Club scholarship. His campus activities include being a member of National Society of Collegiate Scholars and Golden Key International Honor Society. In addition, to finishing his social work degree this December, Dan plans to continue researching his McNair topic before pursuing a graduate degree in Social Work.
Offenders’ educational plans upon release were then compared with what offenders would do if given the opportunity (Table 2). It was found 38.1% planned to pursue a post-secondary education and 34.3% were thinking about it. When given the opportunity, twice as many participants would attend education and 34.3% were thinking about it. When given the opportunity, twice as many participants would attend education. A mean score of 4.41 was calculated as a majority of participants (72.9%) reported they would benefit “very much”. Given four choices offenders reported “more education” would help them get the job they want most (54.7%) over “better work skills” (14.7%), “better work skills” (14.7%), or “better people skills” (14.7%).

A Pearson chi-square analysis was conducted to identify the relationship between low (1 or 2 times in prison) to high rates (3-10) to better understand recidivism rates. A chi-square analysis was conducted to identify the relationship between education and recidivism. Short answer responses were then coded and recorded to further elucidate themes emerging from quantitative analysis.

Results

As in previous studies of offender populations, the sample shows a disproportionately low level of educational achievement when compared to mainstream society. While just over half (52.5%) have a high school diploma or equivalent, many did not have a high school education (34.3%). Post-secondary educational achievement included “technical school certificates” (3.0%), “some college” (7.1%), and “college degrees” (1.0%). On a scale of 1-5 offenders were asked to rate the expected benefit of more education. A mean score of 4.41 was calculated as a majority of participants (72.9%) reported they would benefit “very much”. Given four choices offenders reported “more education” would help them get the job they want most (54.7%) over “better work history” (27.4%), “better work skills” (17.9%), or “better people skills” (14.7%).

A Pearson chi-square analysis was conducted to identify the relationship between low (1 or 2 times in prison) and high (3 to 10 times) rates of recidivism, and educational achievement (high school or less vs. more than high school). A statistically significant (p=.042) negative correlation between recidivism and educational achievement was identified (Table 1). Twenty one of the respondents have been to prison 1 or 2 times and are much more likely to have at least some post-secondary education over offenders who have been to prison 3-10 times (n = 76).

Offenders’ educational plans upon release were then compared with what offenders would do if given the opportunity (Table 2). It was found 38.1% planned to pursue a post-secondary education and 34.3% were thinking about it. When given the opportunity however, twice as many participants would attend
a technical school (23.7% vs. 46.3%) and over four times as many would attend college (14.4% vs. 55.2%). Some offenders reported an interest in both technical and academic pursuits. Of the 34% of the sample without a GED, 19.6% plan to obtain an equivalency diploma, an additional 3.3% would do so if given the opportunity. The number of offenders not interested in pursuing a post-incarceration education dropped from 13.1% to 5.2% when presented with an educational opportunity.

Open ended responses indicated the single greatest obstacle preventing offenders from pursuing a post-incarceration education was funding (47.3%). Other recurring responses included transportation (10.8%), cognitive ability (9.7%), time (4.3%), work (3.2%), and family (2.2%). Only 5.4% of respondents reported there were no obstacles preventing them from pursuing an education. The survey identified specific funding sources offenders believed they could access. Grants and loans were reported to be the most common funding available (47.3%), less than half of the sample. Vocational Rehabilitation (37.3%), personal finances (22.7%), and family and friends (16.4%) were other choices. Some offenders indicated funding sources other than the choices given and many reported access to a combination of sources.

**Discussion**

Because a self report survey instrument was utilized, certain limitations in the study exist. Although the protocol was designed to protect the anonymity of the respondents, it is expected some offenders still believed they could be identified by Department of Corrections’ staff. Responses could therefore be skewed to either impress correctional staff, or to avoid perceived consequences. Additionally, because the study focuses so much on the intentions of participants, it must be noted that an individual’s intentions and actions do not always agree. The limitations of the study are believed to be minimal however and the findings valid.

The following conclusions can be drawn from the results. Although the offender population is less educated than the rest of society, they are aware of potential educational benefits. Most offenders reported more education would help them secure the job they want most and they would benefit very much. Why then are more offenders not pursuing a post-incarceration education? The most common response was the lack of funding. Financing an education for an ex-offender however seems very realistic. Having just been released from prison, most offenders demonstrate an extremely high financial need. Much of the criteria used to qualify for federal grants and loans are need based. It is therefore expected offenders returning to society would likely be eligible for financial aid.

The comparison between educational plans and aspirations if given an opportunity indicate most offenders are not aware of post secondary educational opportunities available after release. Over 90% of the participants want to attend a technical school or college; over half do not know how. Knowledge of G.E.D. opportunities are more prevalent with the gap between plans and aspirations at about 3%. Because offenders are aware of G.E.D. opportunities, mechanisms seem to be in place to inform offenders about education. Post secondary education unfortunately does not appear to be incorporated into the information.

Because there is such a strong relationship between post secondary education and lower recidivism, and most offenders report they would pursue more education if given the opportunity, a definite need has been identified. To develop ways to make offenders aware of educational opportunities and encourage such pursuits would benefit not only the offender population but society at large.

**Implications/Conclusions**

Ongoing work of the investigators includes the creation of the Educational Opportunity and Resource Center. The program would address many of the needs identified in the present study. Information would be distributed through the prison system and probation and parole officers. Upon release from prison the individual could contact the center with questions about educational opportunities and resources. The center would help to facilitate the educational process for interested offenders by answering questions, assisting with financial aid and admissions applications, and helping the individual find the right “educational fit”. The center would provide no direct funding to ex-offenders but would simply introduce them to already available resources.

A program such as this is expected to produce better outcomes for individuals willing to work for positive change in their lives. Because a better education will likely lead to a better career and greater life satisfaction, better outcomes are also predicted for the spouses and children of offenders. Benefits to the community would include lower crime rates, and safer neighborhoods. Fiscal benefits would be derived from

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<table>
<thead>
<tr>
<th>Table 1. Observed Frequencies and Percentages: Educational Achievement and Recidivism (n = 97)</th>
</tr>
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<tbody>
<tr>
<td><strong>Results</strong></td>
</tr>
<tr>
<td><strong>Low Recidivism (1-2)</strong></td>
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<tr>
<td></td>
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<tr>
<td><strong>High Recidivism (3-10)</strong></td>
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x² = 4.145, df = 1, p < .05 (direction predicted)

<table>
<thead>
<tr>
<th>Table 2. Comparing Educational Plans with Aspirations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upon release what will you do?</strong></td>
</tr>
<tr>
<td>Not worried about school</td>
</tr>
<tr>
<td>Go to a technical school</td>
</tr>
<tr>
<td>Go to college</td>
</tr>
</tbody>
</table>
money saved on costs associated with re-incarceration, along
with offenders contributing to the tax base through gainful
employment as opposed to costing the government tax dollars.

Beneficial research in the future would include analyzing
the exact relationship between post-incarceration education and
outcomes. Realistic career paths for former offenders would also
need to be identified as different crimes would produce different
obstacles. Additionally, support systems which would enable
ex-offenders to smoothly transition from prison to an academic
environment would need to be identified.

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Introduction

The financial behaviors of full-time college students differ compared to others. Many students, upon entering college, are just beginning to become knowledgeable about the practice of financial management. Financial decisions that are made during this time, however, will have dramatic effects on their future financial well-being. The circumstances within which each student finds himself or herself while in college will help teach and encourage best financial practices, either as a result of formal education or the “school of hard knocks.” In some cases, the lessons learned can be costly. For example, according to Lea, Webley, and Walker (1995), full-time students are more likely to be employed part-time and rent their housing rather than own and are more susceptible to greater levels of debt. A form of debt that is continually on the rise within the student population is credit card debt, the focus of this paper.

A major financial decision that students face is whether to obtain a credit card and to what extent the card or cards should be used to make purchases. Henry, Weber, and Yarbrough (2001) describe many students as being on the brink of financial crisis. College students, soon to be college graduates, have higher expected lifetime earnings than non-graduates and are seen as a lucrative, secure market for credit card companies (Barron & Staten, 2004; Brustein, 2005; Warwick & Mansfield, 2000). Given this fact, when a credit card is obtained, it is primarily the student’s responsibility to know how to manage its potential purchasing power and associated costs, and many students have neither the education nor experience of the best practices of credit card management.

The focus of this study is to examine how credit card behaviors vary by certain student characteristics, in an effort to improve the financial literacy education efforts of the Personal Financial Planning Department’s Office for Financial Success. The primary characteristics of interest are student year in school, student social group membership, and students’ level of financial responsibility and independence to help understand credit behaviors of students at the University of Missouri-Columbia. As a guide, these research questions will be addressed:

1. Does taking a course in personal finance influence credit card use behaviors?
2. Does belonging to a peer organization, such as a freshman interest group (FIG) or sorority/fraternity, influence credit card use behaviors?
3. Is there a relationship between parental monetary contribution (financial dependence) and student credit card behavior?
4. Does student credit card use behavior vary by year in school?

The first research question addresses whether credit card use behavior changes when students complete a course in personal finance. Perry and Morris (2005) recently conducted an analysis of the 1999 Freddie Mac Consumer Credit Survey. They found that those individuals with higher levels of financial knowledge are more likely to engage in more responsible financial management behaviors. This fact holds true for students as well, meaning that a course in personal finance should encourage students to make more sound financial judgments. To support this, Chen and Volpe (1998) conducted a study geared specifically towards college students that provided evidence of student...
financial literacy, by examining students’ range of knowledge and how that knowledge influenced students’ financial decisions. They found that those with less knowledge are more likely to have incorrect opinions leading to poor decisions in the areas of general financial knowledge, saving, borrowing, and investing. The following null hypothesis will be tested to determine the relationship between taking a personal finance course and credit card use behavior.

H0: Taking a personal finance course has no effect on student credit card use behavior.

Along with positive financial behaviors induced by greater amounts of financial knowledge, it is important to appraise the influence that peers have on financial decisions. This issue is addressed by looking at those students’ financial management behaviors who are members of a freshman interest group (FIG) their first year in school, or a fraternity or sorority. Dr. Lois Vitt (2004) contends that consumers make decisions according to their values, those things that are important in shaping one’s personal and social identities. Social groups where students choose to associate with others, such as sororities, fraternities, or FIGs, are likely to influence members due to the strong member allegiances (Scott, 1965; Norvilitis, Szablicki, & Wilson, 2003). The following null hypothesis will be tested to determine the effects of social influence on student credit card use behavior.

H0: Belonging to a FIG or a sorority/fraternity has no effect on student credit card use behaviors.

The third research question addresses whether the level of student financial independence has an effect on credit card use behaviors. Research conducted on a non-random, convenient sample of college students from three Northeastern colleges found that students who are given parental assistance in the payment of monthly credit card bills tend to have higher credit card balances than students that do not receive any assistance (Palmer, Pinto, & Parente, 2001; Kidwell, Brinberg, and Turrisi, 2003). These studies concluded that parental monetary support significantly influences money management attitudes and behaviors, not necessarily in the direction of best practices. These results lead to the following null hypothesis that will be tested to determine whether student financial independence has an effect on student credit card behavior.

H0: Increased parental contribution has no effect on student credit card use behaviors.

Research question number four addresses whether, and in what ways, credit card use behavior varies by year in school. According to a report on undergraduate students and credit cards conducted by the Nellie Mae Corporation (2005), of those students that have applied for a Nellie Mae student loan and have a credit card, 43% obtained the card during freshman year and 56% obtained their first credit card at the age of 18. Also noted in the same study was a 71% growth rate in credit card ownership between the students’ freshman and sophomore years. With this growth in credit card possession over students’ academic career, it is important to examine how and in what ways credit card behaviors differ across academic levels in order to focus outreach at the appropriate teachable moments.

Also, Bianco and Bosco (2002) conducted a financial literacy study that examined student credit card use and credit card solicitation on the campus of a private university. They found that year in school was significant in determining the number of credit cards that a student had. It is inferred that a student in their fourth year has more cards than a student in their first year due to a greater opportunity to be exposed to credit card solicitors. The current research, more specifically, will examine the behaviors of those students that have cards and the impact that college matriculation has on those behaviors. The following null hypothesis will be tested to determine whether credit card behaviors vary by year in school.

H0: Year in school is not significant in determining positive credit card use behaviors.

Methodology and Sample

An online survey was administered to all undergraduate and graduate students, including professional students, at the University of Missouri – Columbia. The purpose of the survey was to gain knowledge on students’ retail experience, credit use and personal financial management. The survey was pre-tested on a convenient group of students, and following making appropriate changes to the questionnaire, the final survey was e-mailed to 27,003 students. To complete the survey, the student had to click on a web address within the e-mail. Students had 30 days to complete the survey. At both ten and twenty days, reminder emails were sent to the entire population. Students were offered the opportunity to have their name put in a drawing for one of three $150 gift certificates as an incentive to complete the survey.

A total of 7,342 surveys were completed and returned, reflecting a response rate of 27.19 percent. For the current research, all respondents who held no credit cards, who were unaware of their level of debt, who were unaware of their parent’s annual income, and who were under the age of 18 were deleted from the sample. Also, outliers believed to be erroneous responses were removed. For example, one respondent reported holding 76 credit cards and others reported a grade point average of greater than 4.0. The final sample used for the purpose of this study totaled 3,445 student responses.

The sample includes freshman (10.6%), sophomores (13.93%), juniors (21.22%), seniors (27.75%), and graduate students (26.5%) from all colleges on the university campus. The majority of respondents were Caucasian (86.65%), followed by Asian American (5.17%) and African American/Black (3.57%). The majority of respondents were female (68.01%) and from a suburban town (38.18%). Respondents’ GPAs ranged from a minimum of 1.16 to a maximum of 4.0.

Analysis

In this study, five key questions relating to credit card use behavior were picked from the survey in order to measure and determine students’ ability to make financially sound decisions with their credit cards. The five credit card management behaviors selected represent negative financial practices. A five-point Likert scaling method was used for all questions. Students were asked to report how frequent they only paid the minimum payment on their credit card, with responses ranging from 1-very often to 5-never. Students were also asked the extent to which they agreed to the following statements: I never pay off my credit card at the end of each month, and I
frequently take cash advances on my credit card. Responses ranged from 1 - strongly agree to 5 - strongly disagree. For each question, a response of 1 would denote credit card management behavior that is not consistent with sound financial practices, and a response of 5 would denote behavior that is more consistent with sound financial decision-making.

Each dependent variable was analyzed using multiple regression techniques, utilizing the Statistical Analysis System (SAS). The independent variables were coded as dummy variables indicating student completion of a personal finance course, current or past membership in a Freshman Interest Group (FIG), current membership in a sorority or fraternity, financial independence from parents, and student year in school. Other variables of interest were entered as control variables and coded as dummy variables. These control variables included students’ total level of debt by category, parental annual income by category, race, home residence by type of town, and gender. Student grade point average (GPA) was also of interest but was coded as a continuous variable. The mean values for all dependent and independent variables are present in Table 1.

A Proc GLM procedure was used for the multiple regressions for all dependent variables, resulting in estimated regression coefficients which were deemed significant if the coefficient is significant at the .05 level, or less. This procedure is a more efficient than ordinary least squares for the categorical dependent variables presented in this study. The regression results for all variables are present in Table 2.

### Table 1: Means

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
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</thead>
<tbody>
<tr>
<td>Only Paid Minimum Payment</td>
<td>4.0975</td>
<td>1.1990</td>
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<tr>
<td>Credit Card at Maximum Limit</td>
<td>4.9357</td>
<td>0.9728</td>
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<tr>
<td>Use One Credit Card for Payment on Another</td>
<td>4.8015</td>
<td>0.5759</td>
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<tr>
<td>Never Pay Off Credit Card at Month’s End</td>
<td>2.7266</td>
<td>1.9249</td>
</tr>
<tr>
<td>Frequently Take Cash Advances</td>
<td>3.3814</td>
<td>1.2544</td>
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<tr>
<td>Independent Variables</td>
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<tr>
<td>Personal Finance Course (1 if Taken)</td>
<td>.2287</td>
<td>4.201</td>
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<tr>
<td>Freshman Interest Group (FIG) Membership</td>
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<td>Greek Organization Membership</td>
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<td>Financial Independence (1 if Independent)</td>
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<td>Year in School</td>
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<td>Senior</td>
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<tr>
<td>Other Variables</td>
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<td>Student’s Debt</td>
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<td>$1-999</td>
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<td>&gt;$100,000</td>
<td>.2914</td>
<td>4.545</td>
</tr>
<tr>
<td>Race</td>
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<td></td>
</tr>
<tr>
<td>White</td>
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<tr>
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<td>Hispanic</td>
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<td>1.911</td>
</tr>
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<td>Minority (Native American and Other)</td>
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<tr>
<td>Hometown Type</td>
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<tr>
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<td>.3806</td>
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<td>Medium Size Town</td>
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</tr>
<tr>
<td>Small Town</td>
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<td>4.159</td>
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<tr>
<td>Other Demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (1 if Male)</td>
<td>.3199</td>
<td>4.665</td>
</tr>
<tr>
<td>GPA</td>
<td>3.3681</td>
<td>4.957</td>
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</table>
## Table 2: Regression Results

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Minimum Payment</th>
<th>Maximum Credit Limit</th>
<th>Use CC to Pay CC</th>
<th>Pay Off at Month’s End</th>
<th>Cash Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Finance Course</td>
<td>0.0627 (0.0454)</td>
<td>-0.0384 (0.0377)</td>
<td>0.0472* (0.0230)</td>
<td>0.0975 (0.0593)</td>
<td>-0.0420 (0.0512)</td>
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<tr>
<td>Belong to a FIG</td>
<td>0.0586 (0.0478)</td>
<td>0.0407 (0.0397)</td>
<td>-0.0162 (0.0234)</td>
<td>0.0667 (0.0573)</td>
<td>0.1238* (0.0539)</td>
</tr>
<tr>
<td>Belong to Greek Organization</td>
<td>-0.0142 (0.0516)</td>
<td>-0.0609 (0.0429)</td>
<td>-0.0162 (0.0262)</td>
<td>-0.0043 (0.0618)</td>
<td>-0.1281* (0.0582)</td>
</tr>
<tr>
<td>Financially Independent</td>
<td>-0.3013*** (0.0481)</td>
<td>-0.2026*** (0.0399)</td>
<td>-0.0269 (0.0244)</td>
<td>-0.2821*** (0.0576)</td>
<td>-0.0856 (0.0542)</td>
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</table>

### Year in School

<table>
<thead>
<tr>
<th>Year in School</th>
<th>Minimum Payment</th>
<th>Maximum Credit Limit</th>
<th>Use CC to Pay CC</th>
<th>Pay Off at Month’s End</th>
<th>Cash Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>0.1307 (0.0760)</td>
<td>-0.0722 (0.0631)</td>
<td>0.0067 (0.0386)</td>
<td>0.1364 (0.0910)</td>
<td>-0.5910*** (0.0857)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>0.1873** (0.0723)</td>
<td>-0.0931 (0.0600)</td>
<td>0.1057** (0.367)</td>
<td>0.3275** (0.0866)</td>
<td>-0.2639** (0.0816)</td>
</tr>
<tr>
<td>Junior</td>
<td>0.0577 (0.0652)</td>
<td>-0.0597 (0.0541)</td>
<td>0.0883*** (0.0331)</td>
<td>0.0740 (0.0781)</td>
<td>-0.1290 (0.0736)</td>
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<tr>
<td>Senior</td>
<td>-0.0006 (0.0610)</td>
<td>-0.0208 (0.0507)</td>
<td>0.1016** (0.0310)</td>
<td>-0.0819 (0.0732)</td>
<td>-0.0642 (0.0689)</td>
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### Other Variables

<table>
<thead>
<tr>
<th>Student’s Debt</th>
<th>Minimum Payment</th>
<th>Maximum Credit Limit</th>
<th>Use CC to Pay CC</th>
<th>Pay Off at Month’s End</th>
<th>Cash Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1-999</td>
<td>-0.4907*** (0.0759)</td>
<td>-0.3737*** (0.0626)</td>
<td>(0.0383)</td>
<td>-0.4082*** (0.0903)</td>
<td>-0.0712 (0.0850)</td>
</tr>
<tr>
<td>$1000-2999</td>
<td>-0.6696*** (0.0809)</td>
<td>-0.5122*** (0.0671)</td>
<td>-0.1604*** (0.0411)</td>
<td>-0.9199*** (0.0969)</td>
<td>-0.0246 (0.0912)</td>
</tr>
<tr>
<td>$3000-4999</td>
<td>-0.4633*** (0.1077)</td>
<td>-0.3732*** (0.0849)</td>
<td>-0.1980*** (0.0547)</td>
<td>-0.5276*** (0.1290)</td>
<td>0.1096 (0.1214)</td>
</tr>
<tr>
<td>$5000-9999</td>
<td>-0.6288*** (0.0845)</td>
<td>-0.3867*** (0.0701)</td>
<td>-0.1563*** (0.0492)</td>
<td>-0.8623*** (0.1012)</td>
<td>0.0441 (0.0953)</td>
</tr>
<tr>
<td>$10,000-19999</td>
<td>-0.7045*** (0.0960)</td>
<td>-0.5541*** (0.0797)</td>
<td>-0.3260*** (0.0488)</td>
<td>-0.9043*** (0.1150)</td>
<td>0.0346 (0.1083)</td>
</tr>
<tr>
<td>$20,000+</td>
<td>-0.3047*** (0.0823)</td>
<td>-0.1607* (0.0683)</td>
<td>-0.0616 (0.0418)</td>
<td>-0.5439*** (0.0986)</td>
<td>0.1472 (0.0928)</td>
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</tbody>
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### Parent’s Income

<table>
<thead>
<tr>
<th>Parent’s Income</th>
<th>Minimum Payment</th>
<th>Maximum Credit Limit</th>
<th>Use CC to Pay CC</th>
<th>Pay Off at Month’s End</th>
<th>Cash Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$25,000-49,000</td>
<td>0.1322 (0.0731)</td>
<td>0.1665** (0.0607)</td>
<td>0.1658*** (0.0371)</td>
<td>-0.0245 (0.0875)</td>
<td>0.2245** (0.0824)</td>
</tr>
<tr>
<td>$50,000-74,999</td>
<td>0.1962** (0.0720)</td>
<td>0.2039** (0.0597)</td>
<td>0.1602*** (0.0366)</td>
<td>0.0040 (0.0862)</td>
<td>0.1390 (0.0812)</td>
</tr>
<tr>
<td>$75,000-99,999</td>
<td>0.2754*** (0.0758)</td>
<td>0.1987** (0.0629)</td>
<td>0.1759*** (0.0385)</td>
<td>0.1502 (0.0907)</td>
<td>0.2182* (0.0107)</td>
</tr>
<tr>
<td>&gt;$100,000</td>
<td>0.4327*** (0.0727)</td>
<td>0.2979*** (0.0604)</td>
<td>0.2010*** (0.0369)</td>
<td>0.2903** (0.0871)</td>
<td>0.1870* (0.0820)</td>
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</tbody>
</table>

### Race

<table>
<thead>
<tr>
<th>Race</th>
<th>Minimum Payment</th>
<th>Maximum Credit Limit</th>
<th>Use CC to Pay CC</th>
<th>Pay Off at Month’s End</th>
<th>Cash Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>0.6083*** (0.1046)</td>
<td>0.4769*** (0.1674)</td>
<td>0.1316* (0.0531)</td>
<td>0.8208*** (0.1253)</td>
<td>0.2215 (0.1179)</td>
</tr>
<tr>
<td>Asian American</td>
<td>0.5983*** (0.1315)</td>
<td>0.1297 (0.1092)</td>
<td>-0.1602* (0.0668)</td>
<td>0.8069*** (0.1576)</td>
<td>-0.0313 (0.1963)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.1493 (0.1648)</td>
<td>-0.0206 (0.1368)</td>
<td>-0.1361 (0.0837)</td>
<td>0.4897* (0.1975)</td>
<td>-0.0868 (0.1859)</td>
</tr>
<tr>
<td>Minority</td>
<td>0.3313* (0.1534)</td>
<td>0.0241 (0.1273)</td>
<td>-0.0980 (0.0779)</td>
<td>0.4217* (0.1837)</td>
<td>-0.1976 (0.1730)</td>
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</table>
All five dependent variables, if the behavior is frequently engaged in, would be a sign of unsound financial decision making. This study found that there is a significant negative relationship between those students that have taken a personal finance course and the likelihood of frequently using one credit card for payment on another. The multiple regression analysis produced a positive estimate of 0.0472 at a significance level less than .05. This means that the students who have taken a personal finance course are significantly more likely to only pay the minimum payment on their credit card, maintain their credit card at its maximum limit, and never pay credit cards off at the end of the month. When analyzing year in school, freshman and sophomores are significantly more likely than independent students (Palmer, Pinto, & Parente, 2001). 

Findings

Table: Type of Town

<table>
<thead>
<tr>
<th>Type of Town</th>
<th>0.1914*</th>
<th>-0.1548*</th>
<th>-0.0885</th>
<th>-0.2013*</th>
<th>-0.0673</th>
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</thead>
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<tr>
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<td>-0.0896</td>
<td>-0.0063</td>
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<tr>
<td>Suburban</td>
<td>-0.0863</td>
<td>0.1628**</td>
<td>-0.0242</td>
<td>-0.2186*</td>
<td>-0.0753</td>
</tr>
<tr>
<td>Medium Size</td>
<td>-0.1914*</td>
<td>-0.1548*</td>
<td>-0.0885</td>
<td>-0.2013*</td>
<td>-0.0673</td>
</tr>
<tr>
<td>Small Town</td>
<td>-0.1631*</td>
<td>-0.1294*</td>
<td>-0.0584</td>
<td>-0.2080*</td>
<td>-0.1389</td>
</tr>
<tr>
<td>Male</td>
<td>0.1609***</td>
<td>0.1586***</td>
<td>-0.0204</td>
<td>0.2039***</td>
<td>-0.0090</td>
</tr>
<tr>
<td>GPA</td>
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</table>

<table>
<thead>
<tr>
<th>0.0774</th>
<th>0.0642</th>
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<th>0.0927</th>
<th>0.0873</th>
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</thead>
<tbody>
<tr>
<td>0.0751</td>
<td>0.0623</td>
<td>0.0381</td>
<td>0.0875</td>
<td>0.0896</td>
</tr>
<tr>
<td>0.0407</td>
<td>0.0338</td>
<td>0.0207</td>
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</tr>
<tr>
<td>0.0429</td>
<td>0.0356</td>
<td>0.0218</td>
<td>0.0514</td>
<td>0.0484</td>
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</tbody>
</table>

Findings

This study examined five specific credit card management behaviors that exemplified unsound financial management to understand how the behaviors were dependent on changes in specific student characteristics. The student characteristic of taking a personal finance course was found to be influential in determining whether a student would use one credit card for payment on another. In this case, the null hypothesis is invalid and taking a personal finance course has an effect on credit card use behavior. This finding provides support to previous research. As in Chen and Volpe’s study (1998), this study found that decreased knowledge of correct financial management practices decreases the likelihood of making better credit card management decisions. In this case, the decrease in knowledge leads to the poor decision of using one credit card for payment on another.

The student characteristic of belonging to a social group such as a FIG or Greek organization was found to be influential in determining whether a student would take cash advances. The null hypothesis was invalid and belonging to a FIG or Greek organization has an effect on credit card use behavior. Those students that belonged to a FIG were less likely to take cash advances, where those students belonging to a Greek organization were more likely to take cash advances. Those who belong to a Greek organization may find that they are in circumstances that require a need to access cash more frequently than those who are not. The social environment that these students find themselves may encourage a need to access cash. In comparing this finding with previous research, Dr. Lois Vitt (2004) contends that decisions are made based on values. In this case, it could be that those students in Greek organizations are more likely to take cash advances because they value cash more in shaping their personal and social identities compared to those who are not in Greek organizations.

Those students who are financially independent from their parents are more likely to practice three out of five credit card management behaviors that exemplify unsound financial management. Financial independence does affect credit card use behavior. Therefore, the null hypothesis is invalid. Previous research found that dependent students are likely to have more debt than independent students (Palmer, Pinto, & Parente, 2001).

Discussion

When examining the other student characteristics, overall, students with greater levels of debt are more likely to partake in unsound credit card use behaviors compared to students without debt and those students whose parents are in higher income categories tend to make more effective credit card use decisions compared to those students whose parents are in the lowest income category. Overall White and Asian American students tend to make more financially sound credit card use decisions, compared to African-American students, and students from a medium size town are found to display significantly less sound credit card use behaviors than students who reside in rural areas. Male students and students with higher GPAs are more likely to conduct effective credit card use behaviors compared to females and those with lower GPAs.

Discussion

This study examined five specific credit card management behaviors that exemplified unsound financial management to understand how the behaviors were dependent on changes in specific student characteristics. The student characteristic of taking a personal finance course was found to be influential in determining whether a student would use one credit card for payment on another. In this case, the null hypothesis is invalid and taking a personal finance course has an effect on credit card use behavior. This finding provides support to previous research. As in Chen and Volpe’s study (1998), this study found that decreased knowledge of correct financial management practices decreases the likelihood of making better credit card management decisions. In this case, the decrease in knowledge leads to the poor decision of using one credit card for payment on another.

The student characteristic of belonging to a social group such as a FIG or Greek organization was found to be influential in determining whether a student would take cash advances. The null hypothesis was invalid and belonging to a FIG or Greek organization has an effect on credit card use behavior. Those students that belonged to a FIG were less likely to take cash advances, where those students belonging to a Greek organization were more likely to take cash advances. Those who belong to a Greek organization may find that they are in circumstances that require a need to access cash more frequently than those who are not. The social environment that these students find themselves may encourage a need to access cash. In comparing this finding with previous research, Dr. Lois Vitt (2004) contends that decisions are made based on values. In this case, it could be that those students in Greek organizations are more likely to take cash advances because they value cash more in shaping their personal and social identities compared to those who are not in Greek organizations.

Those students who are financially independent from their parents are more likely to practice three out of five credit card management behaviors that exemplify unsound financial management. Financial independence does affect credit card use behavior. Therefore, the null hypothesis is invalid. Previous research found that dependent students are likely to have more debt than independent students (Palmer, Pinto, & Parente, 2001).
This study concluded the opposite. Those students who do not depend on the financial support of their parents are more likely to have trouble with only making the minimum monthly payment on credit cards, having credit cards at their maximum credit limit and not paying off cards at the end of the month.

There are many significant dependent variables across academic levels. Freshman, sophomores, juniors, and seniors were compared to graduate students to measure how financial management behavior changes across academic level. Sophomores are less likely than graduate students to practice three out of five credit card management behaviors that exemplify unsound financial management. Also, as noted earlier, there is a profound growth in credit card ownership between freshman and sophomore year (Nellie Mae Corporation, 2005). This may be a sign that the sophomore level is a prime moment to teach students financial management behaviors that will be beneficial to them for the rest of their academic career.

Students with higher amounts of debt outside of credit card debt and students whose parents are from lower income categories tend to be less likely to practice sound credit card management behaviors. All significant variables were compared to students with the lowest debt level and to those students whose parents are in the lowest income category. An increase in the level of overall debt combined with limited income impairs students' ability to make sound financial decisions, although this interaction was not explored. Students whose parents are in a lower income category are less likely to have the financial support that can help prevent being in a position to make an unsound credit card management decision.

White and Asian American students, compared to African American students, male students, compared to females, and those students with higher GPAs practice more sound credit card use behaviors. White and Asian American students may have better credit card management skills compared to African Americans due to learning credit card management in their family, allowing them to use credit cards to work effectively for, as opposed to against, them. Those with higher GPAs may be exhibiting greater levels of human capital, which enables them to better understand how to effectively manage credit cards.

**Conclusion**

By examining the five specific credit card management behaviors that are a reflection of credit card mismanagement, campus education can be geared in an effective manner towards those students with the greatest likelihood of making unsound credit card use decisions. Populations to target with education outreach in at least one of these five areas include students who have not taken a course in personal finance, students who participate in a Greek organization, students who are financially independent, graduate students, students with greater levels of debt, students whose parents are in a lower income category, African Americans, students from a medium size town, females, and students with lower GPAs.

Hopefully these findings will help reach the University of Missouri’s Personal Financial Planning Department’s goal of effectively providing financial education to those in need. This study concludes that there are populations with credit card mismanagement behaviors. Increased credit card management education provided through financial counseling at the financial aid office on campus or through the Personal Financial Planning Department’s Office for Financial Success will provide students with information enabling them to have better, stronger financial futures.

Increased education can more successfully be achieved through campus financial support for curriculum designed to address the issues of credit card mismanagement and other unsound financial practices. Curriculum that educates students in the best financial practices creates an opportunity for students to decrease their level of debt. With less overall debt, students are able to focus more on school and less on ways to decrease their debt. This gives students more of an opportunity to complete their college education. Support for this curriculum is needed from campus administrators and faculty, as well as students. The impact is one that will be felt throughout campus and the number of individuals whose financial future will be changed for the better is likely to exceed all expectations.

**References**


Introduction

In the course of normal development, children achieve several milestones as they acquire a vocabulary. Before they begin speaking their first words, normally-developing children begin to comprehend words at about eight to ten months of age. Fenson and colleagues (1994) found that the comprehension vocabulary of 10-month-old children ranges from 11 words to 154 words. At this time, children typically recognize words for common items like ‘cup’ and ‘juice’. By 16 months, children can point to a few body parts when asked, follow simple commands such as, “Pick up the book,” and understand simple questions such as, “What is that?” The size of comprehension vocabularies increases to between 92 and 321 words (Hoff, 2005) during this period. Also at this time, children experience a “word spurt” in vocabulary. The rate at which children produce new words increases from about 8 to 11 words per month before the spurt to approximately 22 to 37 words per month following the spurt (Hoff, 2005).

While typically-developing children follow this rapid pattern of development, many populations of children are delayed in developing vocabulary. These populations include, but are not limited to, children with Specific Language Impairments (SLI), autism spectrum disorders, and Down syndrome. Perceptual, cognitive, and information-processing differences may cause many cases of language delay (Bernstein and Tiegerman-Farber, 2002), and different populations might show delays for different reasons. It is unclear how different populations use different strategies for word learning, but a better description of how different disordered groups learn words will help us to understand the mechanisms underlying vocabulary acquisition as well as tailor interventions to the nature of particular disorders rather than to a common, global symptom such as delayed vocabulary knowledge.

A review of factors that normally-developing children use in word learning including factors that may be specific to language and factors that depend on cognition follows. Next, vocabulary development in disordered populations and some of the behavioral characteristics that may play a role in development will be discussed. Finally, there will be a presentation of the hypotheses with regard to the disordered populations and vocabulary development.

Strategies in Word Learning

Language-specific and cognitive factors have both been proposed to influence word learning (Hoff, 2005). Language factors include assumptions children may make regarding the meanings of the words they hear. Cognitive factors include phonological memory and the ability to use familiar verb meanings to infer the meanings of new words.

Language-Specific Factors in Word Learning

Some factors may be specific to language learning. Markman (1991) has proposed that children are biased to consider only a few of the many theoretically possible candidates for the meaning of a new word heard in context. These biases allow children to develop their vocabulary quickly. For example, when an adult points to an object and labels it, the label could refer to the whole object or just a part of it. If this is a novel label, the child apparently assumes that the novel label refers to the whole object if the child does not have a name for that object. However,
he assumes the novel label refers to a part or property of the object if he does already know a name for the whole object. Thus, some strategies are used specifically within the language learning context.

Cognitive Factors in Word Learning

Cognitive factors may affect the ease with which children can learn new words. Two factors that apply to many domains of learning are memory and drawing inferences. One sort of memory is called phonological memory. This refers to the ability to remember a sequence of unfamiliar sounds. Children with better phonological memory skills have more advanced vocabularies, suggesting that phonological memory is involved in the normal process of language acquisition (Gathercole and Baddeley, 1989). Another sort of memory is long-term memory for the pairings of words and their meanings. Goodman, McDonough, and Brown (1998) found that two-year-olds can retain the meanings of words they have just learned for at least 48 hours.

A second cognitive factor is the use of inference to determine the meanings of novel words. Normally-developing two-year-olds draw inferences to map a new word to its referent (Goodman, et al, 1998). Goodman and her colleagues looked at the ability of two-year-olds to use semantic context to infer the meanings of novel nouns. For instance, most normally developing two-year-olds do not know the meaning of the word ferret in the sentence, Mommy feeds the ferret. They do, however, know the meaning of the word feeds. They use that verb meaning to infer that a ferret has to be an animate object because one can only feed something that is alive. It is not known, however, how early children can infer the meanings of novel words using the meanings of words they know.

Vocabulary Development in Delayed Populations

Disordered populations differ from the normally-developing children in the course of vocabulary development. In addition, the disordered populations differ from one another. Behavioral, cognitive, and language-specific characteristics contribute to this dissimilarity. I will discuss these in detail as they relate to children with autism, SLI, or Down Syndrome.

Bernstein and Tiegerman-Farber (2002) identify several behavioral characteristics of children with an autism spectrum disorder. They propose that the most salient characteristic of autism is the lack of eye contact with other people during communication. This inability to hold joint attention with a speaker may affect their ability to learn novel nouns (Bruinsma, Koegel, & Koegel, 2004). Instead of using a speaker’s gaze, autistic children may use a language-specific strategy of assigning new words to new objects (Preissler and Carey, 2005). Children with disorders on the autism spectrum may exhibit echolalia, defined as meaningless repetition of someone else’s words. Most of these children show a delayed onset of first words and are likely to have lower verbal scores than age-matched children (Rice, Warren, & Betz, 2005). Children with autism tend to produce whole phrases and sentences as a repetition of what they have heard and without understanding the individual linguistic elements (Bernstein and Tiegerman-Farber, 2002). With regard to cognition, autistic children are variable but usually show a degree of impairment.

Children with SLI share some characteristics with autistic children (Bernstein and Tiegerman-Farber, 2002); however, language impairment is the defining feature of SLI (Rice, et al, 2005). Rice, et al (2005) describe several language characteristics of children with SLI. First, children with SLI perform below age expectations on language measures even though they have adequate cognitive and sensory skills for normal development. Children with SLI are delayed in the production of early words and first word combinations. They have been shown to have substantial difficulty in acquiring new words, requiring more exposures than typically developing children to comprehend those words (Weismer and Evans, 2002). Children with SLI perform below age-matched controls on receptive vocabulary measures, but similarly to younger children indicating that they show a delay in learning rather than a deviant pattern of acquisition (Rice, et al, 2005).

Down syndrome, or Trisomy 21, is caused by an extra chromosome on the twenty-first pair. Children with this disorder typically have cognitive deficits (Bernstein and Tiegerman-Farber, 2002) with IQs between 35 and 70 (Rice, et al, 2005). Auditory memory deficits are evident in children with Down syndrome. These may be related to the rapid decay of echoic memory (the ability to remember what has been heard even when it is no longer present) (Bernstein and Tiegerman-Farber, 2002). They tend to have a slower acquisition of overall language than is expected for the level of nonlinguistic development. Down syndrome children usually exhibit a disordered language system with vocabulary skills less impaired than grammatical abilities. Their vocabulary skills are often at or above nonverbal levels, but syntactic development is at a lower level than their nonverbal abilities. Children with Down syndrome have significant speech problems and are less intelligible than typically-developing children (Rice, et al, 2005).

The ability to draw an inference and to remember that information is a cognitive task. Typically-developing children can perform these tasks as young as 24 months (Goodman, et al, 1998).

Children with impaired cognition may have difficulties in using familiar word meanings to infer the referent of a novel word and/or in remembering that information. On the other hand, SLI children who have language delays but show normal cognition may be able to use cognitive strategies successfully to learn new words. The present study will use the methodology of Goodman, et al (1998) to further explore the use of these cognitive strategies in word learning. First, it will examine typically-developing children who are only 20-months old to assess whether children younger than two years of age can use this relatively sophisticated cognitive strategy. We chose 20 months because this is the age by which most children begin the period of rapid word learning known as the vocabulary burst. Second, it will extend and explore the use of this strategy by children with disorders. If the use of inference and memory is indeed dependent on cognition, we would expect children with SLI to be able to perform the task at about the same age as typically-developing children, while children with Down syndrome or autism would not be able to perform the task until an older age. We have tested two atypically-developing children to date and in this paper, we present their data as case studies. Studying the ability of atypically-developing children to infer...
the meanings of novel nouns may let us assess the degree to which children with different types of disorders rely on cognitive strategies for vocabulary learning.

**Method**

**Participants**

Two sets of children participated in this study. The first consisted of typically-developing 20-month-olds, 18 boys and 20 girls (mean=20 mos;13 day, range=19;18 to 21;26). The second consisted of a child with pervasive developmental delay (an autism spectrum disorder) with a chronological age of 3;4 and a child with specific language impairment (SLI) with a chronological age of 5;3.

**Stimuli**

The language ability of each child was assessed using the Preschool Language Scale (PLS) (Zimmerman, Steiner, & Pond, 2002). The third edition was used for the control group while the fourth edition was used for the disordered populations, who were tested after this new edition was released. The Auditory Comprehension and Expressive Communication subtests were used to assess children’s ability to comprehend and produce language, respectively.

The Communicative Development Inventory: Words and Sentences Form (CDI) (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993) assessed vocabulary knowledge. The CDI is a standardized checklist on which parents mark which of 680 words their child currently produces.

A list of verbs and nouns from the stimuli (Table 1) was provided to the mother, who was asked to note which of those words she believed her child was familiar with.

**Table 1. Nouns and verbs included in experimental stimuli**

<table>
<thead>
<tr>
<th>Eat</th>
<th>Kitty or Cat</th>
<th>Stein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ride</td>
<td>Juice</td>
<td>Ferret</td>
</tr>
<tr>
<td>Feed</td>
<td>Bicycle</td>
<td>Metro</td>
</tr>
<tr>
<td>Drink</td>
<td>Baby</td>
<td>Sloth</td>
</tr>
<tr>
<td>Pet</td>
<td>Milk</td>
<td>Mead</td>
</tr>
<tr>
<td>Spill</td>
<td>Banana</td>
<td>Artichoke</td>
</tr>
</tbody>
</table>

Nonlinguistic cognitive ability of disordered populations was determined by administering the non-verbal IQ subtest of the Stanford-Binet Intelligence Scales for Early Childhood-5 (Roid, 2003).

This study used the stimuli from Goodman, McDonough, and Brown (1998) to assess word learning ability. Verbal stimuli included six active-declarative phrases that contained subject nouns which denoted agents and highly constraining verbs, as well as low-frequency object nouns, such as, “Mommy feeds the ferret.”

Pictorial stimuli included three test response booklets. Each booklet contained six pages of four pictures, one in each quadrant of the page. The pictures were colored line drawings of objects. Each page included the target and three distracter items. The placement of the target objects was varied so that a response bias in a child’s pointing could not explain the results. At the beginning of each task, the child heard four training sentences in order to familiarize the child with the task.

All children participated in three tasks, a verb comprehension task to assess whether they knew the highly constraining verbs, a novel-noun inference task to assess whether they could use the highly constraining verbs to infer the referent of a novel noun, and a memory task to assess whether they retained the word-referent pairing after a two-day delay. The Verb Comprehension Task used the Familiar Test Booklet, which included pictures of four familiar objects on each page, such as a baby, a book, a truck, and a newspaper. A sample page is provided in Figure 1. Verbal stimuli for the testing of verb familiarity consisted of six active-declarative phrases that contained subject nouns and verbs in which the subject nouns denoted agents (e.g., Mommy) and the verbs denoted common actions that constrained the referents of the object words (e.g., to feed), such as, “Mommy feeds the ____.”

**Figure 1.** An example page from the Familiar Test Booklet.

(Mommy feeds the ______.
What does mommy feed?)

**Figure 2.** An example page from the Novel Test Booklet.

(Mommy feeds the ferret.
Show me the ferret?)

The Novel Test Booklet used in the Novel Noun task contained pictures of four novel objects on each page, such as a ferret, a stirrup, a bagpipe, and a telescope. A sample page is provided in Figure 2. The verbal stimuli in this task were active-declarative sentences that included an agent, a familiar
constraining verb, and a low-frequency object noun, such as, “Mommy feeds the ferret.” In these sentences, the object nouns were intended to be unfamiliar to the participants while the subject nouns and verbs were intended to be familiar to the participants.

The Memory Task used the Memory Test Booklet. Each page contained the target picture for the test sentence, a picture that had served as the target item of a different sentence in the Novel Noun task, a distracter picture that had been on the same page as the target picture in the Novel Test Booklet, and a completely novel distracter picture. The verbs stimuli were commands, such as “Show me the ferret,” without an agent or a familiar constraining verb. Memory of this noun is assessed if the child remembered what the word ferret referred to based on his or her exposure to the word in the presence of the constraining verb during the previous session. For example, if the child correctly inferred, “Mommy feeds the ferret,” he heard, “Show me the ferret,” to assess memory of the target noun.

Procedure

Typically-Developing 20-month-olds

Subjects were tested in two sessions approximately 48 hours apart. On the first day, parents filled out the checklist from the CDI. The PLS was administered followed by the experimental tasks. Four training sentences were presented to the child to acquaint him with the task. For each picture, the child was shown a page containing four familiar pictures and asked to point to a picture of the noun mentioned in the sentence.

On Day 1, each child participated in two experimental conditions. The first was the Verb Comprehension condition in which we examined whether the child comprehended the verbs we intended to be familiar. The experimenter stated a sentence frame without an object noun (e.g., Mommy eats the ______) and showed the child a page from the Familiar Test booklet. The experimenter asked the child to point to a picture in the Familiar Test booklet that could complete the sentence. Each child heard six sentence frames, each with a different constraining verb. If the child knows the verb meaning, he should be able to choose a highly familiar noun object to complete the sentence. The second test condition was the Novel Word condition in which we examined whether the child could use a familiar verb to infer the referent of a novel noun. In the Novel Word condition, the experimenter stated an active-declarative test sentence (e.g., Mommy eats the artichoke) and showed the child a page from the Novel Test booklet. The experimenter asked the child to point to the picture of the novel noun. Each child heard six sentences, each with a different constraining verb and a different novel noun.

On Day 2, the child participated in the Memory Task, which was used to determine whether the child remembered the referents of words he heard the day before. During this session, the novel nouns were presented without the constraining verbs (e.g., Show me the metro), and the child was asked to identify them. As the experimenter said the sentence containing the novel noun, she showed the child the corresponding picture from the Memory Test Booklet. Each child heard six sentences, each with a different novel noun.

The first session, which also included additional tasks for another study, lasted approximately 1-1/2 to 2 hours and the second session lasted approximately one half hour. All sessions were videotaped. The child’s responses were coded from the tapes by marking which item was selected first. If more than one item was selected, both responses were marked in the order they were made.

Disordered Populations

The procedures for the child with PDD and the child with SLI were similar to the procedure for the typically-developing children. However, during the second session, the experimenter also administered the nonverbal IQ subtest of the Stanford-Binet Intelligence Scale-5 to assess nonverbal intelligence following the memory task.

RESULTS

Typically-Developing Children

We first asked whether typically-developing 20-month-olds can use familiar verbs to infer the meaning of novel nouns. The results are presented in Table 2. If children are simply performing at chance, they will choose the correct picture on average 25% of the time, because there are four pictures on each page. The 20-month-old typically-developing children performed at a level significantly greater than chance on all three tasks.

Table 2. Typically-developing 20-month-olds’ performance as measured against chance responding of 25%

<table>
<thead>
<tr>
<th>Task</th>
<th>Percent Correct</th>
<th>T-value (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb Knowledge</td>
<td>96</td>
<td>5.76 (36)**</td>
</tr>
<tr>
<td>Noun Inference</td>
<td>40</td>
<td>5.51 (37)**</td>
</tr>
<tr>
<td>Noun Memory</td>
<td>32</td>
<td>2.36 (30)*</td>
</tr>
</tbody>
</table>

We computed conditional probabilities to see whether children correctly inferred the novel nouns for the particular verbs they comprehended in the Verb Knowledge Task. The conditional probability that children correctly inferred the nouns given they knew the verb was .40 ($t(35) = 2.94$, $p < .01$). Similarly, we looked at the likelihood that typically-developing 20-month-olds remembered the particular novel nouns that they had correctly inferred two days before. The conditional probability that children remembered the noun meaning given they had correctly inferred it was .41 ($t(35) = 2.75$, $p < .01$).

Table 3. A comparison of subjects on the CDI, PLS, Noun Inference Task and Memory Task.

<table>
<thead>
<tr>
<th></th>
<th>CDI</th>
<th>PLS</th>
<th>SB</th>
<th>Comp. Inference</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Group</td>
<td>310</td>
<td>20</td>
<td>N/A</td>
<td>.46</td>
<td>.10</td>
</tr>
<tr>
<td>Child with PDD</td>
<td>255</td>
<td>24</td>
<td>24</td>
<td>.33</td>
<td>.17</td>
</tr>
<tr>
<td>Child with SLI</td>
<td>640</td>
<td>57</td>
<td>43</td>
<td>.83</td>
<td>.33</td>
</tr>
</tbody>
</table>

Disordered Children

We turned next to children with language disorders. The child with PDD had a chronological age of 3 yrs;4 mos, but his language age, as assessed by the PLS-4, was only 2;6 and his nonverbal IQ, as assessed by the Stanford-Binet, was also 2;6. The child with SLI had a chronological age of 5;3; his language age, as assessed by the PLS-4, was 4;9 and his nonverbal IQ, as assessed by the Stanford-Binet, was 3;7. Thus, one child was functioning at a level just slightly above the average 20-month-old while the other was functioning at a level much higher than the average 20-month-old. A comparison of the two disordered children to the
group of 20-month-olds is presented in Table 3.

The child with PDD knew 255 words, according to the CDI. He performed correctly on two of six items on the Verb Comprehension task, one of six on the Noun Inference task, and on one of six on the Memory task (see Table 3). While the novel noun meaning he correctly inferred was the object of a verb he had correctly identified, his correct choice on the Memory task was not an item on which he had performed correctly on the Noun Inference task. When we looked only at the correctly inferred noun, he did not retain that meaning a day later.

The child with SLI knew 640 words, according to the CDI. His mother reported he knew all six verbs we were testing. In the task he made five correct responses and he used five verbs to infer the meaning of novel nouns. He retained only two noun meanings two days later. This child was functioning at a higher level than our 20-month-old typically-developing children, so we were unable to provide a language-match comparison for him.

Table 4. A comparison of task performance between the child with PDD to subjects from the control group matched for vocabulary size and language tasks.

<table>
<thead>
<tr>
<th></th>
<th>CDI</th>
<th>PLS</th>
<th>Inf.1</th>
<th>Inf.2</th>
<th>Mem.1</th>
<th>Mem.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child with PDD</td>
<td>255</td>
<td>2.0</td>
<td>.5</td>
<td>.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PDD Vocabulary Matched Control</td>
<td>268</td>
<td>2.3</td>
<td>0</td>
<td>.2</td>
<td>0</td>
<td>.5</td>
</tr>
<tr>
<td>PDD Language Matched Control</td>
<td>135</td>
<td>2.0</td>
<td>.75</td>
<td>.75</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(Inf.1=1st choice on inference/word-learning task
Inf.2=2nd choice on inference/word-learning task
Mem.1=1st choice on memory task
Mem.2=2nd choice on memory task)

We tried to match the scores of the child with PDD to scores of typically-developing 20-month-olds with similar PLS scores and to scores of children with similar CDI scores from the control group (Table 4). However, no clear trends emerged. A child with a slightly smaller vocabulary performed better than the child with PDD on both the inference and the memory tasks. However, a child with a slightly larger vocabulary performed worse than the child with PDD on the inference task but better on the memory task. The child with PDD performed at about the same level as one child with a similar language age on both tasks, but the child with PDD had a much smaller vocabulary size. On the other hand, a second language-age matched child had a significantly lower vocabulary size, yet performed with more success on the inference task. We will return to the implications of this confusing set of results in the discussion section.

Discussion

This study found that even 20-month-old typically-developing children are able to use relatively sophisticated cognitive strategies to learn new words. They use constraints available in words they know to infer the possible meanings of words they do not know and they remember these novel word meanings after a lengthy delay. Two case studies of children with disorders suggest that children with cognitive deficits may be unable to draw inferences, to retain new word meanings or both.

The child with PDD performed poorly on the task. First, he performed poorly on the verb knowledge task, even on verbs which his mother reported he knew. Second, he inferred a novel noun meaning for only one of the two verbs that he showed he knew, but he did not retain this meaning two days later.

The child with SLI performed with greater success than the typically-developing children on the Verb Comprehension and Noun Inference tasks, but he was older. He comprehended 83% of the verbs tested and inferred a novel noun meaning for five of the six verbs. Typically-developing children comprehended an average of two to three verbs tested and inferred a novel noun meaning for two of the six verbs. However, the performance of the child with SLI was similar to typically-developing children on the Memory Task. His higher age and PLS score explain the success of the first two tasks. In addition, the profile of the child with SLI is not what one would typically see with regard to this diagnosis. This was the diagnosis by the clinic that referred him for the study, but in children with SLI, cognition is typically normal. However, this child was 5;3, but had a nonverbal IQ of 3;7.

The ability to infer word meanings does not seem to be tied to language knowledge in that when we tried to compare performance of the disordered children with language-matched children, no clear patterns emerged. This suggests cognitive, rather than language-specific, skills may be needed for this task, but until we test both atypically- and typically-developing children on nonverbal age, we will not know if this is true.

Despite poor task performance, cognitive mechanisms (i.e., inference and memory abilities) cannot be the only strategy involved in word-learning. The child with PDD has a vocabulary of approximately 255 words, according to the CDI, indicating that he must have some strategy for word learning.

This is the first step in a study that will extend to other populations including children with Down Syndrome as well as additional children with autism spectrum disorders or with SLI. Children with Down Syndrome exhibit mental deficit which causes language delays. The results of these populations compared to the results already presented will help us to understand the mechanisms involved in word learning and to design different therapies for different disordered populations.

The results thus far do not indicate that language ability affects the process of word learning. All of these populations have vocabulary delays. However, the delays are a result of various factors. If cognition is intact in these populations, the inference task may be a feasible means of teaching vocabulary in therapy. Children with cognitive delays, however, may need to utilize other strategies in order to increase vocabulary size.
References


Introduction

One of the biggest challenges facing today’s engineers is the development of fast and accurate methods to detect, locate, and assess the extent of damage in complex structures that are aged and fatigued or that have been subjected to extreme forces due to natural disasters or bombings. Due to the increasing complexity of modern structures (e.g. aircraft, bridges, and large buildings) damage often goes unseen, even during rigorous inspection. Currently available conventional damage detection techniques include ultrasonic methods, magnetic flux leakage inspection, radiography, dye penetration, and eddy current sensing (Collacot, 1985). However, these methods can only detect damage within localized regions, requiring that either probable locations of damage be known prior to testing, or large scale inspection of the entire structure be implemented. Both of these requirements are impractical and uneconomical. Therefore, prevention of catastrophic structural failure necessitates the development of damage detection methods that perform quick, accurate, and non-destructive on-site, global inspection of complex structures.

Damage is defined as “changes introduced into a system, either intentional or unintentional, that adversely affect the current or future performance of that system” (Doebving, et al., 1996). This definition implies a distinction between an initial undamaged state and a damaged state, therefore requiring data of a system both before and after the damage has been introduced. The challenge is to determine what data will provide adequate information to indicate the existence of damage. Fortunately, a structure’s dynamic properties (i.e. natural frequencies, damping ratios, and mode shapes) are functions of the structure’s mechanical properties and damage always changes a structure’s mechanical properties. In addition, damage may also change a structure’s dynamic response from linear to nonlinear. For instance, the opening and closing of small cracks in a beam under a small harmonic excitation will result in a nonlinear response. Therefore, two different dynamics-based approaches have recently been adopted by engineers for structural damage detection. The first approach focuses on measuring damage-induced changes in a structure’s dynamic properties or modal parameters and usually employs a finite element modeling (FEM) procedure to simulate the undamaged structure when actual data are not readily available (Doebving, et al., 1996). Conversely, the second approach uses modern signal processing methods to extract nonlinear characteristics from a structure’s measured time histories and uses this data to detect damage time instants (Yang et al. 2004a).

Modal Shifting Methods

The majority of recently developed damage detection methods generally follow the first approach. A concise summary of many of these methods is given by Doebving et al. (1996). Various methods were employed to detect modal frequency shifts induced by structural damage. However, as pointed out by Doebving et al. (1996), frequency shifts are moderately insensitive to damage and noticeable modal shifting requires either unreasonably precise measurements or relatively large amounts of damage. This insensitivity is verified by Farrar et al. (1994) with a study on an Interstate 40 bridge. The overall bending stiffness of the bridge was reduced by 21%, yielding no significant modal frequency shift. Doebving et al. (1996)
concluded by stating that the only practical situations where these methods are feasible are in controlled environments.

Additional works reviewed by Doebling et al. (1996) include methods that utilize changes in mode shape and/or curvature to detect damage, and each of these methods requires a comparison between pre-damage and post-damage test data. In the event that pre-damage data are unavailable, a FEM must be used as a simulation. Finite element analysis is costly because it is computationally intensive and time-consuming. Another drawback is that the accuracy of the initial FEM must be assumed and there is no reliable way to verify this.

Each of the aforementioned methods uses changes in a structure’s modal parameters to detect damage. However, low modal frequencies are global properties that are insensitive to local changes (Doebling et al., 1996). Because damage is typically localized, these low modal frequencies are ineffective in detecting and locating damage. Contrarily, high modal frequencies are spatially localized, making them very useful in locating damage. Unfortunately, measuring high frequency mode shapes requires a spatially-dense array of sensors. Also, displacement-based finite element analysis cannot accurately predict high-frequency responses because of internal bending moments and shear forces that are not formulated to be continuous at the nodes (Pai and Huang, 2005).

■ Time-Domain Methods

In more recent years, engineers have drifted away from the previously mentioned damage detection methods that require periodic inspections, in which the current data are compared with previously collected data or a FEM. Instead, engineers have adopted more continuous model-independent monitoring-based approaches, where time-domain data such as velocities and accelerations are collected over extended periods of time and analyzed using modern signal processing techniques. These methods utilize the fact that when damage is introduced into a system, the system’s response changes from linear to nonlinear. Moreover, if damage occurs during monitoring, discontinuities will be present in the velocity and acceleration data. Time domain methods are advantageous because they require substantially fewer sensors and are capable of providing the exact time-instant that damage occurred. The challenge is to develop signal processing methods capable of decomposing a measured time signal in order to extract nonlinearities and other phenomena that are indicative of damage.

Signal Processing

Time series data are typically analyzed using a process known as spectral analysis. Spectral analysis is a process whereby a measured signal is decomposed into a linear combination of predetermined basis functions in order to easily identify the signal’s characteristics (Huang, 2000). These basis functions are arbitrary, but they must obey certain mathematical properties to be useful. Examples include trigonometric functions, Legendre polynomials, and Hermite polynomials. The most common analysis method is the Fourier spectral analysis which uses linear, constant amplitude and constant frequency sinusoids as a basis. These basis functions are used to extract the frequency components in a measured signal. Unfortunately, Fourier analysis is not suitable for many structural health monitoring applications due to the fact that most of the time-signals encountered are amplitude- and frequency-modulated nonstationary signals and the Fourier basis is not set up to deal with this. In addition, Fourier analysis relies on orthogonality between the basis functions and the signal. Because orthogonality is a principle from linear algebra, this process does not work well with nonlinear signals. Moreover, Fourier analysis requires the entire signal be processed simultaneously. Thus, it is impossible to determine what frequency components are present at different times throughout the signal. Alternative methods capable of extracting time-varying characteristics include Wavelet analysis, the Sliding-Window Fitting technique, and the Hilbert-Huang Transform.

■ Sliding-Window Fitting

Sliding-Window Fitting (SWF) is an adaptation of the more popular Wavelet Analysis, using windowed regular harmonics as a basis. Given a time signal \( u(t) \) that consists of two major frequencies \( \omega_1 \) and \( \omega_2 \), it can be assumed that

\[
\begin{align*}
\hat{u}(\omega) &= e_1 e \cos(\omega_1 t) + e_2 e \sin(\omega_1 t) + e_3 e \cos(\omega_2 t) + e_4 e \sin(\omega_2 t) + e_5 e + e_6 e \cos(\omega_1 t)^2 + e_7 e \sin(\omega_1 t)^2 + e_8 e \cos(\omega_2 t)^2 + e_9 e \sin(\omega_2 t)^2 + e_{10} e + e_{11} e \\
&= C_1^e \cos(\omega_1 t) + C_2^e \sin(\omega_1 t) + C_3^e \cos(\omega_2 t) + C_4^e \sin(\omega_2 t) + C_5^e + C_6^e + C_7^e + C_8^e
\end{align*}
\]

where \( e_i \) are constants, \( t=\tau-i \) is a moving time coordinate, \( \tau \) is the observed instant, and

\[
\begin{align*}
C_1^e &= \sqrt{\frac{e_1^2}{e_1^2 + e_2^2} \cos(\omega_1 t - \phi_1)} \\
C_2^e &= \sqrt{\frac{e_3^2}{e_3^2 + e_4^2} \sin(\omega_1 t - \phi_1)} \\
C_3^e &= \sqrt{\frac{e_5^2}{e_5^2 + e_6^2} \cos(\omega_2 t - \phi_2)} \\
C_4^e &= \sqrt{\frac{e_7^2}{e_7^2 + e_8^2} \sin(\omega_2 t - \phi_2)} \\
C_5^e &= e_9 + 2e_6 t, \quad C_6^e = e_1 \\
C_7^e &= e_1 + e_2 t, \quad C_8^e = e_3 \\
C_9^e &= e_4 + e_5 t, \quad C_{10}^e = e_6 \\
C_{11}^e &= e_7 + e_8 t, \quad C_{12}^e = e_9 \\
\end{align*}
\]

The coefficients \( C_j^e \) and \( \hat{C}_j^e \) are determined at \( t=0 \) by minimizing the square error, \( E_{\text{sw}} \), for points near \( t=t_i \). The square error is defined as

\[
E_{\text{sw}} = \sum_{i=0}^{\infty} \alpha^{|i|} (u_i - \hat{u}_i)^2
\]

where \( u_i \) denotes \( u(t) \), \( \hat{u}_i \) denotes the experimental data evaluated at \( t_i \), \( \alpha^{|i|} \) is a weighting factor with \( \alpha \leq 1 \) chosen by the user. The coefficients \( C_j^e \) and \( \hat{C}_j^e \) are then found by taking partial derivatives and equating to zero as follows.

\[
\frac{\partial E_{\text{sw}}}{\partial C_j^e} = \sum_{i=0}^{\infty} 2\alpha^{|i|} H(u_i - \hat{u}_i) \frac{\partial u_i}{\partial C_j^e} = 0
\]

\[
C_j^e = C_1^e, \hat{C}_1^e, C_2^e, \hat{C}_2^e, C_3^e, \hat{C}_3^e, C_4^e, \hat{C}_4^e, C_5^e, \hat{C}_5^e, C_6^e, \hat{C}_6^e, C_7^e, \hat{C}_7^e, C_8^e, \hat{C}_8^e, C_9^e, \hat{C}_9^e, C_{10}^e, \hat{C}_{10}^e, C_{11}^e, \hat{C}_{11}^e, C_{12}^e, \hat{C}_{12}^e
\]
It then follows from Eq. (1) that
\[ u(t) = C_1 + C_2 + C_3 \]
\[ \dot{u}(t) = \omega_1 C_1 + \omega_2 C_2 + \dot{C}_3 \]
\[ \ddot{u}(t) = -\omega_1^2 C_1 - \omega_2^2 C_2 + 2 \omega_2 \dot{C}_2 \]
\[ A_1, A_2, \theta_1, \text{ and } \theta_2 \text{ are defined as} \]
\[ A_1 = \sqrt{C_1^2 + \dot{C}_1^2}, \quad \theta_1 = \tan^{-1} \frac{\dot{C}_1}{C_1} = \omega_1 t - \phi_1 \]
\[ A_2 = \sqrt{C_2^2 + \dot{C}_2^2}, \quad \theta_2 = \tan^{-1} \frac{\dot{C}_2}{C_2} = \omega_2 t - \phi_2 \]

then the instantaneous frequency components, \( \omega_1 \) and \( \omega_2 \) at \( t = 0 \) are approximated by
\[ \omega_1 = \frac{d \theta_1}{dt} \approx \frac{\sum_{i=1}^{n} [\theta_1(t_i + i \Delta t) - \theta_1(t_i + (i-1) \Delta t)]}{4 \Delta t} \]
\[ \omega_2 = \frac{d \theta_2}{dt} \approx \frac{\sum_{i=1}^{n} [\theta_2(t_i + i \Delta t) - \theta_2(t_i + (i-1) \Delta t)]}{4 \Delta t} \]

The frequency components are averaged over \( 4 \Delta t \) to reduce noise. From Eq. (7) it is seen that the measured time series can be decomposed into two harmonics with frequencies \( \omega_1 \) and \( \omega_2 \) and amplitudes \( A_1 \) and \( A_2 \), respectively and a low frequency moving average given by \( C_3 \).

Because the harmonic basis functions are windowed, only a small portion of the signal is analyzed at any given time. This allows for extraction of time-varying frequency components. Nevertheless, SWF is a Fourier-based method and also relies on orthogonality between the basis functions and the signal. Although the window length can be chosen to enforce orthogonality, SWF is susceptible to the Uncertainty Principle. If too large a window length is chosen, time localization is lost. This means that it is impossible to extract time-varying characteristics. On the other hand, if too short a window length is chosen, it becomes impossible to extract low frequency components, such as a moving average. Another more promising method is the recently develop Hilbert-Huang Transform.

### Hilbert-Huang Transform

The Hilbert-Huang Transform is a two-step method. First, in a process called Empirical Mode Decomposition (EMD), a signal is decomposed into a finite series of Intrinsic Mode Functions (IMFs). An IMF is defined as a function with equal numbers of extrema and zero-crossings and with symmetric envelopes defined by the local maxima and minima (Huang, 2000). Second, each IMF is analyzed with the Hilbert Transform to give the Hilbert Spectrum (time-frequency-energy distribution) of the signal. This is very useful for engineers because it gives a time-dependent measure of specific frequencies and their respective energy contribution to the original signal.

EMD is capable of decomposing a wide variety of signals, including those that are nonlinear, nonstationary, intrawave amplitude- and/or phase-modulated. The IMFs are extracted from the original signal through a filtering process. First, the local maxima of the original signal, \( u(t) \), are identified and connected with a cubic spline. This is referred to as the upper envelope. Likewise, the local minima are connected to form the lower envelope. The mean of the two envelopes is computed and denoted as \( m_{11} \). The first IMF, \( c_1 \), is estimated as \( c_{11} \) and is taken as the difference between the original signal and the mean \( m_{11} \). Next, the process is repeated using \( c_{11} \) as the original signal and so on. Mathematically this is represented by
\[ c_{11} = u(t) - m_{11} \]
\[ c_{12} = c_{11} - m_{12} \]
\[ \vdots \]
\[ c_{1k} = c_{1k-1} - m_{1k} \]

This process is repeated until the resulting function, \( c_{1n} \), has equal numbers of maxima and zero-crossings, making \( c_{1n} \) the first IMF. The iteration may be terminated when the deviation between the \( k \) and \( k-1 \) steps, \( D_v \), is smaller than some user-specified value. This deviation can be defined as
\[ D_v = \sqrt{\frac{\sum_{i=1}^{N} (c_{1k}(t_i) - c_{1k-1}(t_i))^2}{\sum_{i=1}^{N} c_{1k-1}^2(t_i)}} \]

where \( t_i = i \Delta t \) and \( N \Delta t = T \), the sampled period.

Once the first IMF is extracted, the residue, \( r_{1} \), is computed as the difference between the original signal and the IMF. The above process is then repeated again, using the residue as the data to extract the second IMF, \( c_2 \). In general this process may be repeated \( n \) times, using the residue from the \( n-1 \) extracted IMF, \( r_{n-1} \), as the original data. This is represented as
\[ r_{1} = u(t) - c_1, \quad c_{21} = r_{1} - m_{21} \]
\[ r_{2} = u(t) - c_2, \quad c_{22} = r_{2} - m_{22} \]
\[ \vdots \]
\[ r_{n-1} = u(t) - c_{n-2}, \quad c_{n-1} = r_{n-1} - m_{n-1} \]

The process is stopped when the final residue, \( r_{n} \), becomes a monotonic function from which no more IMFs can be extracted. If the original function has a non-periodic moving average, \( r_{n} \) should represent this. After all IMFs are extracted, the Hilbert Transform is performed on each IMF.

There are many benefits to using EMD as opposed to other signal processing methods. First, the basis functions for decomposition are not predetermined. Rather, they are derived from the original signal, making EMD purely adaptive and extremely versatile (Huang, 2001). Second, any discontinuities present in the original signal are maintained in the first extracted
IMF, c (Pai, 2005). Third, because EMD does not rely on orthogonality, it is not as susceptible to leakage phenomena associated with Wavelet and Fourier transformations (Pai, 2005). Fourth, it is not required to define a zero reference for the signal, making it unnecessary to remove the DC term in measured data (Huang, 2001). Finally, the incorporation of intermittency criteria in the EMD procedure is successful in filtering out unwanted noise (Huang, 2001). The primary disadvantage is that HHT analysis is inaccurate near the data endpoints due to discontinuity-induced Gibbs’ phenomenon.

Many studies have already been performed to determine the ability of HHT to decompose simulated data for structural health monitoring. In an example given by Yang et al. (2004a), HHT analysis and EMD was performed on a simulated four-story ASCE benchmark building in order to detect damage time instants, or damage spikes, that occurred when various braces were removed from the structure. In addition, the experiment was performed with varying degrees of noise pollution and the results for both HHT and EMD were compared. It was found that EMD could accurately detect the damage time instances on every floor with only two sensors on each floor as long as little or no noise pollution was present. However, with a 10% noise to signal ratio, EMD could not detect every damage spike. Contrarily, HHT was able to detect all damage time instants with 10% noise with only one sensor located on the 4th floor. Also, the authors were able to accurately determine the natural frequencies and damping ratios of the structure before and after the introduction of damage (Yang et al., 2004a).

A second study by Yang et al. (2004b) gave similar results. In this study, a 76-story office tower building under ambient wind loading was considered. Again, HHT analysis was able to accurately determine the natural frequencies and damping ratios for both 0% and 10% noise with only one sensor located on the top floor. The authors do warn that for a noise to signal ratio of 20%, the accuracy is degraded but still remains within a reasonable limit.

Experimental Setup and Procedure

In order to experimentally verify the results given above and to provide quantitative comparisons between SWF and HHT analysis for processing measured vibration data, a vertically cantilevered titanium alloy beam (496.8mm × 52.07mm × 0.4699mm) subject to a harmonic base excitation was considered. The beam vibration was induced with a lead zirconate titanate (PZT) patch adhered near the clamped end of the beam. A Polytec PSV-200 scanning laser vibrometer was used to measure the velocities of many equally spaced points on the beam. The PSV-200 scanning laser vibrometer is capable of providing remote, non-contact measurement up to 30m away by detecting the frequency shift of the back-scattered laser beam. In addition, the PSV-200 provides a large scanning area (up to 40° × 40°) as well as a dense measurement grid (up to 512 × 512 points) and a high frequency bandwidth (0.2Hz – 20MHz) with a velocity resolution of 0.1 µm/s. A schematic of the instrument setup is illustrated in Figure 1.

The PSV-200 scanning laser vibrometer was used to measure and record velocity data from the harmonically excited cantilevered beam. This process was performed numerous times with excitation frequencies at or near the beam’s first four linear natural frequencies to allow for maximum displacement amplitude. Figure 2 shows the operational deflection shapes of the beam at these frequencies. In addition, measurements were taken while the beam was impacted with a small steel rod. After the measurement process, the time-domain velocity data were analyzed using both HHT and SWF; both methods were implemented using Matlab.

Figure 1: The experimental setup of the scanning laser vibrometer and a vertically cantilevered beam for vibration testing.

![Figure 1](image1.png)

Figure 2: The operational deflection shape of the beam subject to a harmonic excitation at a linear natural frequency: (a) ω₁=1.313 Hz, (b) ω₂=9.406 Hz, (c) ω₃=26.28 Hz, (d) ω₄=51.25 Hz.

Results

Figures 3-5 illustrate the velocity response of the beam when excited at its first three linear natural frequencies without impact. When the beam is excited at its first and second natural frequencies, HHT and SWF clearly indicate frequency and amplitude modulations at 2Ω, where Ω is the excitation frequency. This is indicative of cubic nonlinearity. Although the
beam is not damaged, this nonlinearity is due to fact that small angle linearization is no longer valid for such high-amplitude vibration. When the beam is excited at its third natural frequency, the signal is decomposed into two IMFs, as indicated in Fig 5. This is a 1:2 internal resonance and is indicative of quadratic nonlinearity. This nonlinearity is caused by gravity-induced static bending. In each of these tests, HHT is more capable than SWF of indicating frequency and amplitude modulation. However, HHT suffers from Gibbs’ phenomenon at the data endpoints, as is evidenced by the presence of large overshoots in the decomposed signal.

Figure 3: Velocity response of harmonically excited beam, $u(t)$, at first natural frequency ($\omega_1=1.313$ Hz) with extracted IMFs, $c_i(t)$, and time-varying frequency and amplitude from HHT and SWF.

Figure 4: Velocity response of harmonically excited beam, $u(t)$, at second natural frequency ($\omega_2=9.406$ Hz) with extracted IMFs, $c_i(t)$, and time-varying frequency and amplitude from HHT and SWF.

Figure 5: Velocity response of harmonically excited beam, $u(t)$, at third natural frequency ($\omega_3=26.28$ Hz) with extracted IMFs, $c_i(t)$, and time-varying frequency and amplitude from HHT and SWF.

Figures 6-9 illustrate the results from the impact tests. In each case, there exists only minor evidence of an abnormality in the measured signal. This evidence becomes slightly more pronounced as the number of impacts is increased. Although the time-varying frequencies and amplitudes obtained from SWF processing provide improved indication of damage time instants, the results from HHT are far greater. There are numerous reasons for this discrepancy. With SWF, the signal is averaged throughout the sampled period and any discontinuities in the signal, in particular those due to an impact, are shared by all extracted components. Conversely, with HHT all discontinuities are preserved in the first IMF. Therefore, this IMF will possess large frequency and amplitude spikes at the time the structure was impacted.

Figure 6: HHT and SWF results for harmonically excited beam with single impact.
Conclusion

Current trends in vibration-based structural damage detection have shifted from model-dependent modal-shifting methods to faster model-independent time domain methods. These methods use a structure’s measured velocity and/or acceleration data in order to detect and locate damage by analyzing the data with modern signal processing techniques. The challenge is developing signal processing tools that can accurately extract damage indicators from nonlinear, nonstationary, and/or transient response data. The results presented here provide comparisons between a Fourier/ Wavelet-based Sliding-Window Fitting technique and the Hilbert-Huang Transform. Unlike SWF, HHT is adaptive, requiring no a priori selection of basis functions, and does not rely on orthogonality; thus HHT is better than SWF for processing nonlinear signals. In addition, whereas SWF distributes all discontinuities from the original signal throughout all extracted components, HHT preserves all discontinuities in the first extracted IMF; therefore, HHT is more capable of providing clear indications of damage time instants. However, care must be taken as the accuracy of HHT is degraded near the data endpoints due to discontinuity-induced Gibbs’ phenomenon.

References:

Introduction

Although many studies have been conducted on the extent to which college students value academics, little research has devoted attention to the factors that motivate “at-risk” African American high school students to achieve in an academic setting. According to Calabrese and Underwood’s (1994) study of the effects of school-generated racism on students of color, they found most research that was geared to the academic success of high school adolescents primarily focused on low socioeconomic status, differences in teacher/student culture and inadequate curriculum, without addressing the factor of how student/teacher relationships are perceived by the students. Though factors that deal with performance in African American adolescents have been studied, it has been difficult to find scholarly research that has attempted to predict what factors are involved in school attitudes among these individuals.

Some scholars (e.g., McWhorter, 2000) have argued that African American culture is anti-intellectual and produces African American students who do not value academic success. However, in an attempt to study the dynamic of the experience in school for “at-risk” or low socio-economic adolescents, Calabrese and Underwood (1994) suggested that race played a large factor in the responses of students regarding the treatment they received from their teachers. According to their study, power relationships between teachers and “at-risk” African American students have been embedded in both parties (Calabrese & Underwood, 1994). That is to say, teachers have learned over time to apply pressure on these black, “at-risk” students, while simultaneously, the students have been trained to not question authority, thus becoming disengaged with school and developing poor attitudes about scholastic achievement (Calabrese & Underwood, 1994).

An example of the power in student/teacher relationships involved a student who was interviewed in the study (Calabrese & Underwood, 1994). In his interview, the student referred to a quiz in which he had been given a failing grade. The student explained that he was called out and punished for missing merely two questions on a test, and received a “F” in the class for that quarter. This particular student had never before failed a class, but was certain of the prejudice of his teacher, considering that only the black children were singled out in his class (Calabrese & Underwood, 1994). With this power struggle, the “at-risk” student must strive to survive among a racially driven system (Calabrese & Underwood, 1994).

It is at this juncture that school attitude and school performance seem to interact with one another. If the burden of poor performance is indeed placed on the adolescent, and that burden is perceived to be racially motivated, how is that individual’s attitude regarding school going to be affected? To accurately address this critical question, we must consider the factor of perceived contextual stress on self-esteem. According to Michael Cunningham et al (2002), contextual stress is composed of the combination of stressors in peer groups, the home environment, and school contexts. In turn, the effects of these stressors in specific areas negatively affect self-esteem (Cunningham et al., 2002). In a cross-sectional longitudinal study of 84 African American high school students who were from low-income families, it was found that the combination of perceived contextual stress indeed affected GPA or academic performance,
with school self-esteem being the most significant variable (Cunningham et al., 2002).

In other studies, attitudes about school and academics are also linked to stress, cultural values, and self-esteem (Cunningham, Hurley, & Hayes, 2002; Calabrese & Underwood, 1994; Schmader, Major, & Gramzow, 2001). Since negative stereotypes of intellectual inferiority are present in certain minority groups, particularly African American adolescents, many of these adolescents may disengage from the academic domain to free themselves from stress or anxiety (Steele, 1997). For example, in Calabrese and Underwood’s (1994) study, it was found that African American subjects’ attitude about school became poor when teachers would constantly degrade the black students in class, telling them that they were “dumb” or “just didn’t get it” (Calabrese & Underwood, 1994). African American students have also been found to discount test scores and intelligence tests as true indicators of ability due to this disengagement (Schmader, Major, & Gramzow, 2001).

It is here where the role of perceived racism and contextual stress contribute to negative school attitudes or devaluing academic success (Cunningham, Hurley, & Hayes, 2002; Schmader, Major, & Gramzow, 2001). Minorities become disengaged with school when they perceive their environment or individuals in their environment to be racist (Schmader, Major, & Gramzow, 2001). Furthermore, African Americans who perceive a great deal of racism against their ethnicity in school will assume that particular racism to be permanent, and thus disengage themselves from school or show negative attitudes toward school (Schmader, Major, & Gramzow, 2001).

Indeed, it can be said that perceived injustice or racism in school is a primary factor in African American adolescents devaluing academic success; however, there are also factors that deal with racial identity that could very well be attributed to scholastic attitudes. According to John Ogbu (1991), African American communities often develop survival strategies in order to reduce the impact of mainstream exploitation by whites. As the black community has evolved in the contemporary world, these strategies have become more ingrained in the culture and have been labeled under the “collective struggle” (Ogbu, 1991). It has also been found that a “collective struggle” does not hold the same regard in the white community (Ogbu, 1991).

Through the implementation of such strategies, adolescents in the black community have found a median to establish the development of racial identity (Ogbu, 1991). This racial identity is then fostered by the common experiences of exploitation (Ogbu, 1991). Since the development of racial identity is also collective among the black population, it is crucial for adolescents, specifically “at-risk” adolescents, to be exposed to environments that will promote the development of racial identity (Ogbu, 1991).

In light of this information, it can be seen that school is most certainly a community where racial identity is developed. As we have discussed, the development of racial identity is both positive and crucial to the African American adolescent; however, in its beginning stages, stereotypes for both the black and white races are highly influential (Cokley 2002; Ogbu 1991; Vandiver et al., 2001). To begin, it is common for blacks to regard certain behaviors, events, and interpretations to be “white” and steer away from them. In addition, Fordham and Ogbu (1986) argue that the fear of “acting white” is a primary factor that influences school-related attitudes among African American high school students. As previously discussed, if blacks perceive racism against them and thus see the entire school system as racist, they are likely to call the system “white” and in turn associate involvement in school as “white,” causing a negative school attitude (Fordham and Ogbu, 1986; Schmader, Major, & Gramzow, 2001).

To establish the progression or placement of identity, it is common to use Cross’s (1971) model of the five racial identity stages. Those stages include the pre-encounter, encounter, immersion-emersion, internalization, and internalization commitment (Cokley, 2002). Cross would go on to revise his model, making specific changes in the pre-encounter and internalization stages (Vandiver, 2001). In a review of Cross’s revised model (1991, 1995), specific interest is shown in two identity clusters; pre-encounter racial identity and immersion-emersion racial identity (Cokley, 2002).

The pre-encounter stage has three distinct clusters, which include assimilation, miseducation, and self-hatred (Cokley, 2002). In the pre-encounter assimilation, the individual has a low salience for race but holds being an American in high regard. For the miseducation cluster, these individuals will internalize negative stereotypes about being black (i.e. lazy or criminal). And finally, the self-hatred cluster will hold extremely negative regard toward blacks and to being black (Cokley, 2002).

The immersion-emersion stage is theorized to hold two identities that are closely related (Cokley, 2002). The first is the extreme celebration of the African American race and the perception of blackness or Afrocentrism as good (Cokley, 2002). The second is characterized as an “anti-white” attitude where the individual sees everything that is white to be evil or corrupt (Cokley, 2002). Those individuals that are in the immersion-emersion stage will be seen fully immersing themselves in black culture (Cokley, 2002).

According to Cokley (2002), pre-encounter and immersion-emersion also positively correlate with internalized racialism. Internalized racialism has been defined as African Americans internalizing negative and positive stereotypes given by whites (Cokley, 2002). Although one component of immersion-emersion identity has been defined as being “anti-white,” this identity will still be found to accept the positive stereotypes that were established by whites (i.e., blacks run faster, jump higher) (Cokley, 2002). In turn, the pre-encounter identity will accept negative stereotypes of blacks (i.e. prone to criminal activity) (Cokley, 2002).

Given the information on racial identity stages and the concept of internalized racialism, it seems that if the adolescent is in the immersion-emersion anti-white stage of their racial identity, stereotypes for “acting white” may act as a medium for devaluing academic success. On the other hand, if the adolescent is in the pre-encounter self-hatred stage, holding negative thoughts and stereotypes about blacks or being black themselves may cause stress that would contribute to devaluing academic success.

Although there is little to be said regarding the employment of afrocentric values to promote positive school attitudes in adolescents, there is evidence that suggests that afrocentric values have a positive affect in the black community (Cokley...
& Williams, 2005). According to Cokley and Williams (2005), if an understanding of the African people is consistent with African-centered values, then people of African descent can be informed of their conceptualizations; thus, eliminating cultural misrepresentation and identity confusion. In determining some of the factors that influence school attitudes in “at-risk” African American adolescents, we contend that having strong afrocentric values and/or a positive relationship with a teacher will cause the adolescent to value academic success, while perceived racism, pre-encounter and immersion-emersion attitudes, and experiences with race related stress will all cause adolescents to devalue academic success.

**Method**

**Participants and Design**

Thirty-one African American high school students between the ages of 14-18 from Columbia, Missouri, participated in the study. 61% were male and 39% were female. Youth involved in this study were required to obtain the consent of a parent or guardian prior to participation. All participants have or will be involved with the City of Columbia’s Career Awareness Related Experience (C.A.R.E.) Program. The C.A.R.E. Program is a city-funded program designed to acquire employment for “at-risk” youth between the ages of 14 and 18. The incentive of free pizza was provided by the researcher. However, some participants chose to participate without an incentive.

**Procedure**

Small groups of three to fifteen youth were selected to participate on different dates. All surveys for this study were administered at the C.A.R.E. Program office. Each participant was checked in via a sign-up sheet upon entering the office, and then seated at a conference room table. After all participants were seated, they were given a youth assent form, which was to be signed and returned to the researcher. A copy of the consent form was also given to each participant. The researcher then instructed the participants to carefully read the assent form, and reminded them that participation in the study is voluntary and will not affect their status in the C.A.R.E. program. After signing the assent form, participants were given a demographic form, where they reported their age, sex, grade classification and answered questions related to school involvement and family background. Participants were also asked to self-report their cumulative high school grade point average. In the event a participant classified himself or herself as not attending high school, they would be released from the study.

Following the demographic form, a series of six surveys were administered. The first was the Perceived Racism Scale (PRS; McNeilly, Anderson, Armstead, et al., 1996). The PRS was originally composed of 51 items dealing with racism in several dimensions, but was shortened to nine items, which dealt specifically with perceived racism in school. “Teachers and students assume I’m less intelligent because of my race,” is an example of perceived racism from instructors and peers while “My academic advancement has suffered because of my race,” is an example of the effects of perceived racism. Participants were able to respond to the statement by assigning a number on a 0-5 scale, which represents how often they have experienced each event. A response of 1 represented “almost never,” while a response of 5 represented “several times a day” (responses 2-4 measure several times a year, month and week, respectively). Finally a response of 0 indicated that the statement is not applicable.

After the PRS, participants completed the Cross Racial Identity Scale (CRIS; Cross & Vandiver, 2001). According to Cokley (2002), CRIS’s scale includes five stages of racial identity: pre-encounter, encounter, immersion-emersion, internalization, and internalization commitment. The first stage pertains to negative feelings about being Black, while the final stage represents a more multicultural and afrocentric perspective. As the individual develops through the stages, he or she moves toward a more psychologically healthy Black identity (Cokley, 2002). Participants completed the 40-item scale, which allowed the researcher to classify each individual to a particular stage. Questions in this scale include “I sometimes struggle with negative feelings about being black,” “I hate the White community and all that it represents,” and “I believe it is important to have both a Black identity and a multicultural perspective, which is inclusive of everyone.” Participants were instructed to respond to each statement on a 7-point Likert scale. A 7 indicated a strong agreement, while a 1 indicated a strong disagreement.

The Disengagement Scale (DS; Major & Schmader, 1998) was then completed. The DS is a 12-item scale which measures the participant’s feelings toward standardized tests and the value that he or she places on them as accurate depictions of intelligence. The DS is divided into three sub-components; discounting, devaluing, and disengagement. An example of discounting would be “I feel that standardized achievement tests are definitely biased against me.” An example of devaluing would be “It usually doesn’t matter to me one way or the other how I do in school.” And finally, an example of disengagement would be “I really don’t care what tests say about my intelligence.” Participants were able to rate each statement on a 7-point Likert scale, much like that of the CRIS.

The fourth scale administered was the Afrocentrism Scale (Grills & Longshore, 1996). The Afrocentrism Scale measures the importance of personal values and the Black community to an individual (statements in this scale range from very positive to very negative). “I have very little faith in Black/African American people,” would be an example of a negative statement, while “I owe something to Blacks/African Americans who suffered before me,” would be a positive statement. Participants rated each statement on a 4-point Likert scale. A 4 would represent a strong agreement with the statement.

The Index of Race Related Stress-Brief (IRRS-B; Utsey & Ponterotto, 1996) is an 18-point scale dealing with the stress felt by African Americans when they encounter racism and/or discrimination. Statements on the IRRS-B are derived from the 4 sub-scales of the IRRS which deal with cultural, institutional, individual, and collective racism. “You seldom hear or read anything positive about black people on the radio, T.V., in the newspaper or in history books.” is an example of these statements. Participants responded to the 18 statements using a 5-point scale. A response of 0 indicated that the event never happened to the participant, while a response of 4 indicated that the particular event has happened and it made him or her extremely upset.

Lastly, participants completed the Student-Teacher Interaction Sub-Scale (stu/teacher). This sub-scale was derived from the
Student-Professor Interaction Scale (Cokley, Komaraju, Patel, et al., 2004), a scale originally created to measure the interactions between college students and instructors. The scale was modified for this study to target high school students, as well as shortened to only measure positive, supportive relationships between the two populations. “I feel that one or more teachers are supportive of me” is an example of one such positive statement. Participants responded on a 7-point Likert scale, 1 being a strong disagreement and 7 being a strong agreement with the statement. Upon completing the last survey, participants were thanked, debriefed and given incentives if applicable.

Results

A bivariate correlation was performed to examine the relationship of perceived racism, pre-encounter self-hatred attitudes (PSH; Cross racial identity), immersion-emersion attitudes (IEAW; Cross racial identity), cultural racism (IRRS-B), institutional racism (IRRS-B), and individual racism (IRRS-B) with devaluing academic success. Similarly, a bivariate correlation was performed to examine the relationship of afrocentric values and a positive interaction with a teacher with valuing academic success. Table 1 contains means and standard deviations for the DS, PR, CRIS, IRRS, AFRO, and stu/teacher scales. Table 2 contains Pearson Correlations for all variables.

As indicated in Table 2, all variables were correlated with the sub-scale of Devalue for the Disengagement Scale. The correlations between variables indicates that perceived racism (-.165), immersion-emersion anti-white attitudes (.291), pre-encounter self-hatred attitudes (.233), cultural racism (-.259), institutional racism (-.026), and individual racism (-.320) were not significantly correlated with devaluing academic success (p > .05). However, the relationship between Devalue and afrocentric values (-.623**), and positive student-teacher interaction (-.616**) were found to have a significant correlation with valuing academic success (p < .001).

Table 1

Means and Standard Deviations for the DS, PR, CRIS, IRRS, AFRO, and stu/teacher scales.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disengagement Scale (devalue)</td>
<td>2.35</td>
<td>1.28</td>
</tr>
<tr>
<td>Perceived Racism Scale</td>
<td>1.51</td>
<td>.91</td>
</tr>
<tr>
<td>Pre-Encounter Self-Hatred (CRIS) (CRIS)</td>
<td>1.69</td>
<td>1.23</td>
</tr>
<tr>
<td>Immersion-Emersion Anti-White (CRIS)</td>
<td>2.44</td>
<td>1.11</td>
</tr>
<tr>
<td>Cultural Racism (IRRS-B)</td>
<td>19.16</td>
<td>6.33</td>
</tr>
<tr>
<td>Institutional Racism (IRRS-B)</td>
<td>4.32</td>
<td>3.13</td>
</tr>
<tr>
<td>Individual Racism (IRRS-B)</td>
<td>12.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Afrocentrism Scale (AFRO)</td>
<td>2.93</td>
<td>.33</td>
</tr>
<tr>
<td>Student-Teacher Interaction (stu/teacher)</td>
<td>5.68</td>
<td>1.46</td>
</tr>
</tbody>
</table>

Note: N = 31

Table 2

Pearson Correlations for Disengagement subscales, PR, CRIS subscales, IRRS-B subscales, AFRO, and stu/teacher scales.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
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<tbody>
<tr>
<td>1.Disengagement (Discoun)</td>
<td>0.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.02</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2.Disengagement (Devalue)</td>
<td>-0.17</td>
<td>-0.16</td>
<td>0.29</td>
<td>0.23</td>
<td>-0.32</td>
<td>-0.32</td>
<td>-0.32</td>
<td>-0.62</td>
<td>-0.62</td>
<td>-0.62</td>
<td>-0.62</td>
</tr>
<tr>
<td>3.Disengagement (Discogage)</td>
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<td>11.Student/ Teacher (stu/teacher)</td>
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*Correlation is significant at the .05 level (2-tailed)
**Correlation is significant at the .01 level (2-tailed)

Discussion

The purpose of this study was to determine whether perceived racism, racial identity attitudes, and race related stress would be factors that contribute to “at-risk” African American high school students devaluing academic success. Furthermore, our purpose was to find whether having strong afrocentric values and a positive relationship with a teacher would be factors that contributed to valuing academic success. Although most research that has been conducted on African American adolescents primarily focused on low socioeconomic status, differences in teacher/student culture, inadequate curriculum, and scholastic performance, we felt it was important to begin understanding what factors determine the attitudes of this population.

Surprisingly, the results of our preliminary study only supported two of our five hypotheses. According to the data, perceived racism does not seem to have an influence on devaluing academic success. In fact, perceived racism was found to have a negative, insignificant correlation with devaluing academic success. Additionally, pre-encounter self-hatred and immersion-emersion racial identity attitudes did not have a significant correlation; however, as predicted, the correlation was a positive one. When race related stress was correlated with devaluing academic success, there was also a negative correlation which was also not significant. The two hypotheses that were supported involved having afrocentric values and a positive...
student-teacher interaction, which were found to have a strong negative correlation with devaluing academic success.

Contrary to our hypotheses, many of the youth that participated in the study expressed racial identity attitudes that were classified under the immersion-emersion multicultural attitude. As Cokley (2002) explains, the multicultural attitude is defined as having positive views for various racial and ethnic groups, but still having a strong tie or bond to being immersed in African American culture. Since many of the youth indicated this attitude, the perception of racism among peers may have been lowered, supporting the negative correlation found between the perception of racism and devaluing academic success.

The data was further examined to show that race related stress seemed to not play a significant role in devaluing academic success. However, from the data it is seen that a strong student-teacher relationship was a very significant factor in the youth valuing academic success. With this information, it is possible to contend that institutional and individual racism had non-significant negative correlations due to the strength of the student-teacher interaction. As for cultural race related stress, the strong significant correlation between having strong afrocentric values and valuing academic success could have been a factor in youth not feeling the stress of cultural racism.

In addition to the data on the Afrocentrism Scale, the information derived in the debriefing process could have been a significant factor in the lack of support for our hypothesis. During that process, it was brought to our attention that many of the participants have been or are currently enrolled in a course titled, “Boys/Girls Empowerment.” This course, designed for ninth grade minority students, is held once a week and touches on race related issues both in school and out of school. In ninth grade minority students, is held once a week and touches on race related issues both in school and out of school. In addition to the issues of racism being discussed in the class, the course is also taught by a Caucasian teacher. After being asked the question of whether or not the youth felt comfortable having a person outside of their race teach them about their culture, most of them said that it was very helpful. They indicated that they felt as though “someone from the majority supported and understood them.”

Due to the limited number of participants in the study (N=31), it is important that we continue this research to further analyze our hypotheses. Further research will be conducted on this subject that will allow for 100 participants (N=100), giving us a greater sample size. Furthermore, there were several factors that were not considered that seem to play a significant role in what is influencing academic attitudes, some of which include; alternative racial identity attitudes and the Boys/Girls Empowerment course. With the new data, we will be able to determine the attitudes of African American adolescents.

References


Introduction

Concern has grown in recent decades over the status of Neotropical migratory passerines. As many of these species have been found to be in decline (e.g., Morton and Greenberg 1989, Sherry and Holmes 1996, Ballard et al. 2003), efforts have been made to understand their ecology and factors that may limit their populations, not only on breeding grounds but on wintering grounds as well (Sherry and Holmes 1995, 1996). Studies on the breeding season ecology of Neotropical migrants are numerous; however, less is known about what occurs on the wintering grounds even though individuals may spend up to 2/3 of each annual cycle in their winter habitat (Keast 1980). Therefore, it is critical for the conservation of these birds that researchers gain knowledge on their wintering ecology and characteristics.

Many migratory songbirds exhibit habitat segregation by sex and/or age on their wintering grounds (e.g., Lynch et al. 1985, Lopez Ornat and Greenberg 1990, Marra et al. 1993, Parrish and Sherry 1994). This has important implications in species conservation, and must be considered when studying wintering ecology because multiple habitat types may be required to meet each species’ needs. With habitat degradation and variation in habitat quality, this intraspecific habitat specialization could, and possibly has, lead to different survival rates between age or sex classes, in turn affecting population viability.

On breeding grounds, territoriality is primarily a male characteristic; however, it is typical of males and females on wintering grounds (e.g., Nisbet and Medway 1972, Rappole and Warner 1980), most likely due to each individual’s need to defend a food supply (Marra et al. 1993). With males and females both defending territories, there is increased competition for high quality habitat, which may lead to dominant individuals of a species excluding subordinate individuals from the optimal habitat (Marra et al. 1993). This could be a cause of habitat segregation in some species, and is important because habitat quality has a direct effect on population numbers. As the quality of habitat decreases, so may the fitness of birds occupying that habitat. Marra and Holmes (2001) reported that American Redstarts (Setophaga ruticilla) wintering in lower quality habitat in Jamaica had lower body mass and lower annual survival than those in higher quality habitat. Because more females winter in the less suitable habitat than males, females are disproportionately affected. This could potentially influence population sizes because less fit females may not be as successful during the breeding season or may not survive to return to the breeding grounds, causing a decrease in numbers of offspring produced (Marra and Holmes 2001).

The Black-and-white Warbler (Mniotilta varia), a common and widespread Neotropical migrant, breeds in central and eastern Canada (Godfrey 1986) and eastern United States (Hamel 1992) and winters along parts of the southeastern coast of the United States, Mexico, Central America (Howell and Webb 1995), South America (Ridgely and Tudor 1989), and Caribbean islands (Arendt 1992). Black-and-white Warblers are considered generalists in their habitat selection (Wunderle and Waide 1993), and winter in habitats ranging from early successional to mature forests, and varying in vegetation structure and amount of moisture (Wunderle and Waide 1993, Kricher 1995). Little evidence exists in the literature to support habitat segregation in Black-and-white Warblers. Moore et al. (1990) found no evidence of sexual habitat segregation on Horn Island in the Gulf of Mexico, and Lopez...
Ornat and Greenberg (1990) found only possible differences in distribution of sexes and age classes in Mexico. However, a study in Guánica Forest, Puerto Rico, found >90% female Black-and-white Warblers in scrub habitat (Dugger et al. 2004).

The purpose of this study was to examine wintering characteristics of Black-and-white Warblers in a dry forest in Puerto Rico by gathering information on the extent of habitat heterogeneity in the forest and how it affects individual choices in habitat selection and site fidelity each year. Understanding these aspects may provide a preliminary understanding of why these birds are found to exhibit sexual habitat segregation in Puerto Rico.

**Methods**

**Study Site**

The study was conducted in the Guánica Forest Reserve on the southwestern coast of Puerto Rico, located at 17°55’N, 67°05’W, and 0 to 228 m above sea level. The 4015 ha forest is classified as mature dry subtropical forest (Ewell and Whitmore 1973) and is dominated by sclerophyllous vegetation as a result of the seasonal rainfall and limestone soil (Faaborg and Arendt 1989). Wooded areas outside of Guánica Forest have been largely altered so that Guánica, with about half of the land in relatively unaltered condition, is considered to be a more natural island of habitat isolated from the rest of Puerto Rico (Faaborg and Arendt 1989). MacArthur et al. (1966) and Kepler and Kepler (1970) found Guánica Forest to be the richest in avian species and density of all habitats surveyed in Puerto Rico.

**Data Collection and Calculations**

A long-term bird-banding study has been conducted in Guánica since 1973 using the techniques described by Terborgh and Faaborg (1973). Net lines of 16 nets (12 m long, 2.6 m high, 30 mm mesh) each were used and were operated from dawn to dusk for three consecutive days. Captured migrants and resident birds were banded and released, with age and sex recorded when determined.

I analyzed Black-and-white Warbler mistnetting data collected from 1989 to 2006 except 2002, for which data was unavailable. Seven net lines began in 1989 and have been run every year since, up to and including 2006. One line was added in 1990, and one line was added in 1991, each also in operation up to and including 2006. Data were collected from 4 January to 15 February within each year.

I calculated the mean captures and mean recaptures per net line per year. To examine “hotspot” areas, I calculated the mean number of captures for each net line. Then I designated “hotspot nets” as nets that had experienced at least 33% more captures than the mean of the total number of captures of each net for the net line they were a part of, and calculated the proportion of recaptures that occurred in these hotspot nets for each net line.

**Results**

The mean number of captures per net line per year and the mean number of recaptures per net line per year varied across all net lines (Fig. 1 and Fig. 2).
Using the classification of at least 33% more captures than the mean of the total captures per net designated two to five hotspots per net line, with a total of 30 hotspot nets overall out of the 144 nets. The proportion of recaptures occurring in hotspot nets varied as well across all net lines (Fig. 4). The proportion of recaptures that occurred in hotspot nets ranged from 0 to 0.75, with a mean of 0.33.

**FIGURE 4. The proportion of recaptures that occurred in nets designated as hotspots for each net line.**

![Proportion of recaptures in hotspot nets](image)

**Discussion**

The results provide strong evidence for habitat heterogeneity, both across Guánica Forest and on a smaller scale. The differences in capture rates across the nine net lines suggest variation in habitat quality on a larger scale, while the hotspot nets suggest very small, local patches of higher quality habitat.

The positive correlation between mean captures per net line per year and total recaptures per net line suggests strong site fidelity in the Black-and-white Warblers wintering in Guánica. Increasing numbers of captures would lead to increasing numbers of recaptures in the area if the birds are locally site faithful. The outlier, net line 3, experienced the highest number of mean captures per net line per year but the second to lowest number of mean recaptures per net line per year. Unlike the other net lines, net line 3 may have been less suitable habitat selected by young birds in their first winter. Those birds that returned in following years may have shifted their territories or moved to different areas.

The proportion of recaptures occurring in hotspots showed more variation across net lines than was expected. If these hotspot nets are of higher quality habitat, they should experience higher numbers of recaptures. This was true for some of the net lines, but others showed much lower proportions of recaptures occurring in hotspot nets. This may suggest that while some habitat may be suitable enough to be selected as wintering territory by a significant number of birds, there may still be subtle differences in habitat quality so that the net lines produce different return rates.

Local habitat heterogeneity is likely a driving factor in how Black-and-white Warblers select wintering habitat, and whether surviving birds choose to return to the same territory or not the following winter. Much work is necessary to further examine these aspects of wintering ecology. Currently I am comparing vegetation data from each net line in Guánica with the capture rates of the net lines to obtain a more quantifiable classification of the differences in habitat quality. Then I will calculate survival rates and compare across net lines, using these habitat quality classifications to determine if the differences in quality are strong enough to have an effect on survival. I will also compare male and female habitat use and examine the movements of individual birds between nets and net lines.

**Literature Cited**


Hamel, P. B. 1992. The land manager’s guide to birds of the south. The Nature Conservancy, Chapel Hill, NC.


Douglas Steinley, PhD

As a recent alumnus of the McNair Scholar program (1995-1996), I only can make the highest recommendations for participation in the program. In short, the McNair Scholar program provided me with a set of skills that led me to receive my Ph.D. in Quantitative Psychology in 2004 from the University of Illinois, Urbana-Champaign. The opportunities provided by the McNair Scholar program are too enumerable to discuss comprehensively; however, a couple of the experiences stand above the rest in shaping my experience at the University of Missouri.

For me, the two most salient experiences were: (a) conducting research with a faculty mentor, and (b) the numerous workshops on writing (including writing a personal statement, a research article for publication, etc.). In order for the importance of these two experiences to be fully recognized, it is important to mention that I was a first generation college student. Although I came from a home with very supportive parents, neither had any experience on the particular challenges that arise when one attends college—not to mention the unique skill set that is required for success in graduate school.

Left to my own devices, I was glad to merely attend classes and work a part-time job to help pay for my education. However, the McNair Scholar program contacted me in the course of my studies and introduced me to possibilities that I did not know existed. First, I had never really thought of attending graduate school or pursuing a career in research. By pairing me with my faculty mentor, Dr. Michael Stadler, two important experiences were promptly introduced: (1) I learned about conducting research and investigated a program of research that I had personal interest in, and (2) I immediately was given a taste of what graduate school would be like, and I could not wait to fully immerse myself in a research program.

However, where I feel that the McNair Scholar program truly excels is that it goes above and beyond introducing undergraduate students to only doing research. In fact, the goal of helping the scholars become as well-rounded as possible is the defining achievement of the program in my opinion. First, the fun and excitement of research is tempered by the realization that the expectations in graduate school go beyond just conducting research. By intermixing learning experiences that require due dates, the McNair Scholars program effectively teaches the importance of time management. This skill augmented by the multiple assignments that teach writing skills (both technical and grammatical), prepared me for the intensive amount of writing that is required in graduate school (both in graduate work and in publishing papers in peer-reviewed journals).

In short, I have the McNair Scholar program to thank in helping prepare me for life in graduate school and beyond. Being a first generation student, I did not have a readily available resource to draw upon to learn the ins and outs of graduate education—the McNair Scholar program filled that void nicely while introducing me to the thrill of independent research and scientific inquiry. It is definitely an experience that I would encourage everyone to take advantage of if they are ever afforded the opportunity.
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<td>Amber Wiewel</td>
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<td>&quot;Overwintering Ecology of the Black-and-White Warbler in a Puerto Rican Dry Forest&quot;</td>
<td>Mark Ryan</td>
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2005-2006 McNair Scholars

Back row: Vicki Curby (Director), Dustin Langewisch, NaTashua Davis (Assistant Director), Jeremy Bloss (Student Services Advisor)
Fourth row: Tiffanie Hamilton, Dawn Shoemaker, Joshua Livingston
Third row: Genny Asher, Jane Davis, Jesus Santiago, Victoria Okoye
Second row: Sharla Marshall, Dan Hanneken, Patrice Relerford, Amber Wiewel
First row: Evelyn Okunbor, Amber McCadney, Andrea Shaw, Maegan Reagan, Melanie SanMiguel, Marcus Brown
(Not pictured): Darlene Dixon (Program Assistant), Stephanie Raney