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From the Administration

The *Undergraduate Research Journal* at the University of California, Riverside, recognizes the collaborative research efforts of students and faculty, showcasing their creative endeavors and accomplishments.

Here, we proudly publish the diverse array of ideas and innovations emanating from our talented and intellectually curious undergraduates. This publication illustrates how UCR’s academic culture nurtures such skills as effective communication, collaboration with peers and mentors, and the academic pursuit of new knowledge and understanding.

We recognize the value of hands-on learning and academic discovery in educating our students as we prepare them for successful careers and advanced degrees in a 21st century world. Never before has human innovation and the transmission of knowledge been rewarded so handsomely and relied upon so heavily by an increasingly interconnected world. In this context, fostering undergraduate research is a vital component of the academic enterprise, and I am exceedingly proud of the work published here.

Sincerely,

Timothy P. White
Chancellor

You hold in your hands the sixth annual UC Riverside *Undergraduate Research Journal*. It provides a selective, peer-reviewed venue featuring the very best faculty-mentored undergraduate research and scholarship on our campus. The peer-review process has been very ably led by our Student Editorial Board, with advice as needed from the Faculty Advisory Board.

I want to congratulate the young scholars whose work appears here in. The process of discovery can be filled with excitement but also riddled with frustration, as we search and stumble in the dark, trying to shed new light that enriches our understanding of social or natural phenomena, nourishes our emotions, or enlivens our souls. During this process, we travel a path that no one has been on before. The journal article is the culmination of that process—a formal presentation to our community of peers and mentors of what we found on that journey. Place this volume on your bookshelf. Pull it down occasionally from the shelf to re-read and to remind yourself of the journey you traveled. I wish you many more such journeys in the future.

With best regards,

Steven G. Brint
Vice Provost for Undergraduate Education
Professor of Sociology
From the Student Editorial Board

The Student Editorial Board is very proud to bring you the sixth volume of the UCR Undergraduate Research Journal. This was a very special year for the journal. We received an overwhelming amount of submissions—in fact, the most ever, which made for a very competitive selection process. The process of bringing you this journal was truly rewarding. After reading through all of the submissions, it became clear that the level of undergraduate scholarship at UCR is tremendous. Research is such a vital part of our intellectual community at UCR, and these students have demonstrated a commitment to excellence beyond what is asked of them. Everyone’s hard work—the student authors, faculty mentors, Student Editorial Board, Faculty Advisory Board and the office of Undergraduate Education—made this journal possible. It is with great enthusiasm that we present you with this publication, filled with outstanding undergraduate writing from diverse backgrounds.
Perceived Division of Labor and Work-Family Conflict Among U.S. Married and Cohabiting Women in Heterosexual Couples

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2School of Business Administration
University of California, Riverside

A B S T R A C T

To increase our understanding of gendered roles in cohabiting and married couples, this study aimed to determine 1) whether married women differed from cohabiting women in levels of perceived fairness of the division of household and paid labor, and 2) whether married women differed from cohabiting women in the amount of conflict between family life and paid work. The nationally representative U.S. sample was composed of heterosexual married and cohabiting women between the ages of 18 to 64. It was hypothesized that cohabiting women would report a more fair division of labor and less work-family conflict than married women. Other variables were also hypothesized to have an effect. 73% of married women and 66% of cohabiting women reported a fair division of labor. 37% of married women and 24% of cohabiting women reported no work-family conflict. Logistic regression analyses showed that, controlling for other individual and couple characteristics, there were no statistically significant differences between married women and cohabiting women in the likelihood of either perceiving an unfair division of labor or reporting conflict between family life and paid work. Income, the number of minor children in the household, current employment, highest level of education completed, and number of times married were associated with the likelihood of reporting conflict. However, none of the covariates in the model predicting the likelihood of perceiving an unfair division of labor were statistically significant.

F A C U L T Y M E N T O R

Tanya Nieri
Department of Sociology

Tanya Nieri is an assistant professor of Sociology and a faculty affiliate of UCR’s Presley Center for Crime and Justice Studies and Center for Family Studies. Her research examines causes and consequences of acculturation; the etiology and prevention of youth problem behaviors, particularly substance use and violence; and community-based intervention and health promotion. The populations that she examines include immigrants and ethnic minorities, especially U.S. Latinos, Mexican cultures and communities, and families and youths. I immensely enjoyed my experience working with Genevie on her research project. Genevie is bright, motivated, and destined to continue to do great things.

AUTHOR

Genevie Co
Sociology

Genevie Co is a second-year University Honors student with a double major in Sociology and Business. Her interest in family and couple relationships and dynamics prompted her to conduct this research, and she is passionate about helping underprivileged families and children. Actively involved in feeding homeless people and providing those in transitional homes with hygiene supplies and groceries, Genevie aims to start a non-profit organization that will focus on children in poverty in our community. Genevie thanks Professor Nieri for her invaluable help and mentoring and for taking Genevie under her wings, as well as her mother for her enthusiastic and continual support.
INTRODUCTION

This study used secondary data analysis to determine 1) whether married women differ from cohabiting women in levels of perceived fairness of the division of household and paid labor, and 2) whether married women differ from cohabiting women in the amount of conflict between family life and paid work. It utilized a feminist theoretical perspective which states that gender plays a central role in determining dynamics within a family and across society and current relationship expectations, such as gender roles, which are constructed. Gendered expectations are often prominent in heterosexual couples in romantic relationships. Married women may be more likely to accept traditional gender roles than cohabiting women, who may strive to maintain independence through cohabiting. Although the societal expectations of cohabiting couples and married couples may differ, they may also be similar in that women, relative to men, will still do a larger proportion of household work, therefore also experiencing higher levels of work-family conflict.

It was hypothesized that: cohabiting women will report a more equal division of household and paid labor and less conflict between paid work and family life than married women (H1); the time spent in the romantic relationship will have a negative relationship with the perceived fairness of the division of labor (H2), and a positive relationship with work-family conflict (H3); education and income will be positively related to the perceived fairness of the division of labor (H4), and negatively related to work-family conflict (H5); the presence of minor household members will be negatively related to the perceived fairness of the division of labor (H6), and positively related to work-family conflict (H7).

BACKGROUND AND SIGNIFICANCE

Many studies have found that cohabiting couples have a more egalitarian division of labor. In Czechoslovakia, cohabiting women were twice as likely as married women to be the main breadwinner. Elsewhere, cohabiting women did less household labor as compared to married women, and cohabiting men did more household labor than married men. Cohabiting women have more similarities (such as the amount of time spent on household labor) with single, non-cohabiting women than they do with married women. Moreover, the gender gap in time spent doing household labor was widest among married women, followed by cohabiting women and then never-married women. However, past studies have not examined in depth women’s perceptions of their household division of labor. This study fills this gap in the research.

Regarding perceptions of division of labor among married couples, wives’ satisfaction with that division is not affected by the total number of hours they spend working, but rather by the extent to which their husbands share in traditionally women’s chores. Married women’s feelings of appreciation were the strongest predictors of perceptions of fairness of the division of labor. Gender ideologies shape not only the division of household labor, but also the distribution of the responsibilities assigned to each. Married women and cohabiting women spend different proportions of their time on household labor, but their household responsibilities (such as cooking, dusting, and dishwashing) are very similar.

Finally, other studies have found that although women do more household labor than men, men today are doing more household labor than in the past. Men have increased their participation in “core” household activities such as cooking, cleaning, and child care. Women spend half the number of hours on household labor they spent in the 1960s, while men now spend double. Presser attributes this shift to the “growing diversity in employment schedules among American workers,” as “(t)he more hours husbands are not employed during times when wives are employed, the more likely husbands are to do household labor that is traditionally done by females.”

I proposed that, work-family conflict is the challenge of balancing family life and work life. There is a dearth in the literature concerning the relative distribution of work-family conflict among married women and cohabiting women. This study aimed to add to the limited literature by focusing on the amount of conflict between work and family life women in couples perceive.
Only minimal research has examined age, education, household income, duration of the romantic relationship, race and ethnicity, and number of children present in the household. The number of children in the household for cohabiting couples was positively related to disproportions in the division of childcare labor. Employment, occupation, education, and urbanization did not reduce the inequity in the division of household labor. The presence of an older female in the household somewhat equalized the division of household labor. While no consensus exists in prior literature on relationship status’ effect on the division of labor and work-family conflict, some evidence supports the idea that married and cohabiting couples will differ.

METHODS

Data and sample

This study is a secondary analysis of data from the Married and Cohabiting Couples, 2010 [United States] online survey conducted by the National Center for Family and Marriage Research (NCFMR) at Bowling Green State University. NCFMR designed the study, and KnowledgePanel (KN), a survey research consulting firm, conducted the data collection. The data collection took place between 7/26/2010 and 10/13/2010. The nationally representative U.S. sample included heterosexual couples, aged 18-64 years. The data set contained 2,150 cases (1,075 couples), composed of 752 married couples and 323 cohabiting couples. The couples were recruited from KN’s active database and online advertisements. Couples in which both partners did not respond were eliminated. The secondary data analysis was reviewed and determined to be exempt from Federal Regulations, per 45 CFR 46.101(b) (4), Exempt category #4, by the University of California Riverside’s Human Research Review Board. The sample used for this study consists of 691 women. Cases in the original study were excluded from the sample if they were men or, among married participants, they cohabited prior to marriage.

Measures

The two dependent variables are conflict in balancing work and family life, and fairness of division of labor. The original conflict variable was self-reported and asked respondents to estimate how much conflict they experienced by choosing from the ordinal response options, “How much conflict do you face in balancing your paid work and family life?”: 1= “not at all,” 2= “not too much,” 3= “some,” 4= “a lot,” and 5= “a great deal.” Preliminary analyses led to the creation of 2 new variables for analysis purposes. The first variable was coded: 0= “not at all,” I= “not too much, some, a lot, or a great deal.” It distinguished between women in couples with no conflict whatsoever and women in couples with some conflict. The second variable was coded: 0= “Not at all or not too much,” 1= “Some, a lot, or a great deal.” It distinguished between women in couples with no problematic conflict and women in couples with problematic conflict.

Respondents’ perceptions of the (un)fairness of the division of labor was captured through a question asking, “How fair do you feel the division of paid work and work around the home is in your household” with 1= “fair to both me and my spouse/partner,” 2= “unfair to me,” 3= “unfair to my spouse/partner.” For analysis purposes, a dichotomous variable was created as a measure of perceived unfairness: 0= “fair,” 1= “unfair.”

Socioeconomic status was determined by two measures, household income and respondent’s education level. Education was measured by the highest degree received. The response categories were: “1st, 2nd, 3rd, or 4th grade,” “5th or 6th grade,” “7th or 8th grade,” “9th grade,” “10th grade,” “11th grade,” “12th grade no diploma,” “High school graduate-diploma or the equivalent (GED),” “Some college, no degree,” “Associate degree,” “Bachelor’s degree,” “Master’s degree,” and “Professional or Doctorate degree.” The 19 response categories for household income ranged from “Less than $5,000,” to “$175,000 and more.” Time in the focal couple relationship was measured by the number of years that married couples had been married and cohabiting couples had been dating. The presence of minor children in the household was measured dichotomously: 0= “none”, 1= “One or more.” Race/ethnicity was self-reported and was measured dichotomously: 0= “other race/ethnicity” and 1= “non-Hispanic White.” The number of times the respondent has been married was measured by a continuous variable: 0= “never married,” 1= “married
once,” 2= “married twice,” and 3= “married 3 or more times.” Current employment status was measured by a dichotomous variable: 1= currently employed (full or part time), 0= other (unemployed, retired, disabled, etc).

**Analysis**

Descriptive statistics were used to find the central tendencies of the full sample. Bivariate statistics were used to compare married and cohabiting women. Multivariate statistics (specifically logistic regression) was used to find the effect of being married or cohabiting on each of the two dependent variables, while controlling for other variables.

**RESULTS**

Table 1 shows descriptive statistics for married women, cohabiting women, and the sample as a whole. A larger percentage of married women than cohabiting women indicated that the division of labor was fair to both them and their partner. More married women indicated that they did not experience any conflict.

The average household income was higher among married women (about $75,000) than cohabiting women (about $50,000). The highest level of education completed for married women was also slightly higher than the level for cohabiting women, with married women having a Bachelor’s degree and cohabiting women having an Associate’s degree on average. Married women were 10 years older than cohabiting women on average and had been with their current spouse 15 years longer than cohabiting women had been with their partners.

Holding other factors constant, age had a positive relationship with perceived unfairness, although this effect was only marginally statistically significant (see Table 2). The older a woman was, the more likely she was to report an unfair division of labor. The number of times married had a negative effect, also only marginally statistically significant.

<table>
<thead>
<tr>
<th></th>
<th>Married</th>
<th>Cohabiting</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairness of division of labor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair to both me and my spouse/partner</td>
<td>73.4% +</td>
<td>65.9%</td>
<td>69.9%</td>
</tr>
<tr>
<td>Unfair to me</td>
<td>21.5% +</td>
<td>28.7%</td>
<td>24.9%</td>
</tr>
<tr>
<td>Unfair to my spouse/partner</td>
<td>5.1% +</td>
<td>5.4%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Conflict in balancing work and family life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No conflict at all</td>
<td>37.1% ***</td>
<td>24.24%</td>
<td>31.1%</td>
</tr>
<tr>
<td>Not too much conflict</td>
<td>33.2%</td>
<td>38.2%</td>
<td>35.6%</td>
</tr>
<tr>
<td>Some, a lot, or a great deal of conflict</td>
<td>29.7% ***</td>
<td>37.6%</td>
<td>33.4%</td>
</tr>
<tr>
<td>Age</td>
<td>46.23 (10,757) ***</td>
<td>36.87 (12,628)</td>
<td>41.8 (12,573)</td>
</tr>
<tr>
<td>Highest level of education completed</td>
<td>10.82 (1.715) ***</td>
<td>10.44 (1.461)</td>
<td>10.64 (1.61)</td>
</tr>
<tr>
<td>Non-Hispanic White †</td>
<td>85.3% ***</td>
<td>73.1%</td>
<td>79.6%</td>
</tr>
<tr>
<td>Number of times married</td>
<td>1.12 (.39) ***</td>
<td>.53 (.82)</td>
<td>.8413 (.694)</td>
</tr>
<tr>
<td>Number of years together in focal relationship</td>
<td>24.34 (11.68) ***</td>
<td>10.05 (8.6)</td>
<td>17.58 (12.56)</td>
</tr>
<tr>
<td>Household income</td>
<td>13.67 (2.987) ***</td>
<td>10.87 (4.175)</td>
<td>12.38</td>
</tr>
<tr>
<td>Minor children present in household ††</td>
<td>32.9% ***</td>
<td>47%</td>
<td>40.5%</td>
</tr>
</tbody>
</table>

+ p < .1   * p < .05   ** p < .01   *** p < .001
† The reference group is other race/ethnicity. †† The reference group is no minor children present in household.

*Table 1: Descriptive statistics of the data set.*
The more times a woman had been married, the less likely she was to report an unfair division of labor. Other variables did not show statistically significant effects. The model explained about 3% of the variance in the dependent variable.

Holding other factors constant, age was negatively related to the likelihood of reporting work-family conflict, although this effect was marginally statistically significant (see Table 3, Model 1). Older women were less likely to report conflict. The number of times a woman had been married was associated with a lower likelihood (.668 the odds) of reporting conflict. Being currently employed was associated with a greater likelihood of reporting conflict. The odds of reporting conflict for currently employed women were 2.688 the odds for other women. Educational attainment had a positive association with the likelihood of reporting conflict. The odds of reporting conflict among more highly educated women were 1.19 the odds among other women. Other variables did not show statistically significant effects. The Nagelkerke R Square indicated that 18.5% of the variance in the dependent variable was explained by the model.

As indicated in Model 2 of Table 3, holding other factors constant, household income decreased the likelihood of reporting conflict; the odds of reporting conflict for women

<table>
<thead>
<tr>
<th>Factors</th>
<th>B (SE)</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married †</td>
<td>-.278 (.257)</td>
<td>.757</td>
</tr>
<tr>
<td>Household Income</td>
<td>-.02 (.026)</td>
<td>.98</td>
</tr>
<tr>
<td>Minor children present in household †</td>
<td>.215 (.19)</td>
<td>1.24</td>
</tr>
<tr>
<td>Age</td>
<td>.024 (.013)</td>
<td>1.024</td>
</tr>
<tr>
<td>Non-Hispanic White †††</td>
<td>.323 (.231)</td>
<td>1.381</td>
</tr>
<tr>
<td>Number of times married</td>
<td>-.279 (.166)</td>
<td>.756</td>
</tr>
<tr>
<td>Currently employed ††††</td>
<td>.228 (.189)</td>
<td>1.256</td>
</tr>
<tr>
<td>Years together in focal relationship</td>
<td>-.011 (.013)</td>
<td>.989</td>
</tr>
<tr>
<td>Highest level of educational attainment</td>
<td>-.004 (.057)</td>
<td>.996</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.465 (.698)*</td>
<td>.231</td>
</tr>
</tbody>
</table>

+ p < .1        * p < .05       ** p < .01      *** p < .001
† The reference group is cohabiting.
†† The reference group is no minor children present in household.
††† The reference group is other race/ethnicity.
†††† The reference group is other (unemployed, retired, disabled, etc.).

Table 2: Factors predicting the likelihood of perceiving an unfair division of labor.

<table>
<thead>
<tr>
<th>Model 1: No conflict versus some conflict</th>
<th>Model 2: None to acceptable conflict versus unacceptable conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>B (SE)</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Married †</td>
<td>-.289 (.261)</td>
</tr>
<tr>
<td>Household income</td>
<td>.008 (.028)</td>
</tr>
<tr>
<td>Minor children present in household ††</td>
<td>.248 (.205)</td>
</tr>
<tr>
<td>Age</td>
<td>-.023 (.014)+</td>
</tr>
<tr>
<td>Non-Hispanic White †††</td>
<td>-.057 (.241)</td>
</tr>
<tr>
<td>Number of times married</td>
<td>-.374 (.164)*</td>
</tr>
<tr>
<td>Currently employed ††††</td>
<td>.981 (.188)**</td>
</tr>
<tr>
<td>Years together in focal relationship</td>
<td>-.005 (.013)</td>
</tr>
<tr>
<td>Highest level of educational attainment</td>
<td>.174 (.059)**</td>
</tr>
<tr>
<td>Constant</td>
<td>-.174 (.728)</td>
</tr>
</tbody>
</table>

+ p < .1        * p < .05       ** p < .01      *** p < .001
† The reference group is cohabiting.
†† The reference group is no minor children present in household.
††† The reference group is other race/ethnicity.
†††† The reference group is other (unemployed, retired, disabled, etc.).

Table 3: Models predicting the likelihood of reporting work-family conflict.
with higher household incomes were .933 the odds of women with lower incomes. Minor children present in household was associated with a greater likelihood of reporting conflict; the odds of reporting conflict for women with minor children present in household were 1.693 the odds of women without minor children present in household. Being currently employed was associated with a greater likelihood of reporting conflict; the odds of reporting conflict for currently employed women were 1.766 the odds of other women. Educational attainment was positively related to the likelihood of reporting conflict; the odds of more highly educated women reporting conflict were 1.199 the odds of other women. Other variables did not show statistically significant effects. The Nagelkerke R Square indicated that approximately 8% of the variance in the dependent variable was explained by the variables in the model.

DISCUSSION

This secondary data analysis aimed to determine whether married women differ from cohabiting women in levels of perceived fairness of the division of labor and in the amount of work-family conflict. Although the bivariate results showed that larger percentages of married women perceived a fair division of labor whereas larger percentages of cohabiting women reported work-family conflict, these differences did not persist in the multivariate results. Only 3% of the variance in the dependent variable was explained by the variables included in Table 2. Perhaps variables such as women’s feelings of being appreciated are more relevant. The variables included in the models in Table 3 explained a substantial amount of the differences. However, the statistical significance of the variables differed between models, suggesting that the relevant variables that explain “no conflict versus some conflict” and “none-to-acceptable conflict versus unacceptable conflict” differ.

It is possible that married and cohabiting women have different expectations, or similar divisions of labor and amounts of conflict. Cohabiting women may not expect to do “women’s work” and may expect their partners to do half of the household labor, while married women may expect to do a larger portion of the work, and specifically “women’s work”. Cohabiting women may expect not to experience work-family conflict because they are not married, thus they should not have the usual problems of married life. Consequently, they may define their conflict as a conflict in interests and as a problem, while married people define their conflict as juggling responsibilities. Thus, both married and cohabiting women may not have the same division of labor and amounts of conflict, but differing expectations may lead to similar perceptions.

The higher percentage of minor children present in cohabiting households may explain the higher rates of reported conflict and perceived unfairness of division of labor in cohabiting households. Consistent with past research, having minor children decreased the likelihood of reporting unfair division of labor. The association between times married and conflict may be due to the lessons learned from each marriage; women with more experience may better pick partners and have more realistic expectations of marriage. Thus, the division of labor may not be more equal and the less conflict experienced, but different expectations simply led to different perceptions.

The higher educational attainment a woman had, the more likely she was to report conflict. Educated women may not actually experience higher levels of conflict, but rather have differing expectations (such as expecting less conflict) compared to women with lower educational attainment. Alternatively, because higher educated women are more likely to hold more demanding jobs (such as managerial positions, doctors, etc.) that come with more after-work responsibilities, these jobs may compete more with home life than the kinds of jobs held by less educated women. Consistent with past research, being currently employed increased the likelihood of reporting conflict. Although the data did not support all of the hypotheses, it lent support to the possible alternate explanation of gendered expectations. Future research can explore this possibility.

Several limitations to the study should be considered when interpreting the results. There were no data on when cohabiting couples moved in together and began cohabiting; the study was limited to when the couples started dating. This data would have allowed for a more direct comparison between married and cohabiting women, as it would measure the time of the focal relationship from when the couples began living together. Although all
income brackets were represented, the sample as a whole was fairly affluent. The overwhelming response of fairness and lack of conflict for both married and cohabiting women may have been due to the non-independent nature of the sampling method, as cases were only included if both partners/spouses responded to the survey, selecting out couples that may not have both completed the sample due to unwillingness to help his/her partner. The fact that both partners participated implies some level of functioning and willingness to help one’s partner.

This study highlights two areas for future research: the actual amount of household labor performed by each member of the couple compared to the attitudes and perceptions of cohabiting and married couples and the effect of cohabitation before marriage on division of labor and conflict in married life. As the data used for this study did not collect on the actual proportion of household labor allocated to each spouse/partner, future research is needed on the actual amount of household labor performed by each compared to the attitudes and perceptions of cohabiting and married couples. Additionally, as married women who had previously cohabited were excluded from the data set, future research is needed on the effect of cohabitation before marriage on division of labor and conflict in married life.

REFERENCES

ABSTRACT

Individuals perceive speech through at least two sensory modalities: audition (hearing) and vision (seeing). We wanted to determine whether people perceptually prioritize emotional information or linguistic information when they see and hear speech. By conducting a series of experiments using cross-modal matching tasks, we sought to answer our main question. Baselines were used to establish the validity of our tokens, and then we asked participants to match auditory tokens to the correct visual tokens. Overall, we found that some individuals prioritize emotion information while others prioritize linguistic information when cross-modally integrating speech.

MENTORS

Faculty Mentor: Larry Rosenblum (right)
Graduate Student Mentors: James W. Dias, (lower left)
Theresa Cook (lower right)

Abigail Montes De Oca was a Research Assistant at the Riverside Audiovisual Speech and Audition Lab (RASAL) for last year and a half, making her one of the most senior and experienced members of our RA team. From her outstanding scholarship and complete trustworthiness, to her fantastic interpersonal skills, Abby stands out as a leader in every respect. We rely on Abby’s intelligence, composure, and diligence to perform the tasks necessary for the daily functioning of our research. From running participants, to producing exacting scientific stimuli, to sensitive data entry, to working with our complex experimental equipment, Abby excels in every area critical to furthering our scientific endeavors. Finally, Abby’s great interpersonal skills are especially noteworthy. The most crucial aspect of our experimental enterprise is our engagement with human participants. She understands how essential it is to maintain professionalism, conscientiousness, authority, and compassion. It is something of an art to be both respected and liked by participants, and Abby manages this responsibility with ease. Her manner of interacting with people generates high quality data, and conveys the utmost of ethics and empathy.

AUTHOR

Abigail Montes De Oca

Abigail Montes De Oca is a graduating senior in Psychology. She worked as a Research Assistant in Dr. Larry Rosenblum’s Riverside Audiovisual Speech and Audition Lab (RASAL) for nearly two years. Her experience with RASAL has positively influenced her in many ways, professionally and personally. She is extremely thankful for the mentorship and support she received from both Theresa Cook and James Dias as it helped her immensely in her academic accomplishments. Abigail also thanks Dr. Rosenblum for the experience provided by working with RASAL, as well as his continued support. She plans to go onto a Master’s program in Social Work and, ultimately, into a Clinical Psychology PhD program.
BACKGROUND

In conversation, have you ever felt that a person is listening to the words you are saying but doesn’t really grasp the emotion behind your words? Have you had someone completely empathize with the emotions you are portraying but not really hear your words? The ability to identify the emotions of others is vital in all aspects of social interaction. People gain critical information regarding appropriate response through emotion identification and speech.

Past research has shown that both speech and emotion are perceived through more than one sense (multimodally). In other words, people use more than one sensory modality (such as hearing and seeing) to reach an understanding about what a person is saying and feeling. When attending to interpersonal situations, individuals use linguistic and emotional variables to process the information presented. However, it is possible that individuals more readily use either linguistic or emotional information to reach their understanding of the presented situation. For example, when having a conversation, a person may attend more closely to the other individual’s expressions or they may pay closer attention to the lexical information they are hearing. In previous research, participants have judged emotional expression using photographs or videos. Studies explored the effects of age, sex and developmental disorder on speech and emotion perception.

Johnson, Emde, Scherer, and Kilnnert (1986) demonstrated the multimodality of emotions. Both visual information and auditory information are essential to identifying emotions; when combined, these cues allow us to accurately interpret the emotions of others. Although it is important to have both aspects to achieve emotion perception, as seen through the studies of Johnson et al. (1986), individuals can still gain some insight into another person’s emotion when the attempt is made to separate them. Participants were able to identify some emotions with good accuracy (e.g. sadness) through one modality alone. However, people had trouble identifying other emotions that were easily identified in the visual and auditory combined condition, demonstrating the multimodality of speech perception and emotion.

De Gelder and Vroomen (2000) examined the integration of auditory and visual components in relation to emotion perception and found that audiovisual integration occurs when perceiving emotion. For example, if a participant is shown a happy face paired with a sad voice, he/she is more likely to rate the face as sad. De Gelder & Vroomen (2000) demonstrated that a strong relationship between spoken and visual speech exists when perceiving emotion. Pourtois, de Gelder and Crommelink (2005) studied the relationship between visual and auditory information by analyzing the brain regions activated during emotion perception and found that the middle temporal gyrus was much more activated when participants were shown audio-visual stimuli rather than audio only or visual only stimuli. The higher levels of activation seen in the brain offer evidence that emotion perception is indeed a multimodal process and people attend to both linguistic and emotional cues when detecting emotion.

Researchers have also investigated age effects on multimodal emotion perception and speech. Hunter, Phillips, and MacPherson (2010) tested the emotion detection performance of younger and older individuals when presented with congruent cross-modal stimuli and found that older participants were able to perform just as well as younger participants when identifying congruent faces and voices. However, older participants encountered more difficulty with cross-modally incongruent faces/voices. Although older individuals do not have a more difficult time identifying emotion in a multimodal encounter, they do experience more difficulty when attempting to derive emotional information from only one cue (auditory or visual alone).

Overall, previous research shows the importance of both visual and auditory cues when perceiving emotion. Speech perception is also integrated multimodally; lip-reading has been shown to be a useful tool for better understanding what someone is saying. The multimodality of speech can also be seen through the method of tadoma, a way of feeling speech. In this method, the individual perceives speech by placing his/her hand over the other person’s mouth and feeling the ways in which speech is formulated (Rosenblum, 2012). Research has also supported the notion that speech is not only perceived through sound. Dohen, Schwartz, and Bailly
Abigail Montes De Oca

(2010) believe that face-to-face interactions offer much more than just sound; the emotions, gestures and facial expressions that are perceived contribute to the perception of speech. We gain vital information about a speaker from interacting with them directly; every part of that interaction is important and gives us a better understanding of the interaction that is occurring.

In the current study, we sought out to see whether individuals gave higher perceptual priority to linguistic or emotional cues in audiovisual speech. In order to establish whether our stimuli were effective, we conducted a series of two baselines, followed by two experiments that used cross-modal matching tasks. In these trials, participants were given two pairs of visual and audio stimuli of a word and the person was to decide which time what they saw best matched to what they heard. For example, a person saw someone say “log” and heard “log,” then saw someone say “log” but heard “dog.” The participant had to decide which time the visual and audio stimuli matched.

METHODS AND RESULTS

Method for Baseline 1: Neutral Word ID

In the first experiment, 21 undergraduate students between the ages of 17 and 25 participated; fourteen of the 21 participants were female and seven were male. The students received research credit to fulfill a course requirement. Additionally, the participants had normal or corrected hearing and vision in order to take part in the study. A research assistant had the participants read and sign an informed consent form prior to conducting the experiment. Each participant received detailed directions and was asked about their comprehension of the task to be conducted. The task consisted of matching visual to auditory stimuli. Participants saw/heard two video and audio stimuli pairs; the participant chose the video in which the visual stimuli best matched what they heard. Each participant heard ten words in five pairs. The words differed only on one part (one visible phoneme). For example, the participant saw a model say “camper” while hearing “camper,” then saw the same model say “camper” but heard the word “pamper.” People had to determine which time what they heard best matched what they saw. It is also important to note that all words were presented neutrally, with no emotion in the face or in the voice. After establishing that the participant fully understood the directions, he/she sat in a sound proof booth to complete the experiment. Directly after the completion of the task, each participant completed a language questionnaire. Overall, completion of the experiment took approximately 15 minutes.

Results for Baseline 1: Word ID

Participants were able to discriminate between incongruent and congruent visual/phoneme tokens at better than chance levels (M correct = 80.9%, SD = 11.0%), t (19) = 8.97, p < .001). These results indicate that participants could match the word they heard with the word they saw 80.9% of the time, meaning that when participant saw “pamper” and heard “pamper” they were able to accurately pair them, rather than choosing the visual “pamper” with the audio “camper.”

Methods for Baseline 2: Emotion Categorization

This experiment sought to test whether participants could discriminate three distinct emotions in the stimuli: happy, mad, or sad. Participants experienced three presentations: participants saw and heard audio only, visual only, or audio-visual stimuli. Ten (6 female, 4 male) UCR undergraduate psychology students between the ages of 17 and 21, who had not participated in the neutral baseline, participated in exchange for research credit. As in the Neutral Baseline, research assistants followed the same general protocol. However, participants now categorized stimuli based on emotion. They heard the same ten words as in the first experiment, but in three distinct emotions: happy, mad, or sad. Participants were to categorize each auditory, visual or audiovisual stimulus into emotional categories. The entire procedure for running this experiment remained very similar to Experiment 1, and it took approximately 15 minutes for each participant to complete.

Results for Baseline 2: Emotion Categorization

Experiment 2 contained three conditions: audio only (AO), video only (VO) or audio-visual (AV). Participants were able to successfully categorize emotion in all conditions:
AO (M = 84.2%, SD = 9.0%), VO (M = 90.8%, SD = 3.2%), and AV (M = 94.0%, SD = 3.5%). In addition, the three conditions significantly differed from one another: AO versus VO, t (9) = 2.8, p = .021; VO versus AV, t (9) = 2.7, p = .025; and AO versus AV, t (9) = 4.2, p = .002. In other words, participants were able to categorize the emotion they saw and heard best, with an accuracy level of 94%. Participants also fared well at categorizing emotions in the face they saw (correct 90.8% of the time). Additionally, they were also able to categorize emotion from the voice they heard with excellent accuracy (they correctly identified the emotion in the voice they heard 84.2% of the time). All three conditions significantly differed from chance, with the least difference in the AO condition, t (9) = 29.8, p < .001.

After determining that our tokens were both linguistically and emotionally discriminable, we conducted our experiments.

**Methods for Experiment 1: Combined Emotional and Linguistic Cross-modal Matching**

Participants (N= 20, 12 female, 8 male) for this study were also undergraduates at the University of California, Riverside and were between the ages of 17 and 23. We tested whether participants were better able to distinguish fully linguistically and emotionally congruent audiovisual in information speech from speech which was incongruent on only one of those factors. In order to test this question, participants saw and heard fully congruent audio-visual stimuli and partially incongruent (linguistically or emotionally, but not both) audio-visual stimuli. The experiment contained two types of trials: In one type of trial, participants compared fully congruent (FC) stimuli to linguistically incongruent but emotionally congruent (EC) stimuli. In the second type of trial participants compared fully congruent (FC) stimuli to those which were emotionally incongruent but linguistically congruent (LC). For example, in FC versus EC trials, participants heard a happy voice say “pamper” and saw a happy person say “pamper” in one stimulus, then in the second stimulus they heard a happy voice say “pamper” but saw a happy person say “camper.” In the FC versus LC trials, participants heard a happy voice say “pamper” paired with a happy face saying “pamper” in one stimulus, while in the second stimulus they heard a happy voice say “pamper” but saw a sad person say “pamper.” In each of the trials, the participant was to best match what they saw with what they heard. Two distinct actors were used, one male and one female. Participants either judged stimuli containing the female actor or the male actor to limit the number of trials. As in the other experiments, the only procedural change was the explicit directions. Figure 1 further clarifies the method used in each phase.

**Results for Experiment 1: Combined Emotional and Linguistic Cross-modal Matching**

We found no difference in participants’ responses based on seeing and hearing the male or female actor, F(1,18) = 1.289, p = .264. We found no difference in people’s ability to distinguish FC stimuli from EC or LC stimuli, F(1,18) = .560, p = .459. People were just as good at discriminating fully congruent from partially congruent stimuli when the incongruency was emotional as when the incongruency was linguistic. Interestingly, an interaction was found in regards to actor and information type (linguistic/emotional), F(1,18) = 6.118, p = .018. Emotionally congruent information for the male model was more easily matched (M = 82.7%, SD = 16.8%) than for the female model (M = 67.5%, SD = 11.4%), t(18) = 2.69, p = .015. However, this was not the case concerning linguistic information: The female model’s (M = 74.8%, SD = 9.5%) linguistic information was not more easily matched than the males model’s (M = 69.2%, SD = 14.3%), t(18) = 1.478, p = .157. Participants performed the discriminating task of fully congruent from partially congruent (linguistic or emotional) at higher than chance levels, t(19) = 9.292, p < .001.

**Methods for Experiment 2: Emotional versus Linguistic Salience Preference**

After establishing the validity and discriminability of our tokens, we conducted a second experiment to attend to the main question: whether people perceptually prioritize emotional versus linguistic information when perceiving audio-visual speech. Participants were twenty undergraduate students enrolled in introductory psychology courses at the University of California, Riverside.
1. **[FC]** Fully audiovisually congruent stimuli.

Example: Participants heard “camper” in a happy voice and saw “camper” articulated with a happy facial expression.

| “CAMPER” 😊 | (CAMPER) |

2. **[EC]** Emotionally congruent and linguistically incongruent stimuli.

Example: Participants heard “camper” in a happy voice and saw “pamper” articulated with a happy facial expression.

| “CAMPER” 😊 | (PAMPER) |

3. **[LC]** Linguistically congruent and emotionally incongruent stimuli.

Example: Participants heard “camper” in a happy voice and saw “camper” articulated with a sad facial expression.

| “CAMPER” 😊 | (CAMPER) |

4. **[FI]** Emotionally and linguistically incongruent audiovisual stimuli.

Example: Participants heard “camper” in a happy voice and saw “pamper” articulated with a sad facial expression.

| “CAMPER” 😊 | (PAMPER) |

**Figure 1.** In Experiment 1, participants saw and heard fully congruent audio-visual stimuli and partially incongruent (linguistically or emotionally, but not both) audio-visual stimuli. The experiment contained two types of trials: In one type of trial, participants compared fully congruent (FC) stimuli to linguistically incongruent but emotionally congruent (EC) stimuli, and in the other trial participants compared fully congruent (FC) stimuli to those which were emotionally incongruent but linguistically congruent (LC). In Experiment 2, on half of the trials participants compared one emotionally congruent/linguistically incongruent (EC) stimulus to one linguistically congruent/emotionally incongruent stimulus and judged which was the best audiovisual match. On the other half of trials, participants saw one fully congruent (FC) and one fully incongruent (FI) stimulus and judged which was the best audiovisual match. These trials served as catch trials to ensure that participants were attending to the task. Emoticons represent tone of voice in auditory portion of stimuli.

Experiment 2 was to test whether participants favored emotional content or linguistic content. In this experiment, on half of the trials participants compared one emotionally congruent/linguistically incongruent (EC) stimulus to one linguistically congruent/emotionally incongruent stimulus and judged which the best audiovisual match was. For example, the person might hear a happy voice saying “camper” while seeing a happy face say, “pamper,” (EC) then the participant might hear a happy face say “pamper” but hear a sad voice say “pamper” (LC). The participant judged which time they heard best matched with what they saw. On the other half of trials, participants saw one fully congruent (FC) and one fully incongruent (FI) stimulus and judged which the best audiovisual match was. These trials served as catch trials to ensure that participants were attending to the task. The procedure for this experiment was very similar to that of the previous studies.

**Results for Experiment 2: Emotional versus Linguistic Salience Preference**

Once again in the FC/FI trials, participants selected completely congruent stimuli at greater than chance levels t(19) = 45.366 p < .001. Distinct preferences for selecting emotional (M = 73.6% SD = 11.1) or linguistic (M = 75.1% SD = 10.3) content as the best audiovisual match were displayed by the participants in the EC/LC trials. Eleven participants judged EC stimuli as the best audiovisual match 73.6% of the time, while nine participants judged LC stimuli as the best audiovisual match 75.1% of the time.
CONCLUSION

Although all stimuli proved to be highly discriminable, further research was needed to truly understand if individuals perceptually prioritize linguistic or emotional information in a cross-modal matching task. Experiment 2 included tokens using both the male and female models. Additionally, Experiment 2 tested whether participants perceptually prioritize information in cross-modal matching. Through the analysis of Experiment 2, we found that some people highly prioritize emotional versus linguistic content when matching auditory to visual speech. Of the twenty participants in Experiment 2, nine of them selected linguistic content, while eleven selected emotional content as the best match. It would be interesting for future studies to explore why some individuals prefer emotional versus linguistic content and what determines this preference. Future studies should also compare scores from the beginning of the task to those at the end, in order to see whether participants change their preferences.

Our findings allow us to further understand the multimodality of speech and emotion by showing that individuals attend to information differently. Some individuals prioritize linguistic information and others prioritize emotional information; utilizing this concept we can develop new teaching tools that are directed to each type of person. For example, individuals can be taught to attend to either emotion or linguistic content; this can be useful for those with impairment.

DISCUSSION

Now that the question of whether individuals perceptually prioritize information in cross-modal speech matching has been addressed, it would be beneficial to conduct further experiments using visually or hearing impaired participants. Some research has already been conducted using such populations. For example, Dyck, Farrugia, Shochet, and Holmes-Brown (2004) analyzed emotion recognition in children with sight or hearing impairments. Results indicated that visually impaired and hearing-impaired groups showed signs of deficit regarding emotion recognition (Dyck et al., 2004). Ludlow, Heaton, Rosset, Hills, and Deruelle (2010) also investigated the emotion perception of deaf children and found that normal hearing children could identify emotion more easily than those with hearing impairment of speech and emotion perception despite modality. It would be beneficial to know whether those with impairment perceptually prioritize linguistic or emotional information and how that compares to individuals without impairment.

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The Audier-Stevenson Rule: 2,6-dimethyl-2-heptene

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University of California, Riverside

A B S T R A C T

In electron ionization mass spectrometry a gaseous molecule is fragmented by the introduction of a high energy electron. According to the Audier-Stevenson Rule it is expected that the fragmentation species of highest stability produces a higher intensity peak on a mass spectrum. However, there is an apparent violation of the Audier-Stevenson Rule when comparing the m/z 69 and m/z 57 fragmentations for 2,6-dimethyl-2-heptene. The lowest energy fragments for an m/z 57 split are more stable than the fragments for the m/z 69 split; yet the mass spectrum shows the m/z 69 peak to be more intense. Herein, we propose an explanation, which takes into account the preferred conformation of the 2,6-dimethyl-2-heptene starting material. In conclusion, the Audier-Stevenson Rule was not contradicted.

F A C U L T Y  M E N T O R

Thomas H. Morton
Department of Chemistry

Tom Morton has been on UCR’s chemistry faculty for more than 30 years. He teaches large lecture courses of undergraduate chemistry; and in 2006, initiated University Honors discussion sections for organic chemistry. In these discussion sections each student performs an original computational investigation. While all the CHEM122H students in Fall 2011 discovered important aspects of thermodynamic versus kinetic control in mass spectrometric decompositions, Howard Park took the opportunity to investigate more deeply the branching between two competing pathways for breaking a single C-C bond, consulting the chemical research literature to propose an explanation as to why the favored fragmentation yields an allylic cation. His effort presents a new insight into unimolecular dissociation and puts forth a hypothesis that can be tested experimentally. This work was supported in part by NSF grant CHE0848517.

A U T H O R

Howard Park
Biology

Howard Park is a second year University Honors student majoring in Biology. With plans to attend medical school, Howard participates in the Critical Care Volunteer Program at Riverside Community Hospital in order to gain experience with patient care and help out within the local community. He strives to excel in all of his science classes; and with this article, his first published academic paper, furthered his understanding of Organic Chemistry. Howard extends many thanks to Professor Thomas Morton for his mentorship and Lisa Sarigiani for her writing consultation.
BACKGROUND

The Audier-Stevenson Rule states that in mass spectrometric fragmentation producing a positive ion, the fragment with the higher ionization energy (IE) will preferentially retain the unpaired electron. This would be shown by lower energy cation fragments having higher intensity peaks on a mass spectrum. Through looking at the energies of two particular fragmentations of compound 2,6-dimethyl-2-heptene, we will test the validity of the Audier-Stevenson Rule under conditions where the charged fragment may rearrange. Therefore, if the Audier-Stevenson Rule is correct, it is expected that the fragment with the lower IE will always be more pronounced in a mass spectrum, even when rearrangement takes place.

Equation 1A – Reaction producing the m/z 69 cation.

Equation 1B – Reaction producing the m/z 57 tert-butyl cation.

Table 1. DFT values of electronic (Eel) and zero point (ZPE) energies for possible reaction pathways

<table>
<thead>
<tr>
<th></th>
<th>m/z 69</th>
<th>m/z 57 (t-bu+)</th>
<th>m/z 57 (s-bu+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Eel (a.u.):</td>
<td>-353.567001</td>
<td>-353.587552</td>
<td>-353.5410503</td>
</tr>
<tr>
<td>Total ZPE (kJ/mol):</td>
<td>628.9</td>
<td>625.0</td>
<td>653.5</td>
</tr>
<tr>
<td>Net Relative $\Delta H_0$ (kJ/mol):</td>
<td>0</td>
<td>-57.9</td>
<td>+92.7</td>
</tr>
</tbody>
</table>

Although the observed relative intensities in Figure 1 could possibly be the result of subsequent dissociations, this seems unlikely; after taking into account possible dissociations to and from m/z 57 and m/z 69, m/z 69 would still have a higher intensity.

Figure 1. DFT values of electronic (Eel) and zero point (ZPE) energies for possible reaction pathways

Though it seems that the Audier-Stevenson Rule is contradicted by the experimental data, there exists another explanation that involves two different isomers of the m/z 57 cation formed directly from fragmentation. The two conformations of the isobutyl fragment prior to any rearrangement are shown in Figure 2.
Considering the concept that a migrating bond must be parallel (or antiparallel) to a vacant p-orbital, an unsymmetrical conformation would rearrange to produce a \textit{tert}-butyl cation and the symmetrical conformation would produce a \textit{sec}-butyl cation. Figure 3 shows the energy comparisons of the neutral 2-6-dimethyl-2-heptene conformations that lead to the two isobutyl conformations. The calculations showed that the unsymmetric conformation was more favorable by 12.0 kJ/mol electronically and by 0.3 kJ/mol vibrationally.

Friedman’s research has shown experimentally that a cation resulting from an isobutyl structure could rearrange to give a mixture of \textit{tert}-butyl and \textit{sec}-butyl cations (shown as the carbocation products in equation 2A and 2B, respectively). An unsymmetrical isobutyl cation, by rearrangement, presumably yields a \textit{sec}-butyl cation. Our calculations showed that conformer B (unsymmetrical) was more stable than conformer A (symmetrical) by 0.6 kJ/mol, corresponding to $K_{eq}=2.2$ (taking into account that B has two enantiomorphs).

The calculated equilibrium constant at 300K between these two neutral conformers was $K_{eq}=0.006$, with >99% of the conformations being unsymmetric. Even after ionization the electronic energy of the unsymmetrical cation is favored over the symmetrical cation.
in the m/z 57 fragmentation, the cation product of equation 1B should be changed to the sec-butyl isomer. The new energies for the products of the revised m/z 57 fragmentation are shown to the far right in Table 1.

When compared against the sec-butyl-producing m/z 57 fragmentation, calculations showed that the m/z 69 was favored by a total energy difference of 66.8 kJ/mol. This matches its higher intensity on the mass spectrum in Figure 1, supporting the extension of the Audier-Stevenson Rule to rearranged cations.

CONCLUSION

In conclusion, although the tert-butyl producing m/z 57 pathway has a lower energy than that of an m/z 69 fragmentation, the sec-butyl cation ought to be preferentially formed. This formation is due to the neutral starting material’s preference for the unsymmetrical conformation, which produces an unbranched cation. This sec-butyl producing m/z 57 pathway has a higher energy than that of an m/z 69 fragmentation; which is reflected in the compound’s mass spectrometric data. Thus, the Audier-Stevenson Rule is not contradicted.

ACKNOWLEDGEMENT

The author is grateful to Professor Thomas H. Morton for suggesting the research problem and assistance with DFT calculations.

REFERENCES

Molecular Analysis of the Interaction Between *Staphylococcus aureus* Protein Sbi and Immune System Protein C3d

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**A B S T R A C T**

Protein-protein interactions form the basis of cellular communication, signaling, and regulation. These interactions are governed by non-covalent forces, originating from electrostatic and van der Waals interactions at atomic resolution. Electrostatic interactions are often crucial to protein recognition and binding, particularly for highly and oppositely charged proteins. We examined the interactions between secreted protein Sbi from antibiotic-resistant strains of *S. aureus* with host immune system protein C3d, using electrostatic clustering and free energy analysis. We used the computational framework called Analysis of Electrostatic Similarities Of Proteins (AESOP) to perform computational alanine scans and we generated a series of protein variants with perturbed electrostatic properties. To elucidate the effect of each mutation in association (defined as recognition plus binding) of Sbi with C3d, we performed electrostatic clustering and association free energy calculations. The analysis of our data revealed which charged amino acids are important for the formation of the C3d-Sbi complex, thus pointing out gain-of-association or loss-of-association mutations. This knowledge will form the basis for the design of proteins with tailored binding properties, and thus tailored biological function, by incorporating multiple critical mutations. This project will guide the development of novel therapeutics for treatment of infections by *S. aureus*.

**M E N T O R S**

Faculty Mentor: Dimitrios Morikis *(left)*
Graduate Student Mentor: Ronald D. Gorham Jr. *(right)*

Department of Bioengineering

Wilson has conducted research in my lab for a little over a year. He is working on molecular level interactions between the bacterium *S. aureus* and the human immune system, using theoretical physicochemical methods. Specifically, he studies how the *S. aureus* protein Sbi disrupts the role of the human protein C3d as a link between innate and adaptive immunity. The role of C3d is to augment antibody response, and Sbi, and other bacterial proteins, disrupt this beneficial function of C3d. Wilson worked carefully and systematically in performing his calculations with the help of graduate student Ron Gorham, and exhibited early evidence of independent thinking. As a junior, Wilson insisted on taking my senior-level class “Biophysics and Thermodynamics” to prepare himself for research in my lab. His performance in this demanding class was excellent. Wilson presented a research poster at the 2012 Southern California Undergraduate Research Conference in Chemistry and Biochemistry at Cal State University, Channel Islands, and gave an oral presentation at the 2012 UCR Symposium for Undergraduate Research, Scholarship, and Creative Activity. After successful submission of an Abstract of his work, he is scheduled for an oral presentation at the UC Systemwide Bioengineering Symposium at UC Berkeley. Wilson will continue working on the same project until his graduation.
INTRODUCTION

The complement system is part of our innate immune system and delivers potent responses to pathogenic infection and disease. Complement component 3 (C3) serves as the central protein of the complement system and can be activated by the classical, lectin, and alternative pathways. Cleavage of C3 results in fragments C3a and C3b, which can participate in amplification of immune response through the formation of convertases, as well as proinflammatory responses, chemotaxis, and the formation of the membrane attack complex (MAC). From these fragments, C3b tags pathogens, through the formation of a thioester bond, for subsequent recognition and elimination by macrophages. C3a interacts with C3aR on the surfaces of leukocytes and induces cell mobilization and chemotaxis. MAC is responsible for directly killing pathogens by cell lysis. Simultaneous interactions with factors H and I lead to cleavage of C3b, yielding iC3b (inactive C3b) and C3d, with both fragments containing the thioester bond moiety. C3d interacts with Complement Receptor 2 (CR2) and antigen-antibody complexes to facilitate B- and T-cell immune response. Through the C3d fragment and the formation of the B cell receptor-coreceptor complex, the complement system acts as a link between innate and adaptive immunities by augmenting antibody responses.

Although our immune responses are able to combat most infections, most bacterial pathogens have evolved and adapted methods for evading the human complement immune system. *S. aureus* in particular has developed a variety of immuno-regulatory proteins for the goal of immune evasion and does so by regulating the innate and adaptive immune systems. *S. aureus* also has the ability to control host regulatory proteins, thus facilitating bacterial function within the host. One recently identified protein responsible for a variety of immune evasive functions is *S. aureus* binder of immunoglobulin G (Sbi). Sbi affects the adaptive immune system by binding to host immunoglobulin G3, but Sbi can also affect the alternative pathway of complement by interacting with C3d. Several experiments revealed that Sbi binds to C3d in a one-to-one ratio but can bind to C3d at two locations: Complex 1 and Complex 2. This mode of binding allows Sbi to potently counter the complement activation. In Complex 1, Sbi inhibits the C3d-CR2 complex from forming and thus blocking C3d from interacting with other branches of the host’s immune system such as the B and T cells. It is also hypothesized that Sbi interacts with residues involved in thioester bond formation between C3d and bacterial surfaces, thus inhibiting binding to pathogenic cell surfaces and retarding the formation of convertases in the classical pathway.

In this study we analyze the effects of mutant variants, which are predictive of protein binding and stability. Through the generation of mutant variants and the calculation of electrostatic potentials, we can elucidate residues critical to the binding mechanism. With these computational mutagenesis results we can model and design therapeutics tailored to enhance or inhibit specific protein-protein interactions.

METHODS

Because electrostatics plays a critical role in protein-protein interactions, we explored the specific role of electrostatics in C3d-Sbi interaction. In order to elucidate the binding and function mechanism of C3d-Sbi complex, the computational framework Analysis of Electrostatic Similarities Of Proteins (AESOP) was employed. The AESOP framework is a
collection of independent and communicating scripts and is written in the R software environment for statistical computing. AESOP performs alanine scans, calculates electrostatic potentials using the Poisson-Boltzmann equation, determines electrostatic similarity distances (ESD), performs hierarchical electrostatic clustering of ESDs, calculates electrostatic free energies of association, and provides a graphical representation of electrostatic potentials. AESOP’s centralized functions have facilitated the study of electrostatics in the function of protein-protein interactions.5-9

The AESOP protocol begins with acquiring a file with the coordinates of the crystal structure from the Protein Data Bank (PDB), which is visually inspected for missing or duplicate residues. Duplicates were removed and no missing residues were found. It is then cleaned by removing the header and footer of the file and any heteroatoms and water atoms the structure may have. Once the PDB file is processed, AESOP performs the aforementioned automated tasks. It starts by reading in the coordinates of the PDB file and changes its format into a PQR file, using the PDB2PQR program.1,2,4 PQR files are very similar to PDB files except that in addition to coordinates, they contain atomic charges and radii. If hydrogen atoms are missing in PDB files, which are typical of crystallographic structures, PDB2PQR also adds hydrogen atoms. The next step is to generate a family of mutants from the parent PQR file. AESOP does so by reading the protein sequence residues one at a time in order to locate one of the five charged residues of interest, histidines, arginines, lysines, aspartates or glutamates, and then truncates the side chain to the beta carbon, shortens the gamma carbon’s bond and changes it into a hydrogen with correct bond length and atomic charge. Once the mutation is made, a new PQR file is saved and stored for further calculations. The script then returns to the parent PQR to search and locate the next available charged residue to mutate to alanine until it has checked and mutated all the residues in the parent sequence. This process is called computational alanine scan and each of the mutant proteins has a single residue mutation generated from the parent protein. In the C3d-Sbi complex there were 94 total residue mutations, 64 belonging to C3d and 30 belonging to Sbi.

Following the computational mutations we calculated electrostatic potentials using the Adaptive Poisson-Boltzmann Solver (APBS)2,6. APBS is called by AESOP to solve the Poisson-Boltzmann equation, which accounts for the fixed and mobile charges and dielectric environment of the protein and solvent. The linearized Poisson-Boltzmann equation is shown below

$$-\nabla \cdot (\varepsilon(r) \nabla \phi(r)) + \varepsilon(r) \nabla^2 \phi(r) = \sum_{i} \frac{Q_i}{|r - r_i|}$$

In equation (1), $\varepsilon(r) = \varepsilon_0 \varepsilon_r(r)$ represents the distance dependent permittivity of the medium ($\varepsilon_0$ being the vacuum permittivity and $\varepsilon_r$ being the relative permittivity with respect to vacuum or dielectric coefficient as referred below), $\phi(r)$ represents electrostatic potential in units of $k_B T/e_c$ ($k_B$ being the Boltzmann constant, $T$ the temperature, and $e_c$ the electron charge), and $\kappa^2(r)$ is the ion accessibility function that incorporates ionic strength and distribution of ions into the equation. Finally, the sum of fixed charges found in the protein are expressed by $Q_i \delta(r - r_i)$, where $Q_i$ represents the protein’s fixed charge at atom position $r_i$. The calculations were conducted using a 129 x 129 x 129 grid of dimensions 114 x 140 x 122 Å$^3$, a dielectric coefficient of 20 for protein interior and 78.54 for solvent, ionic strength of 150mM all at room temperature 298.15K. Visual representations of the electrostatic potentials were generated with Chimera.10 The visual representations play a key role in analysis and understanding of the mechanism behind the binding and stability of an interaction.

We further obtained a quantitative calculation of the interaction by calculating free energies of association of the mutants to find how a particular residue affected the complex, according to

$$\Delta G = \frac{1}{2} q_i \phi_i$$

In equation (2) the free energies of association $\Delta G$ are described by $q_i$ and $\phi_i$ which represents the charge and electrostatic potential, respectively, when calculated through APBS. Using the theoretical thermodynamic cycle shown in Fig. 2, both the free energies of association (horizontal processes) and of solvation (vertical processes) can be calculated.5-7
Molecular Analysis of the Interaction Between Staphylococcus Aureus Protein Sbi and Immune System Protein C3d

Wilson Rodriguez

Figure 2. Thermodynamic cycle for Poisson-Boltzmann free energy calculations. Electrostatic potential is represented by isopotential contours. Red and blue contours have values of +1 and -1, respectively. Proteins A, B, AB are shown in the figure as c3d, sbi and c3d-sbi, respectively. The top horizontal process represents protein association in reference state of uniform dielectric and no ions present. The bottom horizontal process represents the same association with protein dielectric of 20, solvent dielectric of 78.54 and ion concentration of 150mM. Solvation process is represented by the three vertical processes.5-7

In order to simultaneously account for both solvation and association the $\Delta \Delta G_{\text{solution}}$ association free energy (Fig. 2) was calculated which is equal to the difference of the horizontal and vertical processes according to

$$
\Delta \Delta G_{\text{solution}} = \Delta G_{\text{solb}} - \Delta G_{\text{sol}} = \Delta G_{\text{sol}} - \Delta G_{\text{solb}}
$$

$\Delta \Delta G_{\text{solution}}$ was then used in the comparison of mutants and their complex interactions. In order to cluster the mutants based on their electrostatic similarity distances (ESD), the Average Normalized Distance (AND) measurement was employed

$$
\text{AND}_{a,b} = \frac{1}{N} \sum_{i,j,k} \frac{|\phi_a(i,j,k) - \phi_b(i,j,k)|}{\max(\phi_a(i,j,k), |\phi_b(i,j,k)|)}
$$

and represented in a hierarchical clustering dendrogram.\(^5\)

In equation (4) $\phi_a$ and $\phi_b$ are the electrostatic potentials of proteins A and B, respectively, at grid points (i,j,k) and N is the number of grid points.

Theoretically, the mutants that have similar spatial distributions of electrostatic potentials will cluster, or group, together and are expected to behave similarly in terms of their electrostatic interactions. AESOP as a computational tool serves to provide researchers with a theoretical insight to protein physicochemical properties. The analysis can also be used in the design of proteins with desired functions, if these functions depend on the physicochemical properties under consideration (in our case electrostatic potentials). Molecular visualization and analysis outside AESOP was performed using the programs Chimera\(^10\) and VMD.\(^11\)

RESULTS

We generated two pairs of dendrograms, one for each complex site of Fig. 1. The dendrograms represent alanine scan mutations and are shown in Fig. 3. The mutant name scheme is as follows: residue number according to sequence, single letter code of residue and end-mutated residue alanine. The dendrogram is analyzed according to the length of the branches and connections to other “clusters” in the overall family tree of mutants, i.e. two residues next to each other share similarity in terms of electrostatic potential and that cluster is related to mutants next to it as well as other clusters next to it; the shorter the length of the branches, the more similar the clusters (and proteins within the clusters) are. According to equation (4), an AND value of zero denotes identity and as the value deviates from zero denotes increasing dissimilarity (up to a value of 2 for most dissimilar).

In general, mutations of similarly charged residues will cluster together, i.e. mutations of acidic residues form the cluster colored in red in Fig. 3, whereas mutations of basic residues form the cluster colored in blue in Fig. 3. The parent protein and mutations of the neutral histidines also form a distinct cluster, colored in black in Fig. 3. While the dendrograms provide insightful information on similar electrostatic character and function, they do not provide analytical information on the favorability of the interaction. We then use the association free energy of solvation to assess the predicted gain or loss of binding. The free energies indicate the effect the mutation had on the complex where negative energies indicate a favorable interaction and mutations converging toward positive free energies indicate the mutation was unfavorable. In the case of Complex 1, mutations of acidic negatively charged...
residues produced favorable interactions that promote binding, whereas mutations of basic positively charged residues produced unfavorable interactions that disrupt binding and stability of the C3d-Sbi complex. On the other hand, the analysis of Complex 2 did not display typical characteristics of an interaction dominated by electrostatics, but it did elucidate mutations of acidic residues as unfavorable towards the interaction. According to Clarke et al.\textsuperscript{3} the interaction in Complex 2 may be mostly governed by van der Waals interactions, which is in agreement with our conclusion that electrostatics plays a small role in the formation of Complex 2. Favorable inter-molecular Coulombic interactions were calculated for the binding sites of Complexes 1 and 2 (Tables 1 and 2, respectively). The cutoff distance value for Coulombic interactions was set to 6 Å. The stronger role of electrostatics in the formation of Complex 1 compared to Complex 2 is indicated by the larger number and magnitude of Coulombic interactions. Complex 1 includes 7 Coulombic interactions in the range [3.3-5.8] Å, with 3 of them being (strong) salt bridges in the range of [3.3-4.0] Å (Table 1). Complex 2 includes only 4 Coulombic interactions in the range of [4.9-5.6] Å (Table 2), which are collectively weaker than those of Complex 1. This pairwise Coulombic analysis is in line with the overall AESOP analysis.

**DISCUSSION**

In this study, we generated mutations on the C3d-Sbi complex at the two different binding sites, and clustered residues...
the mutants according to electrostatic similarities. From our results it is notable that Sbi shares several binding similarities at Complex 1 with Efb-C and Ehp, two proteins also secreted by *S. aureus*. Efb-C and Ehp interact with C3d or the C3d domain of C3/C3b to disarm complement system function against bacteria. Looking at the free energies (Fig. 3) and Coulombic interactions (Table 1) we note that three mutations on Sbi, Lys53, Arg45 and Arg20, are unfavorable to the stability of the complex, and are therefore assumed to be critical residues for binding. Because of the similarities Sbi shares with Efb-C and Ehp, there could be a possibility to develop novel therapeutics for Sbi targeting the binding site of Complex 1, which could also function against Efb-C and Ehp binding. Although at Complex 2 we did not see typical clustering of an interaction that relies primarily on electrostatics while it may be probable that Sbi’s function at that binding site is to block the thioester-forming residues from anchoring C3b to antigen surfaces. The range of free energies of association is small and a single mutation of Asp 22 to alanine produced a completely unfavorable interaction with positive free energies (Fig. 3b). Another possibility is that the interaction found at Complex site 2 may be a crystallographic artifact or may be non-electrostatic in nature.

![Figure 4. Molecular graphics representations of C3d-Sbi located at two separate binding sites: complex 1 and 2. (A) Complex 1 binding interface of C3d-Sbi. Sbi (green) shown binding to concave side of C3d (cyan). C3d-Sbi backbones depicted as ribbons. (B) Complex 2 binding interface of C3d-Sbi. Sbi (purple) shown binding to convex side of C3d (cyan). C3d-Sbi backbones depicted as ribbons. Acidic (red) and Basic (blue) interacting residues shown on both C3d and Sbi on both complex sites in stick representation. Residues shown in stick representations are within 6Å and depict the pairs of Tables 1 and 2.](image)

**Table 1.** C3d-Sbi intermolecular Coulombic interactions for complex 1. Using 6Å Oxygen-Nitrogen cut-off.²

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Distance (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASP 170-LYS 53</td>
<td>3.3</td>
</tr>
<tr>
<td>GLU 174-ARG 20</td>
<td>3.9</td>
</tr>
<tr>
<td>ASP 43-ARG 45</td>
<td>4.0</td>
</tr>
<tr>
<td>GLU 44-ARG 45</td>
<td>4.5</td>
</tr>
<tr>
<td>ASP 170-ARG 49</td>
<td>4.5</td>
</tr>
<tr>
<td>GLU 174-ARG 24</td>
<td>5.2</td>
</tr>
<tr>
<td>ASP 110-LYS 59</td>
<td>5.8</td>
</tr>
</tbody>
</table>

**Table 2.** C3d-Sbi intermolecular Coulombic interactions for complex 2. Using 6Å Oxygen-Nitrogen cut-off.²

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Distance (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIS 140-ASP 57</td>
<td>4.9</td>
</tr>
<tr>
<td>ARG 148-GLU 60</td>
<td>5.3</td>
</tr>
<tr>
<td>HIS 140-ASP 22</td>
<td>5.5</td>
</tr>
<tr>
<td>LYS 65-GLU 15</td>
<td>5.6</td>
</tr>
</tbody>
</table>
CONCLUSION

The study conducted using AESOP in order to explore electrostatic properties allowed us to clarify the residues responsible for function, especially in Complex 1. We were able to determine similarities of Sbi to other secreted proteins of S. aureus, such as Efb-C and Ehp, and provided insight into the governing forces at each complex site. We have demonstrated that electrostatics is the driving force for the interaction between Sbi and C3d within the binding site of Complex 1, which is also the binding site for S. aureus proteins Efb-C/Ehp and endogenous complement receptor CR2. Given that the function of CR2-C3d association is to augment B cell and antibody response, we propose the hypothesis that electrostatic competition between Efb-C/Ehp and CR2 for C3d binding may a contributing factor for S. aureus infection or successful immune system response. On the other hand, formation of Complex 2 may be dominated by van der Waals interactions or may be a crystallization packing artifact that forced the two molecules in the vicinity of each other, but without forming an actual complex. Crystallization is requirement for the determination of three dimensional protein structures by X-ray diffraction. Future work will be focused on testing this hypothesis, by using molecular dynamics simulations to elucidate whether the interactions of Complex 2 are physico-chemically favorable.

REFERENCES

ABSTRACT

Across the United States from California to Florida and as far north as Virginia, grapevines are succumbing to Pierce’s Disease (PD) which currently infects more than 30% of grapevines and is a threat to the $30 billion wine industry. PD is caused by the bacterial pathogen, *Xylella fastidiosa*, which blocks water from flowing through the xylem of plants. Affected grapevines develop leaves that are discolored and dried out, and usually die within 2-5 years. *X. fastidiosa* is transmitted by xylem feeding insects. The most effective insect vector is a leafhopper, Glassy-Winged Sharpshooter (*Homalodisca vitripennis*). GWSSs are able to survive in mild to scorching temperatures and can feed on the woody stems of plants, making them an optimal vector of the pathogen. In the summer, GWSS populations explode, creating the greatest period of *X. fastidiosa* infection of grapevines. During summer, 2010, we performed a survey on unsprayed grapevines on the UCR campus to determine patterns of GWSSs visiting the plants and their infection status. Insects were collected on yellow sticky traps from late June to late October. All insects were surface sterilized, the DNA was extracted, and real-time PCR was used to test for presence of *X. fastidiosa*. GWSS visitation to the plants was highest in midsummer. From 112 insects collected, 83 were tested for *X. fastidiosa* and approximately 76% were found to be positive. These results indicate that many of the GWSSs feeding on the unsprayed grapevines are infected with *X. fastidiosa*, placing the plants at high risk of infection.

Mentors

Faculty Mentor: Thomas A. Miller (top)
Graduate Student Mentor: Arinder Arora (lower left)
Postdoctoral Mentor: Genet M. Tulgetske (lower right)

Department of Entomology

Candice joined my laboratory as a volunteer shortly after she took my Freshman Advising Seminar in Fall of 2009. From the beginning, Candice fit into our lab very well. She learned quickly from Lab Manager Genet Tulgetske, and soon came to be reliable and dependable so we hired her part time. After becoming familiar with our projects, she selected one, Pierce’s Disease of grapevines, and asked if she could work on that on her own. She monitored the population of the vector insect, *Homalodisca vitripennis*, a leafhopper, and provided reports to the granting agency. Now in her third year, Candice received grant support from the campus’ Undergraduate Research Grants and other scholarships. She is also mentoring other undergraduates who followed her example. She does PCR analyses for the presence of the pathogen in the vector insects causing Pierce’s Disease in our research vineyard at Agricultural Operations. At the 2012 UCR Symposium for Undergraduate Research, Scholarship, and Creative Activity, a grape and wine industry representative praised her poster as work that was critically important to the industry. Candice caught the research “bug” early on and is planning to attend graduate school. As a junior, she already acts and talks like a graduate student and now, is publishing. She has a very bright future.
INTRODUCTION

Pierce’s Disease is a bacterial disease of grapevines, first recognized by Newton Barry Pierce in the late 1800’s near Anaheim, California. To date, the disease has been documented in vineyards from California to Florida and along the East Coast as far north as Virginia (Hoddle, 2004; Wallingford et al., 2007). Affected grapevines develop leaves that are discolored and dried out, and they usually die within 2-5 years (Hopkins, 1989). The disease is caused by infection with the bacterial pathogen, *Xylella fastidiosa*, which multiplies in the xylem of plants, forming a gel-like biofilm that blocks water flow to the rest of the plant (Hopkins, 1989).

*X. fastidiosa* is an insect transmitted bacterium that lives only in the xylem of the infected plant. The xylem is responsible for transporting water throughout the plant. The insects feeding on the xylem transfer the pathogen from the infected plants to healthy plants. There are several pathogenic strains of *X. fastidiosa* each of which is associated with a specific host plant causing diseases in different plants from various families (Hopkins, 1989). *X. fastidiosa* infections are seen more often in areas with mild to high temperatures. These temperatures are also ideal for the insect vector, *Homalodisca vitripennis*, which is frost sensitive and thrives best in hot climates (Johnson et al., 2008).

*H. vitripennis*, most commonly known as the Glassy-Winged Sharpshooter (GWSS), is one of many leafhopper species, referred to as sharpshooters (Figure 1). These sharpshooters feed on the xylem fluid, thus transmitting *X. fastidiosa* to the plant. The GWSS appears to be a much more effective vector of the pathogen than most other sharpshooter species. This ability has been attributed to the insect’s high mobility, wide distribution, and ability to have many hosts (Almeida et al., 2005). Transmission of the pathogen can occur immediately after the GWSS has acquired the bacteria (Hopkins, 1989). This species has become well established and widely distributed in Southern California since its accidental introduction in early 1990’s, making it very difficult for wineries to control the disease. Although GWSS have many hosts, they mainly reside on citrus plants where egg laying occurs during the late winter and early spring (Redak et al., 2004). Insect emergence takes place within 2 weeks of egg laying, adults remain active throughout the summer, then the numbers decrease in early fall (Redak et al., 2004). The Pierce’s Disease pathogen is transmitted most during summer when GWSS populations are at their highest (Almeida et al., 2005).

Figure 1. Photo of adult *H. vitripennis* http://cisr.ucr.edu/ssp_director/albums/album-9/lg/glassy-winged_sharpshooter_gwss-6.jpg.

Pierce’s Disease is a persistent threat to the $30 billion wine industry encompassing 890,000 acres of vineyards across Southern California. In 2000, PD affected 30% of California grape crops and has likely increased since then (Toscano et al., 2006). As a result of this disease, the vine growers have turned to intense use of chemical insecticides for the containment of GWSS. This widespread use of insecticides often prevents us from surveying the natural patterns of *X. fastidiosa* occurrence in relation to GWSS and the grapevines. We obtained access to unsprayed grapevines in AgOps fields on the UCR campus, which gave us the opportunity to conduct a rare survey of GWSS visitations in a natural environment. The information collected allows us to examine visitation patterns as well as patterns of the natural infection of GWSS carrying the bacterium, *X. fastidiosa*. Such information will contribute to understanding the insect-pathogen-plant dynamics of the PD system and aid in the development of more efficient management skills in controlling the disease.
MATERIALS AND METHODS

Surveying and Collection

A plot of 9 unsprayed grapevine rows in the AgOps field on the UCR campus was used for this survey. Each row contained 25 plants, spaced approximately 8 feet apart with trellising wires at 40 in. and 52 in. to allow the plants to fill the spaces in between. We placed 8 insect traps evenly spaced throughout the top 6 rows of the plot. Traps were set on Sunday of each week and left to collect GWSS for 7 days. After 7 days, the number of GWSSs on the sticky traps was recorded and the insects were collected from each trap. All insects were then stored at -80°C for further analysis.

DNA Extraction

*X. fastidiosa* resides within its insect host. In order to detect the presence of the bacterium, DNA was extracted from the GWSSs, which included insect and bacterial DNA. Up to 10 GWSSs were randomly selected from the total collection each week for DNA extraction and analysis. When fewer than 10 insects were collected, all insects were processed. In total 83 insects were used for DNA extraction. The selected GWSSs were individually surface sterilized in 70% ethanol, 10% bleach, and water for 2 minutes in each. The GWSS heads were then carefully severed from the body and DNA was extracted as follows. Each head was macerated in a separate microcentrifuge tube containing 200 µl of PBS using a homogenizer. After the solution was fully homogenized, 180 µl of this solution was transferred to a new microcentrifuge tube. To this, 180 µl of ATL buffer and 20 µl of proteinase K were added to lyse the cell tissue. The solution was fully homogenized, 180 µl of this solution was transferred to a new microcentrifuge tube. To this, 180 µl of ATL buffer and 20 µl of proteinase K were added to lyse the cell tissue. This solution was then incubated at 55°C for one hour to allow full cell lysing to take place. 200 µl of AL buffer was added, followed by an incubation period of 10 minutes at 70°C. After this, 200 µl of 100% ethanol was added and this solution was then transferred to a new column tube. The solution was centrifuged at 8000 rpm for 1 minute. The liquids were discarded and the column was saved. Next, the column was washed with 500 µl of AW1 buffer, followed with 500 µl of AW2 buffer and centrifugation at 8000 rpm for 1 minute. The column was shifted to new microcentrifuge tube. Lastly, 100 µl of AE buffer, elution buffer, was added and the samples were incubated for one minute at room temperature and then centrifuged. The column was discarded and the remaining DNA solution was labeled and stored at 4°C.

Real-Time PCR

To detect the presence of *X. fastidiosa*, the polymerase chain reaction was performed on extracted DNA using primers specific to the bacterium. If *X. fastidiosa* DNA is present in a sample, the bacterial DNA is amplified through this process, resulting in a clear positive result. If the bacterium is absent in the GWSS sample, no amplification occurs and a negative result is recorded. Due to its high sensitivity, real-time PCR was performed instead of the traditional PCR. The real-time PCR was run following protocol developed by Schaad et al. (2002). Each run was performed in duplicate and each run included a positive and a non-template control. The following primers and probe, selected to amplify the ITS sequence of *X. fastidiosa*, were used for the PCR run: forward primer (5’AAAAATCGCCAACATAAACCCA3’), reverse primer (5’CCAGGCGTCCTCACAAGTTAC3’), and probe (5’6-FAM CCTATGCCAACATCAAACCCTGAATGCA BHQ-1 3’) (Schaad et al., 2002). We modified the technique outlined in Arora (2010) to perform real-time PCR reactions in 50 µl units using 5 µl of template DNA. The real-time PCR cycle was run using the following conditions: 3 minutes at 95°C for enzyme activation, followed by 40 cycles of denaturing at 95°C for 15 seconds and annealing and extension at 62°C for 1 minute.

RESULTS

A total of 103 GWSSs were collected from July to October, 2010, the duration of this survey. The number of GWSSs collected in a single week ranged from a low of 0 insects during one week in October to a high of 25 GWSSs in August. The months of October and August also showed the lowest and highest monthly collections with 14 and 59 insects, respectively. We observed two population peaks, one in August followed by a decline and then another peak in late September to early October. The second population peak was also followed by a decline.
in the number of GWSS visiting the plants. After the population peak in August of 25 GWSSs collected, GWSS visitation declined steadily, reaching a low of 3 insects collected. After the second, smaller peak in early October, with a maximum count of 9 GWSSs, the population dropped to 0 then increased to a few GWSSs for the remainder of the season.

Real-time PCR analysis successfully detected the presence or absence of *X. fastidiosa* in collected samples (Figure 2), revealing an overall frequency of infection of 76 percent. We tested 83 of the 103 GWSSs collected for the *X. fastidiosa* bacterium. Of those tested, 63 GWSSs showed positive results for *X. fastidiosa*. We saw two peaks in infection rates, the first from July 23rd to September 9th and the second peak from September 17th to October 15th. There were also two dramatic decreases in infection rate with 0 percent infection on dates September 10th and October 22nd. The weekly infection rates during the survey ranged from 50% to 100% positive per date, except those of September 10th and October 22nd.

**DISCUSSION**

Based on the multiple population peaks seen in the survey results, we believe there are three generations of GWSS during the active season from July to October. In this population survey, two population peaks can be clearly seen, the first peak occurring on August 20th and the second peak occurring on October 1st. The population survey shows rapid declines in GWSS visitation after each population peak (Figure 3). These dramatic decreases in population are believed to correspond to the intermediate points between each generation. A slight decrease in population numbers can also be seen from July 23rd to July 30th, which may correspond to a decline from the previous population peak. Therefore, we believe our survey shows generations 2 and 3 out of a 3 generation active season. The 1st generation of three was likely missed in this survey since collection did not occur until almost mid-season, in late July. As temperatures reached their highest in August, so did the GWSS population. This is expected since GWSS thrive best in hot temperatures. Further, the first generation would be expected to be smaller than the second generation which appeared in our August and early September collections.

The rate of infection among collected GWSSs corresponds to the visitation pattern seen in the population survey with infection rates increasing and decreasing with population generations (Figure 4). Just as there are two visible population peaks in the GWSS visitation survey, there are two clear peaks in

**Figure 2.** Real-time PCR results showing the presence or absence of *X. fastidiosa* in GWSS samples. A) Positive template B) GWSS duplicated samples positive for the *X. fastidiosa* DNA C) GWSS samples negative for the bacterium D) Threshold fluorescence to determine whether samples are positive (Toscano, et al., 2006).

**Figure 3.** Weekly insect collections from July 23rd to October 29th.
X. fastidiosa infection. Infections rates are relatively high from July 23rd to September 3rd, the period corresponding to what we believe is the 2nd active season generation, and rates are high again from September 17th to October 15th, the period that corresponds to the 3rd generation. However, the weeks in which the infection rate was at 0 percent may be due to the fact that very few to no GWSSs were collected during those weeks and may not accurately show the infection rates at the lowest points of each generation.

**Figure 4.** Weekly infection rate of GWSS collected from July 23rd to October 29th.

Further studies are underway to investigate the full seasonal occurrence of GWSS visitation to unsprayed grape plots in Southern California and the rate of infection of X. fastidiosa. The survey period will be extended to include a potential early generation with the corresponding rates of infection. Also we intend to obtain data on additional factors possibly influencing GWSS visitation and infection rates, such as sex, additional visiting sharpshooter species, and grape variety. The described survey and future studies will contribute to the body of knowledge regarding the geographical and seasonal occurrence of the most prominent vector of X. fastidiosa, GWSS. Understanding the insect-pathogen-plant host dynamics in the PD system is essential to developing an effective method to control the disease. This survey provides exceptional data on the seasonal GWSS visitation and infection rates of X. fastidiosa and establishes a foundation for additional studies.

**CONCLUSION**

This population survey consisted of a 15 week collection of GWSS visiting a local, untreated grapevine plot from July to October. The number of GWSS visiting the grapevines was recorded weekly and the insect samples were analyzed using real-time PCR and X. fastidiosa-specific primers to detect infection with the pathogen responsible for causing Pierce’s Disease in grapevines. The GWSS population survey presented here demonstrates the presence of two GWSS population generations at the AgOps grape plots. Based on our knowledge of GWSS biology and the timing of the survey, we conclude these are most likely the 2nd and 3rd generations of 3 generation active season. The overall rate of infection of X. fastidiosa among GWSS visiting the AgOps plot was measured at 76%. This rate appears uncharacteristically high compared to those of previous population and infection rate studies (Hail et al., 2010) but can be explained by the use of the more sensitive real-time PCR technique for bacterial DNA detection. As GWSS visitation appears cyclical, so does the X. fastidiosa infection rate. X. fastidiosa infection rates correspond to the visitation pattern seen in the population survey with infection rates increasing and decreasing with population generations. These low infection rates may represent an actual fluctuation in infection frequency or they may due to low numbers of GWSS collected on the corresponding collection dates. Further studies will need to be performed to confirm the cause of the cyclical infection rates.

This single season survey gives researchers information about GWSS visitation patterns on local grapevines and the rate of infection of X. fastidiosa in local GWSS populations. This valuable data offers insight into the local threat of Pierce’s disease and will be helpful in determining control methods for the pest and bacterial vector, Glassy-Winged Sharpshooter. This survey provides a foundation for additional studies investigating GWSS visitation and X. fastidiosa infection patterns. Continuation of this annual survey will be helpful in understanding the dynamics of Pierce’s disease and developing control measures for GWSS and X. fastidiosa.

**ACKNOWLEDGMENT**

Funding for this project was provided by UCR’s Undergraduate Research Grants program.
REFERENCES


The Effects of Different Genres of Background Music on Women's Trait Inferences About Men

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University of California, Riverside

A B S T R A C T

It has been found that the presence of music can have bearing on an individual’s emotional state, behavior and perception (May & Hamilton, 1980; Bryne & Clore, 1970). The genre of music determines the type of behavior that ensues, with individuals normally acting in accordance with stereotypes about that particular genre, such as buying expensive wines when a sophisticated classical song is playing in a wine store (Areni & Kim, 1993). The current study sought to determine the effect of sophistication levels in music, between classical and popular genres, on women’s trait inferences about men. Participants judged the attractiveness, sociability, sophistication in literature and arts, approachability and socio-economic status of five male photographs in the presence of classical music, popular music, or silence. Results show that sophistication levels in background music did not affect women’s perceptions about men, but the women’s ratings of various traits were significantly related.

F A C U L T Y M E N T O R

Lawrence D. Rosenblum
Department of Psychology

Jasmine and Bowen’s project examined the influences of background music on the inferring of character traits of male faces. While they were unable to find influences of different styles of background music, they were able to establish a methodology that will be useful for examining similar issues in the near future. Moreover, the idea, design, and execution of the project came completely from Jasmine and Bowen. My own lab explores speech and multisensory perception, topics very different from those of Jasmine and Bowen’s project. However, Jasmine and Bowen’s initiative and understanding of their topic led me to trust them to conduct their project in my laboratory. They performed all phases professionally, and demonstrated enthusiasm and enjoyment along the way. They also gained expertise with many different research areas, by reading all of the relevant background literature.

Pictured above from left to right: Jasmine Singh, Bowen Shaner

A U T H O R S

Jasmine Singh
Bowen Shaner
Psychology

Jasmine Singh and Bowen Shaner are both Psychology majors, in their third and fourth year respectively. Both authors work in Dr. Lawrence Rosenblum’s Audiovisual Speech Perception Laboratory as research assistants, an experience that deepened their interest in research. The authors presented this research at the UCR Symposium for Undergraduate Research, Scholarship, and Creative Activity. Jasmine plans to pursue a PhD in Social Psychology, while Bowen is choosing a PsyD in Clinical Psychology. The authors thank Professor Rosenblum for his guidance and support throughout this project.
INTRODUCTION

The relationship between atmosphere, affect and perception has been studied extensively, often with mixed results. Judgments about the characteristics of people have been found to be influenced by one’s mood (e.g., Forgas & Bower, 1987). Byrne & Clore (1970) suggest that a perceiver fails to discriminate between the affective connotation of characteristics of a person and the affective characteristics of contextual stimuli that are simply a part of the perceptual environment. As a result, it has been found that the presence of music can greatly impact one’s moods and consequently, perception (May & Hamilton, 1980; Gueguen, Jacob & Lamy, 2010). For example, May and Hamilton (1980) discovered that rock music increased attraction to the opposite sex more than the absence of music or the presence of avant-garde, atonal music. Similarly, short-term listening to music with violent lyrics has been correlated with increased hostility and aggression in males after the exposure (Anderson, Carnagey & Eubanks, 2003).

Trait inferences refer to the personality characteristics an individual deduces of another. Trait inferences have been thought to be an instantaneous process, of which the individual usually has no specific intention or awareness (Winter & Uleman, 1984). A characteristic as basic as physical appearance can lead to the attribution of traits to an individual (e.g., Andersen & Klatzky, 1987). For example, people tend to associate attractive individuals with possession of positive traits such as sociability and intelligence, while unattractive individuals are perceived as lacking these qualities (e.g., Dion, Berscheid & Walster, 1972). In comparison, stereotypes have been suggested to be an automatic process that enables individuals to more readily identify and recall patterns in behavior and concepts (Winter & Uleman, 1984).

Commonly perceived stereotypes usually determine the considered levels of sophistication in music (North & Hargreaves, 2007). Rentfrow & Gosling (2007) conducted a study in which stereotypes about fans of various musical genres were evaluated. Participants rated personality traits, substance use and moral beliefs of the genres’ fans. Then, these characteristics were examined in the fans of the various musical genres themselves. Rentfrow & Gosling found that general stereotypes existed for main musical genres and that the stereotypes were accurate. Classical fans are perceived as affluent, intelligent and unattractive; meanwhile pop music fans were deemed enthusiastic, attractive and heavier drinkers.

Highly sophisticated music is frequently referred to as “highbrow”, and consists of classical and opera music; middlebrow and lowbrow music are comprised of more widely listened to genres such as popular and country music (Peterson & Kern 1996). Stereotypical perceptions of these musical genres have been demonstrated in psychological research: Areni and Kim (1993) found that using classical background music, in comparison to popular music, in a wine store prompted consumers to purchase more expensive wines. Similarly, North and Hargreaves (2006) demonstrated that playing classical or popular music in a cafeteria causes students to purchase more items than with silence, with classical background music resulting in increased willingness to spend more on items. Participants’ responses after a comparable study indicate that the effect of musical atmosphere on choice was not conscious (North, Hargreaves & McKendrick, 1999).

The current study examined the effect of sophistication levels in music on women’s trait inferences about males. As sophistication levels vary between musical genres and these stereotypes about the genres have been shown to affect one’s judgments on various matters, perceptions regarding the males were expected to vary according to the presence of different types of background music.

METHODS

Phase I: The Selection of Male Stimulus Photographs

Participants. Thirty female undergraduate students, ages 18 to 25, were the raters for the rating task.

Materials. Six frontal headshot photographs of adult Caucasian males between the ages of 25 to 33 with neutral expressions were obtained from a free online face database.
**Procedure.** The six photographs were assembled into an online survey using “Survey Monkey” (Survey Monkey, 1999) in which participants rated the attractiveness of each. A 7-point scale was used to rate attractiveness: 1 = extremely unattractive, 2 = unattractive, 3 = slightly unattractive, 4 = neither attractive nor unattractive, 5 = slightly attractive, 6 = attractive, 7 = extremely attractive. Five out of the six photographs were rated as neutral (M = 3.8, SD = 1.8). One photo received a rating of “unattractive” (M = 2.3, SD = 1.4) and was excluded.

**Phase II: The Effect of Background Music on Participants’ Judgments**

**Participants.** Thirty female undergraduate students, ages 18 to 25, were obtained by the investigators emailing students in their psychology courses at UCR with an inducement of free snacks for their participation in this experiment. Each participant had normal or corrected to normal hearing and vision. Only females were used to control for gender differences in susceptibility to the effects of background music (Beardslee & Fogelson, 1958). Half of the participants were run by the male investigator, while the other half were run by the female investigator, to control for effects of experimenter’s gender on the results (Barnes & Rosenthal, 1985).

**Materials.** The five validated neutral photographs were used in this phase of the experiment. Also, pairs of photographs of scenes were used for a distractor task. The scene photos in each pair were similar, but contained twenty subtle differences which subjects were asked to identify during the distraction phase of the experiment. Finally, a paper rating chart was utilized by each participant to make judgments about the photographs.

**Procedure.** In the experiment, individual participants were seated in a sound booth, while music played in the background through a computer speaker both in the sound booth and throughout the laboratory. Participants were told that music was played for the laboratory’s enjoyment, to prevent suspicion about the nature of the experiment.

The type of music playing was dependent upon the three conditions: a classical music playlist, a popular music playlist and a control group with silence. Current popular songs were determined from the Billboard Top 100 list, while classical music was chosen from a list of classical songs (Mitterschiffthaler, Fu, Dalton, Andrew & Williams, 2007). Instrumental versions of all music were used to prevent possible effects from the lyrics (Anderson, Carnagey & Eubanks, 2003; Gueguen, Jacob & Lamy, 2010). There were ten participants in each condition. The participants sat for 15 minutes with the background music playing, performing the “find the difference” task with the pairs of scene photos. This allowed for the exposure to the musical stimulus without drawing attention to it (May & Hamilton, 1980).

Subjects were then presented with the five photographs of the male stimuli on a computer screen inside the sound booth for one minute per photograph while music continued to play. During this one minute, the participants made judgments regarding each male featured. A 7-point ranking scale was used for perception of 5 traits: sexual attractiveness, approachability, sociability, sophistication in literature and arts, and socioeconomic status. Statements regarding these respective traits were as such: “This person is sexually attractive,” “I would walk up to this person,” “This person has a lot of friends,” and “This person is sophisticated in literature and arts.” Participants were asked to rate the perceived socioeconomic standing of the male photographs. The 7-point scale is: 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = agree, 7 = strongly agree. For socioeconomic status, the 1-3 was lower class, 4 was middle class and 5-7 was upper class.

**RESULTS**

A multivariate analysis of variance (MANOVA) was conducted to determine differences in influences between classical or popular background music and silence on trait inferences for each male photograph. Musical condition had no effect on the women’s judgments for the male stimuli, Wilks’ $\lambda = .709, F (10, 40) = .752, p>.05$. Furthermore, there was no effect of experimenter gender on the results, Wilks’ $\lambda = .790, F (5, 20) = 1.066, p>.05$.  

Jasmine Singh, Bowen Shaner
Pearson correlation coefficients (r) were determined to observe degrees of correlation between various trait inferences of the male stimuli. There was a significant positive correlation between ratings of attractiveness and sociability (r = .581, n = 30, p = .001), attractiveness and sophistication in literature and arts (r = .366, n = 30, p = .047), and attractiveness and approachability (r = .570, n = 30, p = .001). Additionally, a significant correlation existed between ratings of sociability and sophistication (r = .529, n = 30, p = .003), and sociability and approachability (r = .687, n = 30, p = .000). Furthermore, a significant correlation was found between ratings of sophistication in literature and arts and perceived socio-economic status (r = .424, n = 30, p = .020).

DISCUSSION

Overall, the sophistication level of background music, whether highbrow or lowbrow had no effect on women’s trait inferences of men. Also, the general presence of music in comparison to a silent atmosphere did not affect the judgments made. Thus, these findings may provide evidence that the levels of sophistication in an atmosphere may not significantly impact women’s perceptions of men. The exposure to the musical stimuli may have been too conspicuous an aspect of the experiment; perhaps conducting the experiment at a desk in the laboratory, instead of a sound booth, would have made the background music appear more natural and realistic (May & Hamilton, 1980). Additionally, subjects’ individual musical preference could have played a role in determining trait inferences while either classical or popular music was playing (Caldwell & Hibbert, 2002). Moreover, the volume of the music could have had an impact on the results: research indicates that females react more positively to music when it is played at a lower volume (Kellaris & Rice, 1993). Therefore, the experiment could be enhanced by first testing the effects of music’s volume on ratings of various traits by females. Correlations found between various trait ratings were predictable. The results suggest that approachability, sophistication, sociability can be contributing factors to an individual’s attractiveness; by the same token, a higher rating of attractiveness could have led to the attribution of the aforementioned traits to the male stimulus, as research has shown the positive perceptions others have about good-looking individuals (e.g., Dion et al., 1972). The significant correlation between ratings of sociability and approachability supports research that approachable people are more likely to be befriended (Blau, 1960). Additionally, the relationship between sociability and sophistication in literature and arts may indicate that sophisticated people make more friends. Finally, a significant correlation between sophistication in literature and arts and perceived socio-economic status was found. This supports the notion that women hold stereotypes that wealthier men tend to be better educated or more refined (Christopher & Schlenker, 2000).

REFERENCES


Effects of Dietary Phytoestrogens on Paternal Responsiveness and Maturation in the Biparental California Mouse

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ABSTRACT

The California mouse (Peromyscus californicus) is a monogamous, biparental rodent in which fathers show strong attraction to pups while virgin males show variable paternal responsiveness. Previous studies have demonstrated that circulating testosterone enhances paternal behavior in this species via aromatization to estrogen. We tested the hypothesis that paternal responsiveness in virgin males would likewise be enhanced by dietary estrogens (i.e., phytoestrogens) from soy. Virgin males (N=16 per group) were fed commercially available diets containing high, medium, or low levels of soy from the time of weaning until sacrifice in early adulthood, and behavioral responses to an unfamiliar pup, body mass, testis masses, fat-pad masses, and epididymal sperm counts were compared among the three groups. No differences were found in males’ behavioral responses to a pup. Similarly, testis masses, fat-pad masses, and sperm counts did not differ as a function of dietary phytoestrogen content. However, changes in body mass over time differed significantly among groups (P<0.001), as mice on the high-soy diet gained more mass across the study than those on the low-soy diet (P<0.001); neither of these groups differed significantly from the medium-soy group. These results suggest that the levels of phytoestrogens in the three diets used in this study differentially affect patterns of physical growth but not paternal behavior, fat deposition, testicular development, or spermatogenesis.

MENTORS

Faculty Mentor: Wendy Saltzman
Graduate Student Mentors: Breanna Harris, Juan Pablo Perea-Rodriguez

Department of Biology

My lab investigates neural, endocrine, sensory, and experiential influences on paternal behavior in the monogamous, biparental California mouse. After assisting with a number of ongoing studies in the lab, Aaron Stamp became very excited by the possibility that dietary phytoestrogens might be affecting paternal care in our captive colony. He showed a great deal of initiative and enthusiasm in developing this hypothesis and designing an experiment to test it, and received a UCR Undergraduate Research Grant to fund his independent study. In conducting the experiment, Aaron worked closely with Trey Amador, a newer student in the lab, and the two of them did a terrific job in every aspect of the project, from developing methodology to coordinating procedures to collecting and analyzing data to presenting their results. Both Aaron and Trey are extremely bright, hard-working, and capable students who made many contributions to my lab. I am delighted that both of them are planning to pursue research careers, and have no doubt that they will both be highly successful.

Pictured above from left to right: Aaron T. Stamp, Trey Amador

Aaron Stamp and Trey Amador are third-year Bioengineering and Biology students, respectively. While working under Dr. Wendy Saltzman, the two authors developed a keen interest in understanding and experimenting with the neuroendocrine system and how it influences behavior. For their research, Trey and Aaron received financial support from the campus’ Undergraduate Research Grant, the MARC*U Fellowship, STEM Pathways Grant, and Regents Scholarship. Recently, Trey was presented the 2012 Academic Excellence Award for Biology. They sincerely thank PhD students Breanna Harris and Juan Pablo Perea-Rodriguez for their invaluable support, as well as everyone else in the Saltzman lab.
INTRODUCTION

Mammalian paternal behavior is rare in nature, as fewer than 10% of mammalian species exhibit some type of male parental care (1, 2). The California mouse (Peromyscus californicus) is one of those rare mammals that exhibit paternal care, as well as monogamy, in the wild (3). These behaviors parallel those of humans and thus make the California mouse a superb candidate for examining paternal care on a biological level. Expression of paternal responsiveness in male California mice has been shown to occur primarily after the birth of a male’s pups, as virgin males have been reported to exhibit indifference or infanticide when exposed to pups (4). However, data from our lab suggest that virgin males may behave more paternally than previously reported. De Jong et al. (5) found that 50% of virgin males behaved paternally, and in a recent experiment, the majority of virgin males behaved paternally and no infanticide was observed (unpub. data). The fact that virgin males in our lab exhibit more paternal behavior than those in some other labs suggests that an unknown variable is affecting the mice.

In California mice, circulating testosterone enhances paternal behavior, an effect mediated by intracellular conversion of testosterone to estrogens within the brain (6, 7). The mice in our colony are fed an ad libitum diet of Purina 5001 rodent chow, a pelleted food that contains a high amount of soy. Because soy contains high levels of estrogen-like compounds (i.e., phytoestrogens), we aim to investigate whether ingestion of a high-soy diet affects paternal behavior, estrogen receptor density, and reproductive physiology in male California mice.

Soy has the highest amount of naturally occurring phytoestrogens (PEs) (8), also known as dietary estrogens. These compounds, especially the two most prominent ones, Daidzein and Genistein (9), have similar molecular structures to estradiol (the major endogenous estrogen in vertebrates), can bind to and activate estrogen receptors, and thus can mimic estradiol’s actions on an animal’s physiology, morphology, and potentially behavior (10). Exposure to PEs in male Wistar rats has been reported to decrease sperm production and decrease the mass of male reproductive organs (11). Furthermore, adipose tissue, or body fat, is responsive to estrogen (12). These and other effects of estrogen can potentially occur during prenatal/early postnatal development (organizational effects) (13, 14) or later in life, around the time of puberty and during adulthood (activational effects) (15).

We aimed to investigate the activational effects of dietary exposure to soy on paternal behavior in male California mice by feeding males food containing low, medium, or high concentrations of PEs. To test for estrogenic effects, we measured reproductive organ masses, fat-pad masses, sperm count, and, eventually, estrogen receptor density in the brain. We predicted that paternal behavior and fat-pad masses would vary directly with PE content, and that testis mass, sperm counts, and ER density would vary inversely with PE content.

METHODOLOGY OVERVIEW

Animals and Experimental Design

This study used 48 adult virgin male California mice initially housed in groups of 4 age-matched males. Mice were housed in the Spieth Vivarium with routine maintenance, as described elsewhere (5). Animals were randomly partitioned into three treatment groups (n = 16 per group) based on soy (and therefore PE) content of their diets: low-soy, or LS (~0-20 ppm; Diet 2020x, Harlan Laboratories), medium-soy, or MS (250-350 ppm; Diet 2018x, Harlan Laboratories), and high-soy, or HS (650-850 ppm; Purina 5001, our colony’s standard diet). The nutrient profiles of the three diets are virtually identical, with 24% of calories from protein, 16% from fat, and 60% from carbohydrates. Each group of mice had ad libitum access to its specific diet from weaning (at 27-32 days of age) until the end of the study, as well as ad libitum access to water from a glass bottle. The mice and food were weighed twice per week at 15:00-17:00 h, at 3- to 4-day intervals. Testing began 50 days after weaning, at 77-82 days of age (California mice reach sexual maturity at around 60 days of age (16, 17)), when each group of four males was split into two pairs. Mice were tested for paternal responsiveness 2 weeks after pair formation, and euthanized 10-13 days later for collection of tissues, at 102-110 days of age.
We utilized standardized paternal-behavior tests (18) to determine the effect of dietary soy on paternal responsiveness. Each mouse was placed in a clean cage with identical environmental conditions at 08:00-09:30 h and allowed to habituate for 15 min. We then placed an unrelated pup (1-3 days old) in the corner of the cage farthest from the male, and videotaped the male for 15 min. We later scored behaviors from the videotapes using the JWatcher event-recorder program (19). Behaviors scored included proximity measurements to the pup (in contact with, within one body length of, and greater than one body length from the pup), jump, attack the pup, approach the pup, carry the pup, eat/drink, sniff the pup, lick the pup, and huddle over the pup. In the event that a pup was attacked by the male mouse, the pup was removed immediately and euthanized if necessary. Proximity measures were scored in 30-sec instantaneous scan samples. For jump and attack we determined the total number of occurrences, and for all other behaviors we determined the total duration of time that the male spent performing the behavior.

**Testes Masses, Fat-Pad Masses, and Sperm Counts**

On the day of sacrifice, one mouse from each pair (n = 24 total) was selected for sperm, testis, and fat-pad analyses. Within 3 min after disturbing the cage, blood was collected from the retro-orbital sinus (20) and centrifuged, and plasma was removed and frozen. Mice were then euthanized by CO2 inhalation, and testes, caudal epididymis, and fat pads (gonadal, upper back, and longitudinal) were removed within 15 min and weighed. For each testis and fat pad we determined both a wet weight and a dry weight. Dry weights were obtained by placing the organs in a drying oven at 60°F for 16 weeks prior to re-weighing.

Caudal epididymis were placed in 5 ml of saline and minced with microscissors. Ten μl of the sperm/saline mixture was added to 90 μl of saline to create a 1:10 dilution, then vortexed briefly. Six μl of the 1:10 dilution was removed and placed on a hemocytometer, and sperm were counted using methods described elsewhere (21).

**Brain Estrogen-Receptor Density**

The second mouse from each pair (n = 24) will be used for estrogen receptor (ER) analysis. On the same day as their pairmates were euthanized, these mice were perfused transcardially with phosphate-buffered saline and then with paraformaldehyde (5, 18). Brains were sliced into 30 μm coronal sections on a cryostat (5, 18). Immunohistochemistry will be performed, as described by Trainor et al. (22), to determine the density of ER-α in the medial preoptic area, lateral septum, and bed nucleus of the stria terminalis, brain regions that have been shown to play a role in paternal behavior and contain ER in California mice (16, 22-24).

**Analysis**

We utilized non-parametric Kruskal-Wallis tests to compare behavioral data among mice in the HS, MS, and LS groups. Testis and fat-pad masses were analyzed by analysis of covariance (ANCOVA), with body mass on the day before sacrifice as the covariate. Analysis of variance (ANOVA) was employed to compare sperm counts among the three groups of mice.

**RESULTS**

**Paternal Behavior**

Kruskal-Wallis tests revealed that dietary PE caused no significant differences among the three groups for any of the behaviors scored (Table 1). The LS group, although not significantly different from the others, had a median latency to approach the pup that was >60 sec faster than the HS group and >50 sec faster than the MS group. No other noteworthy trends towards behavioral differences among the groups were observed. A substantial number of attacks was recorded, however, with one third of the mice (N=7/16 HS, 5/16 MS, and 4/16 LS animals, respectively) attacking the pup during paternal-behavior tests.

**Testis Masses, Fat-Pad Masses, and Sperm Counts**

The three treatment groups showed no significant differences in wet or dry testis or fat-pad masses. Similarly, no differences were found in sperm counts (Table 2),
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although the LS group had a higher average sperm count than the HS and MS groups.

Body Mass

A 2-way (diet x week) repeated-measures ANOVA, using mass at weaning, weekly mean masses for weeks 1-10 after weaning, and final body mass (day before euthanasia), revealed a significant main effect of week...
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(F[11,473]=520.414, P<0.001) and a diet x week interaction (F[22,473]=2.536, P<0.001), but not a main effect of diet (P=0.288). Pairwise ANOVAs revealed that the HS and LS groups showed different patterns of body-mass change over time (F[11,308]=3.602, P<0.001), as the HS group gained more mass over the course of the study than the LS group. Neither of these groups differed reliably from the MS group (P>0.1). When analyzed on a week-by-week basis, body mass showed a marginally significant difference among the three treatment groups at weaning (P=0.054) and differed reliably among the three groups in weeks 1, 2, and 3 (P<0.03) after weaning but not at any subsequent time point. At weaning, the LS group was heavier than both the MS and the HS group (P<0.05, Fisher LSD tests). The LS group had higher body mass than the MS group in each of the subsequent three weeks (P<0.05, Fisher LSD tests), and the HS had higher mass than the MS group in weeks 2 and 3 (P<0.05, Fisher LSD tests).

DISCUSSION

In this study, we tested the hypothesis that high levels of dietary estrogens in the form of phytoestrogens from soy would increase paternal responsiveness in virgin, adult male California mice. We additionally determined whether high dietary phytoestrogen levels would affect physical and reproductive development of males, including testis masses, sperm counts, and adipose tissue masses.

Contrary to our hypothesis, paternal behavior did not differ significantly across the three treatment groups. This finding has several possible explanations, most notably that phytoestrogens are not a strong enough endocrine disruptor to influence the behavior of this species, and/or that phytoestrogenic influence is not significant during periods of activational activity in virgin male California mice. This could be due to a low ER density in the medial preoptic area, a brain region that has been strongly implicated in the regulation of paternal behavior in California mice and other species (5, 6, 23, 24) and that, in house mice, undergoes an increase in ER density when males become fathers (25). However, the number of attacks on pups observed during our study was much higher than that observed in other experiments performed in our lab (including one during the attributable from additional study). This difference might be from diet, influencing paternal behavior in our mice. For example, in our study we used glass water bottles to minimize the potential effects of xenoestrogens (which may function similarly to dietary phytoestrogens) from the chemical Bispheanol-A (BPA) in plastic water bottles (26), whereas other studies in our lab have used plastic bottles.

No significant differences were noted among treatment groups in epididymal sperm counts, dry or wet testicular masses, or dry or wet fat-pad masses. Our values recorded for epididymal sperm counts were of the same magnitude (millions) as previously found in the same species by Nelson et al. (27), but were lower than those reported by Nelson et al. by ~184 -235 million sperm (27). This disparity in the values for sperm counts could possibly be attributed to methodological differences between the two studies.

Figure 1: Body mass (mean ± SEM) from the first through the tenth week of the study of male California mice fed high-soy (HS), medium-soy (MS), or low-soy (LS) diets. * - P<0.05 comparing weekly means of all three groups.
studies; however, the method by which Nelson et al (27) quantified sperm counts was not described.

We considered the possibility that the differences in soy content between the diets used in our study were too small to affect our measures. This seems unlikely, as Wisniewski et al. (28) studied the effect of a high-Genistein diet of 300 ppm (almost 3 times as low as our HS diet) on C57BL/6 mice and found a significant decrease in testis size compared to mice not exposed to Genistein, with mice being of approximately equal age as those in our study (28). Another possibility is that the testes and fat pads are not as responsive to estrogens in California mice as in some other species; however, no data are available with which to evaluate this hypothesis.

Analysis of body mass over time revealed that the LS group was initially heavier than the HS and MS groups but gained body mass more slowly over the next few months than the HS mice. This result is consistent with previous findings in which male C57BL/6 mice that were exposed to dietary Genistein weighed less than controls at the age of puberty (40-45 days of age) (28). Importantly, though, the only time point at which body mass differed significantly among our groups was at weaning and from week 1 through week 3 after weaning; at the time of sacrifice, no significant differences were observed. Therefore, it is unclear whether the increased body-mass gain in the HS group resulted from their diet or was simply an artifact of their lower body mass at the time of weaning.

**CONCLUSION AND FUTURE OBJECTIVES**

This is one of the first studies to determine if soy has an effect on parental behavior in any species. The results may be of interest to animal researchers, zoo administrators, and farmers, as soy is common in many animal feeds and bedding. This study also has implications for the human population, as soy consumption has been increasing steadily in the United States since the 1950’s (29). In the near future, we hope to assay the blood samples from our animals for plasma testosterone and Daidzein or Genistein concentrations, and to quantify ER-α expression in the collected brains, to further characterize possible effects of dietary phytoestrogens in male California mice. Eventually, a similar study examining organizational effects could be employed.

**REFERENCES**


Rhetoric of Retention: Malcolm X's “A Message to the Grassroots”

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ABSTRACT
This independent study will investigate how black leaders such as Malcolm X and Amiri Baraka use African American rhetorical features, including distinct racial appeals, ideology critique, and identifiable black urban charisma. I will examine how the narratives that they transmit contribute to the valuing of cultural retention. My research will ask how and to what end these two figures utilized rhetorical styles and ideological content in order to promote a diasporic consciousness that would position distinct points of reference such as West African cultural and intellectual traditions that remain prevalent in the culture and intellectual traditions of African Americans presently. Overall, this project will provide a clearer understanding about how dynamic and charismatic African American speakers have used rhetorical strategies to enable various cultural retentions among African Americans. Readings will include poetry, speeches, history, literary criticism, gender studies, and rhetorical studies.

FACULTY MENTOR

Erica Edwards
Department of English

With Malcolm X’s “A Message to the Grassroots,” Alexander Sterling mobilizes rhetorical criticism and the scholarship on West African retentions to analyze the reverberations of West African communalism in one of Malcolm X’s well known speeches. Emphasizing that African American social movements often resist Western frameworks of knowledge and politics, Sterling’s analysis offers a lucid analysis of Malcolm X’s radicalism that places the speech in vital conversation with scholarship by Cedric Robinson, Vorris Nunley, and other important theorists of black rhetorics and politics. This is an excellent example of undergraduate research.

AUTHOR

Alexander Sterling
English

Alexander Sterling is a fourth year English major. Alexander furthered his passion for African American Literature and Rhetoric with the assistance of Professor Erica Edwards during an independent study experience. He investigated the use of African American rhetorical features including distinct racial appeals, dominate white ideology critique, and identifiable black urban charisma. Alexander received the Ross Scholarship and is a member of the Golden Key International Honour Society. His long and unconventional life journey will continue this Fall in the UCR’s PhD program in English. Alexander thanks Professors Erica Edwards and Vorris Nunley for their help and invaluable research in the field, and Dr. Audrey Howard for her endless encouragement and support.
In his 1963 speech, “A Message to the Grassroots,” Malcolm X utilizes ideological content and rhetorical strategies to promote a diasporic consciousness that would position distinct points of reference, such as West African cultural retentions—Africanisms—that remain current in the culture and intellectual traditions of African Americans. (This writer suggests that moving beyond the simple anthropological observation of linguistics to include the broader considerations of rhetoric and ontology would inform the discussion of retention.)

This analysis of Malcolm X’s “Message to the Grassroots” is based on the assumptions of neo-Aristotelian methodology. This methodology includes historical context and considers the occasion and issues to which the speech was responding; the connection and receptivity of the original audience to the propositions addressed by the rhetor; and the motivational, logical, and ethical appeals—as defined and or discussed by Cicero and Nunley—made in an attempt to shape content and craft arguments to facilitate idea adaptation and social action.

This paper provides evidence that “Message to the Grassroots” emphasizes the West African cultural retention of privileging the community over the individual—a retention considered by Malcolm X as necessary to give voice to the grassroots long silenced by Western ideologies. In addition, though not specifically articulated, the speech supports black ontology shaped by a West African worldview. Regardless of the intent, this speech also invites an exploration of black existence and identity formation and what it means to be black—through the lens of the black radicalism that profoundly influenced it.

Robinson discusses the divergent concept of being, using narratives related to slave revolts in America to address the issue of the scarcity of African and African American slaves’ violence against their white colonial oppressors. He posits that there was violence, but that its motivation and manifestation served to subvert dominant expectations: “This violence was not inspired by an external object; it was not understood as a part of an attack on a system, or an engagement with an abstraction of oppressive structures and relations” (160). Actual being was renounced for historical being in order to preserve the “ontological totality granted by a metaphysical system that had never allowed for property in either the physical, philosophical, temporal, legal, social, or psychic senses. . . . Defeat or victory was an internal affair” (161).

Robinson’s conclusion lays the foundation on which this paper’s arguments for retention are constructed. No attempt is made to venerate or elevate Malcolm X as a person. The focus is on the cultural retention he espouses through the use of selected rhetorical devices.

In “Message to the Grassroots,” Malcolm X reinforces a view of the formidable power of community, beginning with his depiction of the masses. In contrast to the Western notion of the individual, the following quote elevates the African cultural retention of collectivity:

[T]he grass roots out there in the street . . . scared the white man to death, scared the white power structure in Washington, D. C. to death. . . . When they found out that this black steamroller was going to come down on the capital, they called in . . . these national Negro leaders that you respect and told them, “Call it off.” And Old Tom said, “Boss, I can’t stop it, because I didn’t start it” (Breitman 14-15).

Discussion of “Message to the Grassroots” in context requires a brief overview of black resistance history. Marable and Robinson are informative in this regard. Robinson introduces a late nineteenth century manifestation of two competing ideals concerning revolution that later becomes evident in Malcolm X’s “Message to the Grassroots.” He writes that cooperation and community were prominent features of black existence—an understandable response to blacks’ collective suffering under white oppression. He also provides evidence not only of black Americans’ resistance, but also of their retentions of certain Africanisms, including community:

By the second half of the nineteenth century, two alternative Black political cultures had arisen, each nurtured by a particular Black experience. . . . Free Blacks gravitated toward the privileged political and social identities jealously reserved
for non-Blacks. At the same time, on the plantations and in the slave quarters, slaves tended to form [their own] historical identity. . . . Black mass movements of the late nineteenth and twentieth centuries proved both the existence and vitality of an alternative Black political culture . . . inventive rather than imitative, communitarian rather than individualistic, democratic rather than republican, Afro-Christian rather than secular (Robinson 97).

Robinson informs understanding of “Message to the Grassroots” against a backdrop of 1960s racial and political realities, as well as personal and social forces that contributed to the politics and development of Malcolm X into a charismatic nationalist leader. A critical link in the life of Malcolm X was Jamaican-born social activist Marcus Mosiah Garvey, Jr. (“Marcus Garvey Biography”), who immigrated to the United States to meet and discuss with George Washington Carver his plans to establish a school in Jamaica modeled after the Tuskegee Institute. However, Carver died four months before Garvey arrived in the United States.

Disappointed but undaunted, Garvey traveled and lectured across the country, garnering among discontented, disillusioned American blacks support for the Universal Negro Improvement Association (UNIA), a fraternal organization he had founded in Jamaica. His gift for oratory created an exciting gospel of racial pride. He also inspired the global Black Nationalism and Pan Africanism movements that advocated African American resettlement in Africa and unification of all African diaspora in order “to establish a country and absolute government of their own” (“Marcus Garvey Biography”). At its height in 1920, the UNIA boasted 4 million members.

Two young foot soldiers in the Garvey army—Earl Little and Louise Langdon North—met and married in Montreal, Canada, when an informal chapter of the UNIA was established there (Marable 24-25). Working first in Philadelphia and later in Omaha, Nebraska, they labored for the UNIA—even after Garvey’s arrest in 1922 and subsequent conviction and imprisonment for mail fraud. Their fourth child, Malcolm, was born May 19, 1925 (“Malcolm X Biography”).

Malcolm’s childhood was painfully scarred by the racist society that touched all aspects of his life. Harassment, death threats, home destroyed by arson, murder of his father, mental breakdown of his mother, separation of his family, destruction of his dreams by a school teacher, imprisonment, and introduction to the Nation of Islam were all contributing factors in the development of the man who later delivered the fiery “Message to the Grassroots” (“Malcolm X Biography”). Later, in alliance with Nation of Islam leader, Elijah Muhammad, he became a major force in the expansion of the philosophy of black nationalism—with “each recruit a visible rebuke to American conceits” (Marable 146).

In a speech delivered before more than 4,000 Muslims and non-Muslims at the Detroit Temple on August 10, 1957, Malcolm X described the power of rank-and-file black Americans within America’s political system: “[I]f the so-called Negro intelligentsia, intellectuals and educators won’t unite to help alter this nasty and most degrading situation, then the little man in the street will henceforth begin to take matters into his own hands” (Marable 145). His concluding sentence issued a clear warning to black leaders and the black middle class that the marginalized, disadvantaged, desperate, and despairing working-class and poor blacks denied a seat at the table of participatory politics would one day lose their patience and rise up violently. His oft-repeated theme of grassroots agitation subsequently became the basis for what many consider to be his most famous address, “Message to the Grassroots” (Marable 145-146).

Malcolm X delivered “Message to the Grassroots” at the Northern Negro Grass Roots Leadership Conference on November 1, 1963, at King Solomon’s Baptist Church in Detroit, Michigan. On the occasion of this speech, King Solomon’s Baptist Church served as a hush harbor space—a place where a marginalized and disenfranchised audience met, absent the disapproving gaze of whiteness, to encourage themselves with the hope and assurance that brighter days lay ahead (Nunley 26). Historically, enslaved
Africans and African Americans were heavily scrutinized by their masters to minimize the danger of “resistance, rebellion, and retention of African culture within hidden transcripts” (Nunley 26). Nineteenth century hush harbors were created as safe spaces for free expression of what went unsaid in the public sphere.

Hush harbor audiences were bound together by their common experiences, the tactics they employed to negotiate those experiences, and their common knowledge and expectations resulting from their experiences. Within the confines of the secure hush harbor space of King Solomon’s Baptist Church, cultural retention was both being preserved and produced. In his role as rhetor/orator, Malcolm X employs tropes, knowledge, terministic screens, and nomenclature “anchored in African American life and culture” to connect with, inform, and persuade his audience (Nunley 30). Drawing from familiar stories, history, and the common frustrations of his listeners, he effectively incorporates humor to keep his audience engaged (Nunley 30).

Nunley’s discussion of the principles of African American hush harbor (AAHHR) rhetoric includes three terms that inform the analysis of “Message to the Grassroots”: nommo [power of the word], parrhesia [speaking truth to power], and phronesis [practical wisdom, intellect, virtue] (44).

Facilitated by nommo or rhetoric/the power of the word, Malcolm X attempts to reshape thinking by addressing West African cultural retentions related to ontology, worldviews, and the value of community over the individual. The material world is understood, constructed, impacted through language; language and rhetoric are not epiphenomenal to reality. Nunley emphasizes the importance of nommo as “fundamental not only to the binding together of community but also to that community’s understanding of reality. . . . Informed discussion of African American rhetoric in its public, literary, or hush harbor forms must take nommo (the power of the word) into account (23, 44).

Using the imagery of a plow, Nunley illustrates how nommo functions in and through the materiality of the world: “[L]ike the plow, which parts the earth in preparation for the planting of seed, the word does work in the world” (Nunley 45). As Malcolm X began to plow with his words the soil of his listeners’ minds, he also dropped the seeds of cultural retention—effectively recalibrating their sense of self. Now while words can operate as tools, they can also operate as weapons. Nunley observes: “Nommo intensifies the understanding of what is at stake in African language use and African American oppression when words are often the only or primary weapon left to a subjugated people advocating not only for their rights but also for recognition as being fully human” (45).

Using his words as weapons to fight against impediments to unity, Malcolm X first wages battle with “differences” among the diverse groups in the audience. He urges his listeners to “forget about our differences” and to understand what really made them victims in society—not religious or political or civic affiliations; and not because they were Americans “‘cause if you was an American, you wouldn’t catch no hell. You catch hell ’cause you’re a black man” (Breitman 4). He warns against public disharmony and the temptation to air their “dirty laundry” in the public eye: “[W]e’re all the same family. And when you have a family squabble, you don’t get out on the sidewalk,” (Breitman 6). He also cautions against weakening the Black Revolution by allowing white people to play an integral part in it.

The narrative presented by Malcolm X contrasted starkly with the dominant narrative of his time. It inserted what Nunley calls “a kind of undomesticated Blackness into the world” (45)—one that rejects white supremacist ideologies and origin stories. Many whites and some mainstream black leaders considered his words dangerous and their inability to control him troubling.

Malcolm X makes a direct connection to Africa by reminding his audience how African Americans came to this country: “You are ex-slaves. You didn’t come here on the ‘Mayflower.’ You came here on a slave ship—in chains, like a horse, or a cow, or a chicken. . . . brought here by the people who came here on the ‘Mayflower’” (Breitman 4-5). He argues a common origin, stresses unity, and gathers the factions of his audience under one banner.
As he clarifies for his audience the distinctions between what he calls the Negro Revolution and the Black Revolution, he elicits support for the Black Revolution by “citing true examples and historical parallels”—the rhetorical device Cicero called exemplum. Considering history to be the discipline best qualified to provide solutions to current problems (Breitman 8), he cites historical revolution models—the American, French, and European revolutions—and identifies the nature and objectives of these events. Despite some logical inconsistencies, he effectively insulates his subsequent argument for violence as a natural aspect of revolution since the goal of revolution is the acquisition of land, which is the basis of independence; and land acquisition is achieved most often by bloodshed (Breitman 7).

Malcolm X then employs two more classical rhetorical devices. He repeats the word “land” five times—because he wants this word to penetrate the mind of his audience. Cicero called this redundancy—“sometimes repeating an idea, word, or phrase. He also used the rhetorical question—“a query with an obvious or obviously desired response used for effect, emphasis, provocation—[to invigorate] his arguments and [press] home the counter frame”—that the white power structure advocates violence only in white revolutions. This point is not lost on the audience when he establishes through exemplum that violence is historically a winning strategy in the context of revolution.

“Message to the Grassroots” identifies two forms of revolution but ignores a third form that is neither fundamentally violent nor nonviolent—one that is driven by different values, and by ambitions that have nothing to do with land. Enslaved Africans’ and African Americans’ decision to opt completely out of the Western system in order to preserve black ontology and way of being is an example of such a revolution.

In the following passage, Malcolm X infuses questions and statements with pathos in order to persuade his listeners to overt action; to arouse emotions (e.g., anger, sadness, shame); and to point out the absurdity of an argument for nonviolence when the nation responds with violence whenever threatened or provoked:

You bleed for white people. But when it comes time to seeing your own churches being bombed and little black girls murdered, you haven’t got no blood. You bleed when the white man says bleed. . . . How are you going to be nonviolent in Mississippi, as violent as you were in Korea? How can you justify being nonviolent in Mississippi and Alabama, when your churches are being bombed, and your little girls are being murdered, and at the same time you’re going to be violent with Hitler, and Tojo, and somebody else that you don’t even know? (Breitman 7-8)

Malcolm X characterizes blacks who support nonviolent revolution as traitors and Uncle Toms who impede black progress and aid white selfishness and sense of entitlement. He equates nonviolence with “crawling back onto the plantation (Breitman 10). In contrast, he lauds the Mau Mau Revolution in Kenya and the Algerian rejection of France. Their scorched earth policy and destruction of everything in their path, their rejection of integration and insistence on land for themselves, their nationalistic aspirations and willingness to engage in bloody battles to gain their desired ends—this is the stuff of which revolutions are made. He then tethers the idea of African revolution to the concept of African American revolution and challenges his audience to unite, embrace their African roots and connection, provide for their self-defense, and opt out of the Western system as citizens empowered and emancipated by the acquisition of land.

Addressing a primarily black audience, Malcolm X refutes the hypocrisy evident in the hegemonic logic that demonizes black nationalism while supporting white nationalism. Speaking truth to power, he refuses to be silenced by the possible consequences of rejecting the ideology that frames revolutions according to different standards. In African American hush harbor rhetoric, this is described as parrhesia. “Parrhesia requires the rhetor to put her/his self at risk in speaking truth to power, to the dominant political rationality, or hegemony that could result in the loss of status, influence, resources, legitimacy, or life” (Nunley 46).

Malcolm X now turns to the main aspects of African cultural retention—African values, epistemologies, and knowledge.
He begins recreating his audience’s terministic screen by addressing the way black people perceive themselves. Nunley writes: “Terministic screen is both a reflection and deflection of reality and . . . any nomenclature necessarily directs the attention into some channels rather than others. No stance or view, no claim to reasonableness, lies outside of the contamination of human perspective” (30).

Here, his oversimplified house Negro/field Negro analogy and trope is pressed into service: the house Negro representing Western individualism, and the field Negro representing African communalism. The analogy is used not only to contrast the two views but also to launch a criticism of what he considers to be co-opted black leadership. He speaks in plain style—the rhetorical device described by Cicero as a “direct, staccato style [that] that ensures the understanding and engagement of the audience.” Wit is interjected into this analogy, the rhetorical feature described by Cicero as “sometimes mocking or employing humor.” Making fun of the house Negro diminishes the value of this worldview. The field Negro and his worldview—including the cultural retention of valuing the community over the individual—are elevated.

Again nommo—the power of the word—is used to invigorate the audience’s reception of phronesis, the third of the African American hush harbor rhetoric devices Nunley discusses: “Phronesis, which refers to practical wisdom, intellect, or virtue, embraces high theory but wrenches it down to earth around functionality and usefulness. . . . Phronesis taps into the sensus communitas—the commonplaces—of African American culture and provides the subjective fortification highly valued in African American communities” (47).

Possibly anticipating resistance to the idea of cultural retention and maintaining a perpetual, positive link to Africa, Malcolm X again resorts to humor to proactively present historic truth regarding African ontology: “I mean, this is what you say. ‘I ain’t left nothing in Africa,’ that’s what you say. Why, you left your mind in Africa” (Breitman 11). This use of wit readjusts the focus of his speech to the heart of the matter: lost values, identities, ways of relating to each other, and worldviews.

Herskovits observes: “In West Africa, an important cultural value is cooperative endeavor. Any research relative to “survivals of the African tradition of discipline and control . . . and . . . furtherance of community needs must consider various kinds of cooperative and mutual-aid effort among Negroes of this country. The tradition of cooperation in the field of economic endeavor is outstanding in Negro cultures everywhere” (Herkovits 160-161). Based merely on this anthropological evidence of the importance of community and cooperatives in the African and African American traditions, a more realistic appraisal of African retentions would conclude that African Americans maintained some degree of their cultural heritage while also accommodating themselves to whatever extent was necessary for survival.

Nunley describes the effect of what he called “African American podium-auction block rhetoric,” a rhetoric that takes into account worldviews, knowledge, figures of speech and commonplaces that identify with and can be persuasive in African American contexts. However, when that rhetoric is co-opted, it “privilege(s) more mainstream American (read: White), worldviews, epistemes, and tropes that are hegemonic, and therefore offer a more comforting, domesticated, consumable, and marketable Blackness” (Breitman 6).

Using plain language, Malcolm X continues his discussion of the influence of co-opted Negro Revolution leadership on the black masses. Comparing their effect to Novocain on the body, he concludes that co-opted Negro Revolution leaders numb the pain of the masses without addressing the underlying conditions causing their discomfort. Unable to correctly interpret the messages filtered through the lenses of their leaders, the black masses continue to suffer on all levels the negative effects of a political system intent upon controlling them. This simile “paints a picture so clear that the audience can see with the mind’s eye”—Cicero’s definition of the rhetorical device sub oculos subiectio—as he drives home his points. Reverting to the parrhesia that speaks truth to power, Malcolm X advocates the need for blacks to be respectful but to know when to draw the line—when self or community is threatened and when co-opted black leaders put their personal interests above the community’s (Nunley 16).

Malcolm X’s admonition to resist contemporary enslavement (anesthetization) through some form of resistance reflects Edwards’s observations of Kelly’s ancestral Africans and Robinson’s black radicals who
broke with “liberal epistemologies of order and resistance” (119). Robinson’s claim is important because of what it reveals about the lengths to which African captives went in their resistance to enslavement in the New World. Their attempts to flee, whether across the ocean back to Africa or to maroon communities in the vicinity, cannot be understood as simple reactions to plantation servitude. Rather, they must be understood as complete rejections of their lot. It was simply to “reconstitute the community that ‘black radicals took to the bush, to the mountains, to the interior’” (Robinson 118).

Nunley makes a case for ontology shaped by rhetoric: “To push the racial-spatial, rhetorical trope further, ontology, being writ large, and racial ontology, Black being, in particular as they relate to the body, are inherently rhetorical and spatial in the American context” (17). Ontology is not automatically determined at birth but is constantly in the process of being reframed and recreated throughout life by words and various social factors.

Based on Robinson’s analysis, it becomes clearer how and why an African American Revolution would differ from a White Revolution. Enslaved Africans/African Americans did not have land or property—they were property. The only thing of value they could claim was their being—who they were as black people at the very core of their being. A successful revolution would not involve the acquisition of land; it would involve their retention of an African worldview sustained in the face of Western determination to colonize and assimilate them.

“Message to the Grassroots” adds to understanding of African American rhetoric as a medium for reframing black ontology—that is, what it means to be black in the world and how one uses that understanding to affirm personal dignity, build and enhance community, and integrate the past with the present as a building block for the future. Rather than marginalized masses of powerless victims, the grassroots were recast as a force capable of liberating themselves from the political and social burden of oppression. Malcolm X in a symbolic hush harbor context defied the cultural history of severe censure, strict regulation, and intolerance of the notion of free speech uttered by an authentic black voice and challenged his listeners to action oriented toward the best interests of the community as opposed to the individual.

By focusing on the anti-Western notion of community above individual aspirations, by urging his listeners to renounce former mindsets of adjustment and submission, and by acknowledging the high cost of participating as change agents in the world, Malcolm X challenged his listeners to adjust their thinking to accommodate his proposed insights, which reflect connection with and continuity of a West African worldview.

WORKS CITED


Previous studies of monkey mandibles were used to evaluate different forms of an osteoconductive bulking agent (compression-resistant matrix (CRM)) in a critical-sized mandibular defect.[1] Our research focuses on a finite element model which examines the mechanical efficiency of the CRM complex. We computationally modeled these matrix complexes using Comsol Multiphysics® to capture the von Mises stress as well as the deformation along the maxillary jaw. Subdomain conditions such as the density, Young’s Modulus, and the Poisson’s ratio were physiologically set. A separate subdomain within the jaw was modeled to represent the regenerative CRM complex defined with its physical properties. Two cases of mastication were considered: the closing stroke and the power stroke. Our aim is to ensure that the regenerated bone in the jaw can withstand the relevant mastication forces.

Faculty Mentor: Victor G.J. Rodgers (right)
Research Mentors: Prashanthi Vandrangi, Dr. J. Yalung, Dr. J.M. Caruso
Department of Bioengineering

Typically our laboratory offers the opportunity for undergraduates to experience research in biotransport phenomena at an advanced level so that they can see the opportunities research has for them. However, with Ryan and Heran, their interaction with the B2K Group (Biotransport and Bioreaction Kinetics Group) has helped forge new collaborations with Loma Linda University. Their high energy and drive, together with Prashanthi’s determination, helped to bring to fruition our effort to support modeling analysis of biomaterials for practical applications, such as are described here.

A copy of this paper in its entirety can be found online at www.ugr.ucr.edu in Volume VI.
A Simplified Positron Lifetime System by Means of a Digital Storage Oscilloscope


Department of Physics and Astronomy
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A B S T R A C T

Recent technological advances in the production of commercial digital storage oscilloscopes have made it possible to create fast timing systems without using analog electronics for positron annihilation lifetime spectroscopy. This considerably simplifies such experimental systems, can lead to an improved time resolution, and makes it possible to perform multiple data selection methods for improved optimization. Herein, we describe the construction and testing of a digital positron lifetime spectrometer. The system consists of two BaF2 scintillator crystals attached to XP2020 photomultipliers, a 500MHz, 4 GSa/s digital sampling oscilloscope, a computer, and software with on-line and off-line capabilities. The lifetime of positrons produced from the decay of a 22Na test source are determined using a 1.27 MeV nuclear gamma-ray as a start signal, and one of the two 0.511MeV gamma-rays originating from positron annihilation as a stop signal. This apparatus is straightforward, easy to construct and operate, and allows for the implementation of a broad range of digital sampling techniques. Our preliminary arrangement yields a time resolution of less than 2 ns, largely determined by the approximate peak detection routines in place. With more sophisticated analysis routines, which are in development, we anticipate a time resolution of approximately 0.5 ns. This resolution, which will ultimately be limited by the sampling rate and bandwidth of the oscilloscope, is significantly lower than the state of the art (~ 0.15 ns), but will be more than adequate for future measurements of positronium (the bound state between a positron and an electron) formation in porous structures, which will have lifetimes in the 10-100 ns range.

M E N T O R S

Faculty Mentor: Allen P. Mills Jr. (left)
Research Mentor: David B. Cassidy (right)

Department of Physics and Astronomy

Professor Allen P. Mills and Dr. David B. Cassidy are two innovators in the field of Positron and Positronium Physics. Over the years, they pioneered techniques to study positronium and are currently working on utilizing these techniques to obtain a Bose-Einstein condensation of positronium. Dr. Cassidy commented, “Alina is a hard working and self motivated student who was able to complete this project with very little help. Her understanding of the underlying concepts was an important aspect in her ability to complete the project and write it up in a manner fit for publication in this journal.”

A copy of this paper in its entirety can be found online at www.ugr.ucr.edu in Volume VI.
ABSTRACT

In this article I will argue that through civic and theological reforms, John Calvin, along with reforming Christian doctrine within the church and city and Geneva, reformed the institution of marriage specifically to encourage mutual love between spouses while still retaining the traditional discipline found within the marriage relationship. However, when it came to broken and failing relationships, Calvin also used marriage reforms to save and restore these relationships for the overall betterment of the community. I will examine Calvin’s theology through his sermons, Bible commentaries, and marriage reform laws. I will also examine a case from the Genevan Consistory, in which Calvin was directly involved, to explicate how this theology of love, discipline, and restoration enacted itself in the lives of Geneva’s citizens. Through my analysis I conclude that Calvin found a balance between encouraging mutual love and a disciplined marriage relationship in order to restore people to a right standing with the church and community.

FACULTY MENTOR

Dana Simmons
Department of History

Love, courtship and marriage were as complex in John Calvin’s day as they are now. In this work, Caleb explores the personal foibles of people in love in Calvin’s Geneva. As Caleb recounts, Calvin and his followers recognized that love is sometimes misguided and that decent people sometimes fall from grace. Caleb shows that religious courts often overlooked the rigors of doctrine in order to maintain a harmonious community. Caleb is gifted with a curious spirit and incisive intellect; he employs those qualities with generosity, modesty and elegance. He is a pleasure to mentor.

AUTHOR

Caleb Flores
History
Caleb Flores is a graduating senior majoring in History with an emphasis on the European continent. He is primarily concerned with the history of the Christian Church and its effect on society. This research article stems out of an interest in the Protestant Reformation and the smaller movements within it. Caleb thanks Professor Dana Simmons for her support and guidance while conducting the research for this project. He would also like to thank his beautiful wife, Katy, for all of her love and encouragement throughout his academic career.

A COPY OF THIS PAPER IN ITS ENTIRETY CAN BE FOUND ONLINE AT

www.ugr.ucr.edu in Volume VI.
ABSTRACT

Current metallic orthopedic implants include stainless steel, titanium, and cobalt-chromium based alloys. Although these materials are effective in securing fractures, they also possess many disadvantages. They can slowly break apart into toxic ions which can lead to local inflammation. Moreover, they require a second surgical procedure for removal after they have served their purpose. Magnesium (Mg) alloys are a great alternative to these metallic implants. They are biocompatible, biodegradable, and can promote new bone growth. Moreover, their light weight and mechanical resemblance to bone make them an ideal material for orthopedic implant applications. However, their rapid degradation in the physiological environment is a major obstacle. In this study, pure Mg, AZ31 (3% aluminum, 1% zinc), and Mg-4Y (4% yttrium) were tested to determine the rate of degradation. Each screw was submerged in 3mL of phosphate buffered saline (PBS). 1 x PBS was used for the first 15 days of the study. 10 x PBS was used from 17 days through 31 days. Of the three metals, Mg-4Y was the first to completely degrade. Large pieces began to break off making it the fastest degrading screw we tested. AZ31 showed the best improvement in degradation, followed closely by pure Mg.

MENTORS

Faculty Mentor: Huinan Liu (right)
Graduate Student Mentor: Maria Iskandar
Department of Bioengineering

Our research goal is to develop fully biodegradable medical implants that will eliminate the need for secondary surgeries for implant removal, funded by a National Science Foundation BRIGE award. Tejas worked with my graduate student Maria Iskandar as a team to study the degradation of a group of novel magnesium-based resorbable interference screws in physiological fluids. His results provide implant guidelines for designing next-generation biodegradable implants. Tejas is self-motivated and determined to accomplish the project goal. I am impressed by Tejas’s research capability, hard work, and professional communication skills. He presented his research results at the UCR Symposium for Undergraduate Research, Scholarship, and Creative Activity, and his work will also lead to a research article to be published in a scientific journal. In my observation of Tejas, I know that his initiative, enthusiasm, and hard work prepares him well for success in future research. He asks important research questions, and thinks about them actively. He always participates our group meetings, and presents his research progress in a professional and scientific way. Tejas has learned the exciting aspects of scientific research and has decided to apply for graduate school.

AUTHOR

Tejas Patel
Bioengineering

Tejas Patel, a fourth year Bioengineering major, transferred to UCR in 2010 from American River College in Sacramento. He joined the Liu Research Group in the summer of 2011 where he works on the degradation of magnesium alloy screws used for graft fixation during ACL reconstructive surgery. He focuses his research on pure magnesium, AZ31, and Mg-4Y to determine the rate at which they degrade in phosphate buffered saline. This experience sparked Tejas’ interest in research and he will pursue a Master’s degree in Bioengineering. Tejas Patel thanks Dr. Huinan Liu and Maria Iskandar for their guidance and support.
Speech Alignment Between Interlocutors

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A B S T R A C T

Speech alignment is defined as the inclination of individuals to produce speech that shares characteristics with an observed speech signal (Giles, et al., 1991). These speech characteristics include tone, rate of speech, and dialect (Giles, et al., 1991). Evidence has suggested the visual information enhances speech alignment between interlocutors of a live interactive task (Dias & Rosenblum 2011). This study aims to determine the effect of visual speech information on interactive speech alignment. In the first experiment, participant pairs performed an interactive task, in which nine key tokens were repeatedly uttered. Interacting participants either had full visibility of each other, or a screen was positioned to obstruct visibility of the mouth. Utterances of the nine tokens were recorded from each participant prior to, during, and after the interactive task. Alignment was then judged by naive raters in an AXB task. In the second experiment, a different group of participants performed the same task, but in the presence of background babble noise. Results show that speech alignment does not significantly increase with visibility of the mouth region and minimal alignment occurs between interlocutors in the presence of background noise.

M E N T O R S

Faculty Mentor: Lawrence Rosenblum (top)
Graduate Student Mentors: James W. Dias, (lower left)
Theresa Cook (lower right)
Department of Psychology

It is rare to find a student with the self-motivation and interest to pursue a research topic from beginning to end. Jasmine Singh proved herself to be such an individual. Her dedication to the field of research manifested in not only one, but two published articles in this current issue of the UCR Undergraduate Research Journal. The study reported here further investigates previous findings in our lab indicating that visibility of a conversational partner increases the amount to which interlocutors converge in their speech characteristics, a phenomenon referred to as speech alignment (Dias & Rosenblum, 2011). However, the question of what visible information is most salient to increasing speech alignment is raised. In the current investigation, we examined the influence of visibility of the mouth during conversation on the degree of speech alignment between conversational partners. Though visibility of the mouth was not found to have an influence, the presence of environmental noise was found to eliminate speech alignment. This finding raises many questions regarding the fragility of speech alignment and the potential influences of other speech phenomenon, such as clear speech, on speech alignment.

A copy of this paper in its entirety can be found online at www.ugr.ucr.edu in Volume VI.