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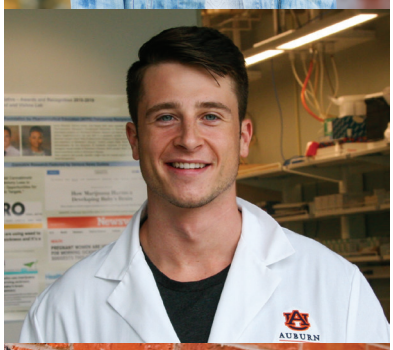

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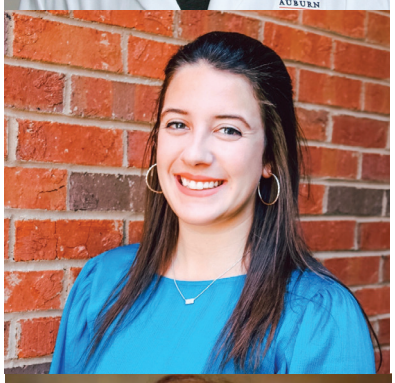

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Editor-in-Chief: Dr. Lorraine W. Wolf is the Auburn University Director of Undergraduate Research and the Lawrence C. Wit Professor in the College of Sciences and Mathematics. She has served as the editor-in-chief of AUJUS since 2013. She has been a faculty member in the Department of Geosciences since 1993, where she teaches courses and mentors undergraduate and graduate students in the field of geophysics. Dr. Wolf's main research interests are in earthquake and geologic hazards.

MENTOR OF THE YEAR: Dr. Gretchen Oliver

Dr. Gretchen Oliver first began her research journey as a mentor in 2010. While teaching athletic training at University of Arkansas, she felt as if she needed to do more. When a student approached Oliver asking her to be a mentor, Oliver agreed. At this time, Oliver did not even have a research lab, but after receiving funding for equipment, she began her role as a research mentor. Since 2010, Dr. Oliver has mentored over 70 students, including both doctoral and undergraduate students. Dr. Oliver's research primarily focuses on injury prevention and performance enhancement in baseball and softball athletes.

Oliver strongly encourages students interested in research to commit for at least two years. She believes that it takes at least four semesters to receive the full research experience. She adds,

"I would rather accept a freshman who is interested in research, than a senior that just needs to check research off of their list."

Although it takes a while for students to complete the research lab training, the students can fully understand how research works and the protocols, how to write an IRB, and how to collect data by the end of their research experience. Since most of the students that she mentors go on to graduate or medical school, Oliver believes that their knowledge about how research works is extremely beneficial in their future interviews.

Oliver runs a very focused lab, and the students working in the lab learn each step in the research process. Any participant that volunteers in her lab goes through the same protocol: a full body analysis coupled with a strength data collection. By doing the same protocol each time, a larger database for the lab is created. Because of this larger database, more advanced research questions can be addressed.

When asked what she loves the most about research, Oliver notes that research keeps you on your toes and that intellectual curiosity keeps her moving forward. "My philosophy is that reading is like brushing your teeth. That is an expectation. In the same way, reading literature is an expectation, it is a given," Oliver said. As a research mentor, Oliver's satisifaction comes with seeing her students develop into researchers whose questions and writing become more advanced and they can synthesize literature to come up with great research questions. They also learn the peer review process.

"The peer review process is what holds us accountable, but it also strengthens the research paper."

Oliver's advice to students is straightforward: "If you're interested in research, do not be afraid to ask a research mentor about joining a lab. Read what has been published from the lab and what the mentor's research focuses on." One of Oliver's biggest accomplishments as a research mentor is that she has had more student first-authored publications than publications where she is the first author. This accomplishment demonstrates that her mentoring has succeeded.

The Effects of Pre-adjudicatory Factors on Therapeutic Alliance Among Detained Youth

Samantha Guajardo and Kelli Thompson

Abstract

Therapeutic alliance is the mutually secure relationship between client and therapist known to foster the most efficacious success. This reciprocal relationship is considered one of the most critical components of overall treatment efficacy and client improvement. As it can influence treatment trajectory, it should be ensured throughout the entire process. Yet, there is a gap in the literature assessing the ways in which prior legal mistrust of authority may hinder this relationship, especially if found within a particular racial or ethnic group. The current study seeks to extend the literature on therapeutic alliance and determine if any significant associations exist in pretreatment variables indicative of legal mistrust. Archival data were used from a small sample of detained youth (N = 31) enrolled in trauma-focused therapy at a residential treatment facility. The Working Alliance Inventory –Client Report (WAI) was used to assess therapeutic alliance from the perspective of the adolescent. Variables measuring number of prior arrests, number of prior adjudications, prior juvenile commitments, and number of prior inpatient psychological commitments were used as indicators of possible legal mistrust. A series of linear regression analyses were used to test if those with higher levels of prior court and residential treatment involvement may show lower levels of therapeutic alliance. None of the regressions were significant, indicating pre-treatment variables indicative of possible mistrust of authority did not play a significant role in the development of therapeutic alliance in this setting. This is a positive finding for residential treatment programs, indicating that therapists can overcome possible sources of mistrust to achieve appropriate rapport.

Keywords: juvenile offenders, working alliance, residential treatment, justice-involved youth, disproportionate minority contact, legal mistrust

Introduction

When looking at the overall improvement trajectory for individuals in the active therapeutic process, there are a variety of factors playing into the general success of treatment and the overall goal of individual change. Though there is no single, concrete, and universal definition, therapeutic alliance is one of the most fundamental components to this treatment process and is often described as the helping, mutually secure relationship between a client and therapist which develops over time (Bickman et al., 2004). It embodies Bordin's (1979) multidimensional model of alliance, which focuses on the quality bond between the client and therapist, mutually agreed upon goals, and accordance with the tasks of therapy (Roest et al., 2016). In the client-clinician relationship, there is a continuous commitment to overall client assurance, development of trust, empathetic perspectives, and much more (Bovard-Johns et al., 2015). This relationship has yielded critical impact in overall client improvement, as it has been found to make up around 40% of the variance within general treatment effectiveness (Bovard-Johns et al., 2015). If therapeutic alliance cannot be achieved, this kind of correlative interaction may impede the treatment process. This is particularly relevant for younger individuals who have been court-involved, such as adjudicated adolescents. Adjudicated adolescents may be resistant to treatment, especially considering the conditions that precipitated their choice for treatment, such as court mandated interventions or placement in a secure residential facility (Elvins & Green, 2008; Roest et al., 2016). This is but one variable that may affect therapeutic alliances between therapist and client.

Additionally, there is a need to account for the ways in which prior legal mistrust of authority may hinder such a critical relationship, especially if it is found within a particular racial or ethnic group. The onset of such mistrust stems from the idea of legal socialization, the developmental process of personal values and beliefs about the legal system laying the foundation for a long-lasting predisposition toward authority, which influences overall cooperation and attitudes with future

authority figures (Woolard et al., 2008). Such beliefs have the ability to dictate adolescents' conceptions towards other aspects regarding the law, such as known legal regulations, policing, judges' fairness, and the treatment of those who violate the law (Fagan & Tyler, 2005). Legal socialization has been found to be a prominent factor of general mistrust within ethnic and racial communities (Woolard et al., 2008). The historic practices and implementations of institutionalized racism and discrimination against minority groups has further perpetuated this lack of confidence towards legal and social control authorities (Fagan & Tyler, 2005). For example, minorities make up around 34% of the total population under the age of 17 yet comprise 62% of adjudications in juvenile courts across the country (Desai et al., 2012). If minority youth come to encounter, hear of, or fully experience such partiality and discrimination, it can forge and propagate mistrust toward general rehabilitation, court-mandated treatment, or other mental health services in residential settings (Venable & Guada, 2014).

Considering the variability that comes with a developing and vulnerable population of individuals, our research sought to investigate the ways in which therapeutic alliance is impacted by pre-adjudicatory variables indicative of legal mistrust, and the possible racial patterns within a population of adolescents in long-term residential treatment facilities. The current paper seeks to further the current body of literature, which suggests those with higher occurrences of prior court and residential treatment involvement may show lower levels of therapeutic alliance, and this may be particularly heightened for racial minorities. These variables should be investigated to gain better understanding of the ways in which legal mistrust may negatively affect adolescents' overall ability to trust and proactively work with a therapist, especially considering the reason for referral and the treatment setting. Additionally, examination of these associations can contribute to the ways in which therapeutic alliance may be improved or enhanced for those with greater histories of negative legal interaction, especially if discrepancies are found to be higher within different minority groups.

Methods

The current sample was selected from an archival data set (n=31) of adolescents adjudicated for illegal sexual behavior (AISB) completing a court-mandated treatment program at a secure juvenile correctional facility. The Accountability-Based Sex Offense Prevention Program (ABSOPP) is an evidenced-based treatment program for AISB in the state of Alabama. The program features several notable multidisciplinary collaborations to provide full-scale psychological services such as applied behavioral analysis, multi-family group interventions, and trauma-focused therapies (Brogan et al., 2018; Everhart-Newman et al., 2018). Regarding race, 60% of the population identified as non-white and 40% identified as white. The mean number of arrests for the sample was 1.97 with a maximum of 16 arrests.

Therapeutic alliance was measured using the Working Alliance Inventory short form (WAI-S; Horvath & Greenberg, 1989). This self-report measure is based on the previously mentioned multidimensional theoretical model, Bordin's Alliance Model (1979), which focuses on three components of a treatment relationship: goals, tasks, and bond. The measure contains 12 items, each associated with a particular component of the treatment relationship. Both client and therapist versions are available that incorporate statements such as, "My client and I are working towards mutually agreed upon goals," or "I am confident in [their] ability to help me." Subjective responses to items are given according to how one currently feels in relation to the given statement. The measure is scored on a 7-point Likert-type scale with total scores ranging from 12 to 84. Higher scores indicate better overall working alliance. For this study, only client reports were used to investigate possible associations between pre-adjudicatory variables. The three subscales and the total working alliance score serve as the four dependent variables in our analyses.

The number of prior juvenile court commitments, arrests, adjudications, and psychological commitments were used as indicators of prior legal experience, which may impact legal socialization and legal mistrust of authority. These four variables were derived from a clinical interview completed as a pre-treatment assessment and could signal a heavy involvement in court interactions and legal actors which impact legal mistrust at any point. With predetermined fears of bias or partiality, these individuals may continue to enhance their negative perceptions of this kind of authority, especially after being placed in a juvenile residential facility for

therapeutic services.

Results

A series of multiple linear regression analyses were used to test the hypothesis that those with higher levels of prior court and residential treatment involvement may show lower levels of therapeutic alliance. The WAI-S client report scales (i.e., task, bond, goals, and total) were entered independently as outcome variables. The four pre-adjudicatory variables indicative of mistrust were entered as the predictor variables in each of four separate multiple linear regression analyses as seen in Table 1. The results yielded non-significant associations across all four WAI scales: Total Score, $F(4, 30) = 0.88$, $p=.49$; Bond Score, $F(4, 30) = 0.94$, $p=.45$; Task Score, $F(4, 30) = 0.96$, $p=.45$; Goals Score, $F(4,59)= 0.62$, $p=0.65$. See Tables 2 for means, standard deviations, and betas of variables of interest.

A point-biserial correlation was conducted to test for associations between race (1=white; 0=non-white) and number of arrests ($r =.28$; $p= .03$). Results indicated that white students in this sample were arrested at a higher rate. Upon further investigation of the data, much of this appeared to be driven by a single outlier in the data as seen in Figure 1. The data were re-analyzed without the single outlier and the correlation was no longer significant ($r =.24$; $p=.07$) indicating the outlier was driving the association.

Discussion

The analyses found contrasting evidence to our original hypotheses, which proposed that the pre-adjudicatory variables would have a significant effect on a client's report of therapeutic alliance. These non-significant results suggest high rates of working alliance, despite the contribution or presence of pre-adjudicatory factors that normally contribute to contrasting effects on this component of treatment success. Our results signified conclusions that differed from the current body of literature's original propositions. Though it would normally be suggested that greater mistrust could be seen among youth who have had more experiences with legal authority/procedures, we found dissimilar associations.

These non-significant findings could initially be viewed as an unintended or non-preferred result, especially when considering the research and history within the current body of literature. However, the findings may demonstrate positive implications for the current treatment program in place. In our sample, high rates of alliance were still found after accounting for the four independent variables indicative of mistrust. This may imply therapists are establishing critical bonds with adolescent clients despite the presence of variables which normally indicate difficulties doing so. This finding speaks well for the overall developmental process of therapeutic alliance, regardless of the previous legal experiences encountered prior to arriving to the facility. Additionally, while the non-significant correlation between clients' total reports of therapeutic alliance and race variables suggests something contrary to theories of inequality for certain racial groups, the current sample found that race, as a stand-alone factor, had no critical effects on the independent and dependent variables. This again, may point to the extensive clinical efforts of the therapeutic team at the facility.

With these results come some clinical implications to be noted. Our study contains a small sample size that may not be fully generalizable to other populations, especially considering the characteristics that make up this sub-sample. These participants were actively enrolled in Trauma-Focused Cognitive Behavioral Therapy (TF-CBT), due to having experienced more severe symptoms of trauma exposure. The WAI-S measure was administered one month into treatment, which may have given time for greater bond building and development of alliance before the construct was measured. Nonetheless, these findings are informative for understanding how therapeutic alliance continues to develop within a residential treatment program. Finally, the current study provides valuable and positive insights regarding the wide range of pre-adjudicatory factors that could negatively hinder rapport and weaken overall treatment efficacy. Results indicate therapeutic alliance can be achieved and maintained despite many of these challenges with well-trained and attentive therapeutic efforts.

Acknowledgments

I would like to thank my research mentor, Kelli Thompson, for the continuous support, learning experience, and overwhelming amount of knowledge she has granted me. Additionally, thank you to the College of Liberal Arts and the Undergraduate Research office for making

this work possible by awarding my year-long research fellowship. Lastly, a big thank you to the Alabama Department of Youth Services (ADYS) for making excellent student research like mine possible by funding a more than 20-year public-public partnership with Auburn's Department of Psychological Services.

Table 2. Means and Standard Deviations.

	M	*SD*
WAIS Goals	20.774	5.334
WAIS Task	20.097	5.287
WAIS Bond	19.065	6.797
WAIS Total	59.387	16.323
Priorjuco	1.26	.893
Prioradj	1.06	.359
Priorarr	2.16	2.899
Priorpsych	.81	1.470

Note: Priorjuco= Number of prior juvenile commitments, Prioradj= Number of prior adjudications, Priorarr= Number of prior arrests, Priorpsych= Number of prior psych. commitments.

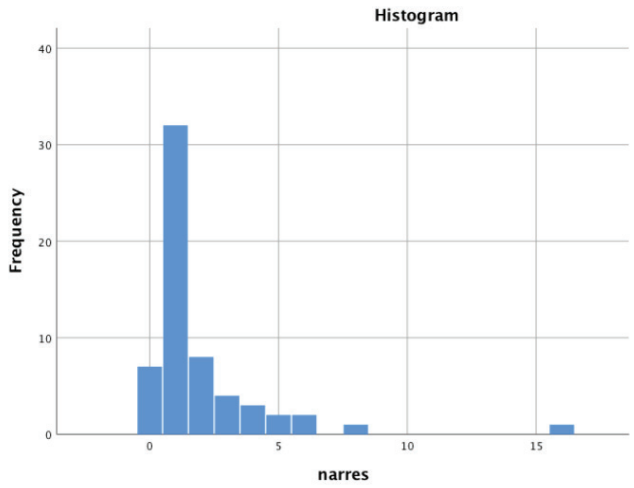

Figure 1. Histogram for number of arrests (Narres).

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Table 1. Multiple Linear Regression Coefficients.

WAI-S	Pre-adjudicatory Variables	B	SE B	β	t	p
Goals	# of prior juvenile commitments	-.380	.292	-.198	-1.301	.199
	# of prior adjudications	-.019	.128	-.021	-.148	.883
	# of prior arrests	.272	.249	.164	1.092	.279
	# of prior psych. commitments	.015	.406	.005	.038	.970
Task	# of prior juvenile commitments	-2.683	1.546	-.453	-1.735	.095
	# of prior adjudications	.717	2.711	.049	.265	.793
	# of prior arrests	.836	.473	.458	1.765	.089
	# of prior psych. commitments	.204	.677	.057	.301	.766
Bond	# of prior juvenile commitments	-3.120	1.989	-.410	-1.569	.129
	# of prior adjudications	2.155	3.488	.114	.618	.542
	# of prior arrests	.995	.609	.424	1.633	.114
	# of prior psych. commitments	.628	.871	.136	.721	.477
Total	# of prior juvenile commitments	-7.623	4.798	-.417	-1.589	.124
	# of prior adjudications	4.729	8.413	.104	.562	.579
	# of prior arrests	2.327	1.469	.413	1.584	.125
	# of prior psych. commitments	1.062	2.102	.096	.505	.618

Examining Perceptions of Care Efficacy Among Nursing and Social Work Students

Jada Norford and Sarah O. Watts

Abstract

In health care, interprofessional team work and collaboration among health professionals can improve patient outcomes, increase job satisfaction among professionals, and decrease cost of healthcare. Global organizations call on health professional programs to provide Interprofessional Education (IPE) within curricula to prepare students to work effectively and efficiently within interprofessional teams, yet minimal pedagogical research has been conducted in this area. Social work and nursing students, the two disciplines who spend the most contact hours with patients, can benefit significantly from IPE because the activities can lead to an increase in student confidence and prepare them to provide collaborative care within interprofessional teams. Further inquiry into student perceptions of IPE and collaboration can be beneficial to pedagogical advancement and enhancement of educational experiences in the future. This study of IPE pedagogy incorporated a mixed methods approach to understand nursing and social work students' perceptions of interprofessional collaboration. Items from the Interprofessional Collaboration Scale and open-ended questions were used to gather data via a Qualtrics XM Platform™survey. Quantitative findings noted similarities between nursing and social work students regarding perceptions of communication and differences about roles and responsibilities of disciplines within an interprofessional team. Qualitative analysis revealed the following themes: *communication, advocacy,* and *role definition*. Implications from this study can inform future educational objectives and gaps in learning for social work and nursing students by providing insights into similarities and differences in perception to guide future IPE pedagogy. Continuous studying of social work and nursing interprofessional collaboration may benefit a student's potential for professional practice as well as promote positive patient outcomes and efficient collaborative care environments.

Introduction

Preparing future health professionals for interprofessional collaborative practice is critical and can lead to improvement in patient outcomes, increase in overall satisfaction for health care professionals, and decrease in health care costs (Institute of Medicine, 2015). Interprofessional Education (IPE), which prepares students for interprofessional collaborative practice, aims to increase students' understanding of the roles and responsibilities of various members of the healthcare team while providing an opportunity for students to learn how their discipline of study interacts as a member of a multifaceted care team (Interprofessional Education Collaborative, 2016). Establishing strong skills in areas such as teamwork and communication, central aspects of IPE, is critical in health professions education to prepare students for practice (National Academies of Sciences, Engineering, and Medicine [NASEM], 2021). Incorporating critical competencies of interprofessional practice into educational curriculum better prepares students for professional practice and increases the efficiency of their work when they begin to practice at the professional level (Hermann et al., 2016). Yet, providing meaningful experiences for health professional students can be challenging (NASEM, 2021), and limited research has focused on IPE pedagogy.

Nursing and social work students must develop strong interprofessional collaboration skills prior to professional practice. Social workers and nurses spend the most time with clients and can greatly impact patient outcomes. Thus, preparing them for practice is essential work for programs. Sims (2011) outlined the benefits and increased efficiency related to role classification and greater understanding of scope of practice through thoroughly defining professional roles. In the case of nursing and social work students, assessing for role definition prior to professional practice can provide information about possible gaps in understanding and allow for educational interventions. Similarly, in a study by Clark et al. (2015), increased understanding of scope of practice results from embedding IPE in curriculum, especially for nursing and social work students. This

study further emphasizes the importance of integrating student perceptions of interprofessional collaboration into educational curricula and notes the importance of greater understanding of individual and interacting scopes of practice (Clark et. al., 2015).

While understanding individual scope of practice and roles is important to professional practice, joint training between nursing and social work disciplines is important to prepare students for practice. Overall, assessment of student perceptions of interprofessional collaboration and personal understanding of professional scope of practice is imperative both to educational outcomes and success in future professional practice. Thus, the purpose of this mixed methods study was to evaluate role perceptions between social work and nursing students to help inform educational curriculum for future interprofessional practice.

Methods

This study incorporated a mixed methods design to understand perceptions of interprofessional collaboration among undergraduate nursing and social work students. A non-experimental, descriptive design was used for the quantitative component of the study and a descriptive phenomenological approach was used for the qualitative component. Prior to the collection of data, IRB approval was obtained to ensure protection of human subjects and research. The sample population included nursing and social work students enrolled in baccalaureate programs at a large, public academic institution in the southeastern United States. Participants were recruited from two cohorts of senior-level nursing students and two cohorts of senior-level social work students via an email that contained an informational letter. Participation was voluntary. Students must have completed IPE activities within their program's curriculum to be eligible to participate in this study.

Data were gathered via a Qualtrics XM Platform™ survey consisting of 13 Likert-like scale items and five open-ended questions. The 13 Likert-like scale items were adapted from the Interprofessional Collaboration Scale (ICS) tool (Kenaszchuk et al., 2010). Items from the ICS, a valid and reliable tool, were used to understand perceptions of collaborating with team members during IPE-related activities, as well as how they perceived collaboration in professional settings. A 4-point agreement scale for each item ranged from strongly disagree to strongly agree. Two examples of questions on the tool were: "I feel that patient treatment and care are not adequately discussed between and among team members" and "Team members would be willing to cooperate with new, agreed upon practices." Descriptive and inferential statistics were used to analyze data collected via the ICS.

Additionally, five open-ended questions were provided to further understand perceptions of roles and expectations. These questions were designed to students' understanding of core facets of interprofessional collaboration, including role definition, effective team collaboration, and the impact of collaboration on patient outcomes. The questions were

1)Describe how you perceive nursing and social work professionals' roles in healthcare settings.
2)What roles do you think overlap between nursing and social work?
3)How can nurses and social workers collaborate to improve patient outcomes?
4)What roles and responsibilities are specific to your discipline (nursing or social work) and how can your discipline contribute to an interprofessional team?
5)What characteristics or tasks are important for effective collaboration between nursing and social work professionals in healthcare?

Responses were coded for common themes and thematic statements identified. Upon completion of data collection, qualitative and quantitative data were analyzed separately and then compared to understand student perceptions of interprofessional collaboration.

Results

A total of 14 students, nursing (n=10) and social work (n=4), participated in the study by completing the survey. A Mann-Whitney U statistical analysis was conducted in SPSS© and found no statistically significant difference among the two groups, nursing and social work, for all questions from the ICS. This was not surprising given the small sample size. Through quantitative analysis, nursing and social work students agreed almost unanimously on questions such as "Team members are usually willing to take into account the convenience of individuals when planning their work." Elev-

students agreed with this question and students across both disciplines agreed with this particular question. Additionally, students almost unanimously agreed on questions related to communication; questions related to communication received eight to twelve students' selections of agree. In terms of variance, the question, "Some individuals think their work is more important than the work of others on the team," showed the most variance among the students. Five students disagreed, six students agreed, and two strongly agreed; however, this was equally split between disciplines, and neither nursing or social work fell solely into one category. The most variance in the quantitative section was with questions related to role definition and ability to work within roles to create successful communication.

In terms of qualitative analysis, data collected from the five open-ended questions were used to assess qualitative perceptions of interprofessional collaboration. Through analysis of collected data, the common themes of *communication, advocacy,* and *role definition* were noted among both disciplines. Additionally, some differences emerged in themes between nursing and social work students, especially in role definition between the two disciplines.

The most common theme expressed by both nursing and social work students was *communication* and how valuable the attributes of effective communication could be not only to interprofessional collaborative efforts but to their personal disciplines and practice as well. Participants expressed the importance of effective communication between themselves and their patients, as well as the importance of effective communication between nursing and social work disciplines to ensure efficient collaborative care. Both nursing and social work students highlighted the importance of communication in effective interprofessional collaboration and expressed communication as a central theme on effective interprofessional collaboration that could be continually practiced and implemented for successful interactions. Communication related to patient care focused on psychosocial needs and explaining connections between medical and social needs for both groups of students. Both social work and nursing students noted the role of communication in providing competent social or psychosocial interventions in patient care and connected proper communication with improved patient outcomes and advocacy. When asked to express what attributes nursing and social work share, one nursing student noted, "Communicating effectively and fully with each other and the clients. Respecting each other's abilities and responsibility." A social work participant similarly noted, "Effective communication, getting to know one another on a deeper level, understanding, patience's [sic] and respect" were the most important tasks related to interprofessional collaboration.

Another significant theme to emerge from the qualitative analysis was the theme of *advocacy.* Both disciplines noted advocacy as a key role of their discipline. Advocacy was described by students as providing education and promoting the desires of patients in their healthcare experience. For example, when asked to express what attributes nursing and social work share, one participant noted, "being a good listener, a good patient advocate, and a good role model," while another student similarly noted "patient advocacy, patient safety, therapeutic communication" were similar roles that were shared.

Role definition also presented as a shared theme among the two disciplines. Nursing students defined their role as both physical and social components of care, while highlighting the enhanced psychosocial nature of social work. Social work students noted nurses' roles in physical and or medical aspects of care, while defining their own role as providing social support. Differences in role definition account for a significant portion of the qualitative variance between the two disciplines. Both nursing and social work students provided differing qualitative descriptions of their roles and the role of the other discipline. This theme provided information into how students perceived their personal scope of practice and how the scope of practice interacts with the opposite discipline. For example, one nursing student noted, "The way I perceive the nurses role in healthcare settings is to provide medical care but also support and comfort for the patients. Nurses also seem to be focused on the present, as well as medical issues of the past. Social workers look at the issues currently effecting the patient, but also look at the past and future. For example, they could look into why a patient has had anxiety or what resources the patient needs when they go home." Additionally, one social work student noted

"These two professions are very much intertwined in the healthcare setting. Both care very strongly about the shared client and their family, which not only facilitates positive collaboration but also client outcomes." Both students acknowledge the varying roles each profession played while noting the overlap in roles that social work and nursing professional can experience in professional settings.

Both quantitative and qualitative findings provided insights into student perceptions; however, the qualitative data were more helpful in this small data set for increasing insight into patterns of student perceptions. The ability to thematically analyze qualitative data allowed for better understanding of similarities and difference between both disciplines. While qualitative findings were more specific in this study, quantitative findings provided some information related to perceptions of teamwork. Comparatively, qualitative findings provided more descriptive information, while survey questions provided quantitative measures for comparison between students. Open-ended questions provided the most information and insight into students' perceptions and gave participants the ability to full express their ideas, while survey questions provided more information about specific aspects of collaboration and teamwork. Due to the small sample size, qualitative data greatly enhanced the quantitative findings in this study and provided supplemental, descriptive understanding of student's accounts of interprofessional collaboration.

Discussion and Implications

In terms of central themes and take aways from the data in this study, participants focused on roles related to advocacy, education, and communication as central concepts for collaboration. Thematic analysis of qualitative data throughout this study noted similar themes between both nursing and social work students who participated in this study. In regard to individual disciplines, nursing students perceived themselves as responsible for physical and medical aspects of care but noted the significance of social components of care provided by social work. While nursing students incorporated both social and physical components of care into their definitions of the role of nurses, their definitions were more likely to rely on physical or medical components of care as their primary objective. Social work students noted their role in psychosocial, long-term patient care and described nursing patient care as physical and short-term focused.

Both disciplines defined their roles in a similar fashion and assessed the impact of differing and similar task oriented jobs on collaborative efforts. Students used similar verbiage to discuss the roles and scope of practice of their personal disciplines; however, social work and nursing students were more likely to focus on either physical or social descriptions of roles instead of integrating physical and social descriptions for both disciplines. This is to say that physical and social aspects of care and their implications on professional practice were not always combined in students' descriptions of individual scope of practice. For example, when describing social work scope of practice, nursing students were likely to focus on social or psychosocial components of care while social work students might also incorporate physical care into their personal role definition.

Findings from this study can have a myriad of applications, especially for interprofessional education and preparing nursing and social work students for professional practice. Further strengthening communication between these professional disciplines can create significant impacts on patient care outcomes by enhancing efficiency of care from members of the team that spend the most time with patients. Additionally, enhanced interdisciplinary communication and collaboration in health care settings can increase the efficacy of these systems. If practitioners, especially those practitioners spending the most contact hours with patients, are able to collaborate more efficiently, then the quality and efficiency of care given to patients will be improved.

Allowing for more thorough care management and collaboration between these two disciplines may decrease rates of patient recidivism, medication compliance and other patient-related problems. Furthermore, understanding current perceptions of students can inform educational goals and outcomes for future cohorts of students to promote more efficient collaborative practice. Assessing the ways students perceive interprofessional collaboration can allow educators to understand gaps in knowledge or areas in which students may be struggling and provide instances for educational supplementation in these areas. Ultimately, understanding the degree to which students understand the defined

roles of healthcare team members can inform curricular decisions that encourage more time for interdisciplinary collaboration.

Several limitations of this study are noted. First, participants were only recruited from one public institution, limiting the generalizability of results. Additionally, the sample size was small and students from only two disciplines were included, even though three other disciplines participate in IPE activities. However, the findings are important and add to the knowledge of IPE pedagogy, specifically understanding the differences of perceptions of social work and nursing students. Due to the small sample size in this study, very little variance was predicted between the two groups and the data showed students in both disciplines gave similar answers to the array of Likert-likescale questions. This outcome may not be the case with a larger sample size.

Conclusion

Increased understanding of nursing and social work student's perceptions of interdisciplinary collaboration allows for efficient and comprehensive education and preparation for future professional collaboration. Further assessment of student perceptions can increase understanding of students' educational needs and foster increased pedagogical intervention in healthcare professional programs. Increased implementation of IPE activities in educational settings can greatly benefit student's confidence and ability to replicate interprofessional collaboration skills in future professional practice. Implications from this study can help to inform future educational objectives and gaps in learning for social work and nursing students related to interprofessional collaboration. Continuous studying of social work and nursing interprofessional collaboration may benefit a student's future potential for professional practice as well as promote positive patient outcomes and efficient collaborative care environments.

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IRB Statement

This project received approval for protection of human subjects and research to conduct the study from Auburn University's Institutional Review Board (#20-568).

Associations between Parent Physical Activity, Negative Parenting Behaviors, and Child ADHD Symptoms

Kylie Seaton and Josh Novak

Abstract

Attention-deficit/hyperactivity disorder (ADHD) is one of the most commonly diagnosed childhood disorders in the U.S., affecting 9.4% of the youth population. Parenting behaviors and practices displayed in the home can directly impact the child's expression of ADHD symptoms, specifically hyperactivity-impulsivity behaviors. Differences in parenting behaviors are associated with the amount of internal anxiety and stress experienced by the parent, which often can be reduced through implementing health daily behaviors, such as physical activity. This study sought to examine the relationship between parent physical activity levels and their child's ADHD hyperactivity-impulsivity in the home through the parenting behavior mediator of anxious intrusiveness. Ninety-five parents completed online questionnaires and a hypothetical mediated model was tested using regression and a path analysis framework. Results indicated that higher parent physical activity was associated with lower anxious intrusiveness, which was associated with lower hyperactivity-impulsivity behaviors by the child in the home. Clinical implications and future directions are discussed.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most commonly diagnosed childhood disorders in the United States. With a prevalence rate of 9.4% among children, ADHD can be found in millions of households nationwide (Danielson et al., 2018). Currently, the most common form of treatment for ADHD in children and adolescents is pharmacotherapy, specifically using stimulants as a way to decrease the majority of symptoms associated with ADHD (Spencer et al., 1996). Although stimulant medication has been found to be an effective treatment of ADHD in children, it can have some adverse side effects such as severe sleep disturbances and appetite suppression (Noble et al., 2011; Spencer et al., 1996). Because of the potential negative side effects of medication, parents may prefer to seek other forms of treatment that do not involve pharmaceuticals. Nearly all practitioner guidelines in the past decade regarding the management of ADHD recommend a multimodal treatment approach (CDC, 2020). This approach is largely due to the fact that one form of treatment, such as medication, does not demonstrate improvements in every single facet of a child's symptoms. Parents of children with ADHD may be able to aid in symptom reduction in ways that other treatments may not, specifically through altering their parenting practices and behaviors. Interestingly, differences in parenting styles are associated with different levels of physical activity by the parent (Jago et al., 2011; Sterrett et al., 2013). As such, the purpose of this study was to investigate the association between parents' physical activity levels and their child's ADHD symptom expression in the home.

Literature Review

ADHD Symptoms

From a neuropsychological perspective, it is theorized that the causes of ADHD symptoms are due to an irregularly low amount of dopamine, possibly due to the weak anticipatory cell firing in the prefrontal cortex (Volkow et al., 2011; Arnsten, 2000; Tripp & Wickens, 2008). Together, the dopaminergic system and the prefrontal cortex are responsible for a wide range of functions: motor control, reward, motivation, and affect (Cohen et al., 2002). Deficits in dopamine production, as seen with people with ADHD, can lead to different behavior patterns relating to these cognitive processes (Steinau, 2013). These behavior patterns are often categorized into an inattention category and a hyperactivity-impulsivity category. The inattention construct of ADHD combines behaviors such as being easily distracted, often loosing items, or having difficulty holding attention. Hyperactivity-impulsivity encompasses excessive fidgeting, talking excessively, and being often

"on the go." Because of adopamine deficiency, children with ADHD require more reinforcement for demonstrating desired behaviors and can be influenced more by their immediate environment than a neurotypical child (Tripp & Wickens, 2008). Educational programs and behavior management training programs for parents of children with ADHD often focus on addressing these behavior differences by having parents become more active in the reinforcing and rewarding of desired behaviors in order to increase anticipatory cell firing of these behaviors so that the child can regulate their behavior on their own. Children whose parents provide a more structured and purposeful approach to their parenting tend to show improvements in their executive functioning, processing of rewards, and even academic and social functioning (Tamm et al., 2014; Tarver et al., 2015).

Parenting and Child ADHD Symptoms

Parents' styles, behaviors, and everyday practices can directly influence their child's ADHD symptoms in the home. The strength of the relationship between a parent's behavior and a child's behavior can be seen through the efficacy of widely used parenting behavior management trainings, such as Parent-Child Interaction Therapy (PCIT) and Triple P –Positive Parenting Program (Thomas & Zimmer-Gembeck, 2007). Specifically, research from these programs have demonstrated that parents who implement authoritative parenting tactics, such as creating consistent structures and establishing clear discipline expectations, report decreases inhyperactivity-impulsivity behaviors from their child in the home (Thomas & Zimmer-Gembeck, 2007; Wagner& McNeil, 2008). Conversely, parents who practice authoritarian or permissive parenting styles are more likely to experience a continuation of their child's disruptive or inattentive behavioral patterns (Wagner & McNeil, 2008). In addition to parenting styles, higher parental stress and internal anxiety towards parenting can predict increases in hyperactivity-impulsivity behaviors by the child (Theule et al., 2013; Breen & Barkley, 1988). Another relevant factor, parenting anxious intrusiveness, is a term coined to describe a cluster of parenting behaviors that encompasses overprotection, domineering behavior, infantilizing, and an overgratification of the child's wishes (Becker, 1964; Reid et al., 2015). These behaviors tend to be the opposite of what is suggested by research-backed programs, yet have not been linked with child ADHD symptoms and are important parenting behaviors relevant to child behavior. One method of lowering stress and internal anxiety in parents that shows promise is the monitoring of their own daily health behaviors, such as physical activity.

Parent Physical Activity and Parenting Behaviors

Exercise has shown positive effects on parenting styles and behaviors. Parents who are more physically active tend to practice more positive or authoritative parenting behaviors, as opposed to the more maladaptive, authoritarian behaviors (Jago et al., 2011). Conversely, parents who engage in less physical activity tend to display more laissez-faire parenting behaviors or a permissive discipline parenting style (Sterrett et al., 2013). Theory suggests that this relationship exists because exercise increases overall self-efficacy and alleviates stress through released endorphins, which has positive impacts on mood and behaviors (Bandura, 1989; Rebar et al., 2015). Understanding these mechanisms is important because parents of children with ADHD tend to have lower self-efficacy towards their parenting abilities (Alizadeh et al., 2007). Additional stress brought about from the behavioral symptoms of ADHD in children and from a lack of dedicated self-care time are largely responsible for these lower self-efficacy levels in parents. While there is evidence for a link between child ADHD behavioral symptoms and increased parental stress, there is not a link for how changes in parental stress levels, through daily health practices, may be related to child ADHD symptoms. This gap exists largely because of the heavy focus on various and important parenting behaviors and hyperactivity-impulsivity behaviors in children with ADHD.

The Present Study

This study aims to investigate the relationship between parents' physical activity levels and their child's ADHD symptom expression in the home through proposing a theoretical model involving specific parenting practices. While this study is correlational in nature and hopes to lay the groundwork for future causal research, understanding this relationship would provide parents with specific health behaviors that can impact their child's ADHD-related behaviors. We hypothesize that higher levels of parent exercise will be associated with fewer ADHD behavioral symptoms in their child because exercise will lower anxious intrusiveness parenting.

Procedures

Participants in this study were recruited online using a snowball convenience sampling procedure across the United States via Facebook™. Survey information was shared on personal and research lab Facebook™ pages, and some participants shared the post to their pages as well. Snowball sampling involves participants sharing the study with others who may be interested and qualify. Participants were sent a unique survey link from Qualtrics™(Qualtrics, Provo, UT), gave their informed consent, and began the study. One hundred forty-one-participants saw the survey, but only 106 participants met criteria for inclusion and provided consent. Inclusion criteria were having the ability to complete the form in English, being of legal adult age in Alabama (ages 19+), having a child between the ages of 2-19, and having a child that has had an official diagnosis of ADHD from a licensed professional for at least 6 months. Eleven participants chose to exit the survey at various points before completion, leaving a total of 95 completed surveys. The average length of time to complete the survey was 15.70 minutes. If they met criteria and participated in the survey, participants were offered a $5 compensation for participating. This study was approved by the Auburn University Institutional Review Board, Protocol #20-419 EP 2010.

Participants

The majority of parent respondents were responding about their child between the ages of two to 10 years of age, with almost 97% of these children having an official diagnosis of at least three or more months. The parent participants had an average age of 32.5 years (SD=7.68) with the largest racial group being white participants (N=71). Eighty-one of the participants had children who were on some form of medication for their ADHD. See Table 1 for further demographic information.

Measures

Parenting Behaviors

Anxious intrusiveness was measured using the Anxious Intrusiveness subscale from the Parenting Behaviors and Dimensions Questionnaire (PBDQ; Reid et al., 2015). The Anxious Intrusiveness subscale (five items) encompasses parent behaviors that tend to discourage autonomy or independence in the child, such as overprotective behaviors and attempts at shielding the child from experiencing any form of distress. Examples include "I am more concerned with my child's feelings than my own" and "I try to anticipate what my child desires and then provide them before he/she has to ask." Responses were measured by a six-point Likert scale ranging from 1 (never) to 6 (always). Scores were averaged so that higher scores represent more anxious intrusiveness. The Cronbach alpha reliability coefficient for the present sample was 0.834.

Child ADHD Hyperactivity-Impulsivity

In order to grasp the parents' experience with their child with ADHD, regarding their behavior patterns, the ADHD Rating Scale-IV: At Home Version (DuPaul et al., 1998) was used. The ADHD Rating Scale-IV assesses hyperactivity-impulsivity behaviors in the child, and parents report on their child's behavior at home on a 4-point Likert scale ranging from 0 (Never or Rarely) to 3 (Very Often). Items for each of the two subscales were added together, respectively, to get a total score for each subscale. This norm-referenced checklist refers to the child's behavior over the past six months in the home, with questions based on information from the DSM-IV regarding ADHD and includes frequency items such as "has difficulty waiting turn" or "talks excessively." The ADHD Rating Scale IV has adequate validity and reliability; the Cronbach alpha reliability coefficient for the present sample was 0.745.

Parent Physical Activity

Lastly, there were questions regarding the parents' physical activity habits and those relating to active play with the child. Specifically, the two items in this section inquired how much the parent engages in physical activity by themselves and how much they engage in physical activity with their child. All of the physical activity items were measured on half-hour increments per day, with the maximum amount for each category being five hours per day. The two items were then added together to get a total parent physical activity score.

Control Variables

The variables controlled were the parent and child age, if the child had a formal diagnosis or not (dummy coded 0 = no diagnosis, 1 = diagnosis), the number of years since the diagnosis, medication usage (dummy coded 0 = no medication, 1 = prescribed ADHD medication), income, and parent education (in years).

Analytic Plan

The collected data were analyzed using IBM® SPSS© Statistics version 22.0 and macro-program PROCESS 2.1—a freely available and downloadable add-on to SPSS© that allows for testing mediation using a regression and path analysis framework to provide indirect effects (Hayes, 2013). Parent physical activity was regressed onto anxious intrusiveness and hyperactivity. Parent anxious intrusiveness was regressed onto child hyperactivity impulsivity. The final model represented a fully mediated model, as hypothesized. The indirect paths were tested with bootstrapping procedures at the 95 percent confidence interval and 5,000 samples (Preacher & Hayes, 2008). Finally, parent and child gender and age, income, parent years of education, years since formal diagnosis, and if the child was on ADHD medication were also controlled for in the present study.

Results

Bivariate Correlations

Bivariate correlations and descriptive statistics were explored first to determine if the data met the requirements for structural equation modeling. More parent physical activity was associated with less anxious intrusiveness (p=.014; p=.04). Additionally, higher hyperactivity-impulsivity scores were associated with higher amounts of anxious intrusiveness (p<.001). Interestingly, hyperactivity-impulsivity was not associated with parent physical activity. With these results proceeding generally as expected, the main analysis was continued.

Final Model

The final model contained parent physical activity being negatively correlated with hyperactivity through anxious intrusiveness. The final parsimonious model fit the data well: p=.0016, F=4.18. Additionally, parent physical activity accounted for 6.4% of the variance in anxious intrusiveness and parent anxious intrusiveness accounted for 14.6% of the variance in child's hyperactive impulsivity. More parent physical activity was negatively associated with anxious intrusiveness scores (β=-.13; p=.015). More parent anxious intrusiveness was associated with more hyperactivity-impulsivity (β=.70; p=.002).

Indirect Effects

There was a statistically significant indirect effect from parent physical activity to their child's hyperactivity-impulsivity: parent physical activity level → parent anxious intrusiveness → child hyperactivity-impulsivity (β = -.09, CI [-.221, -.010]). This result can be interpreted as follows: A 1-standard deviation unit increase in parent physical activity is associated with a 0.09 standard-deviation unit decrease in child hyperactivity-impulsivity via the prior effect of parent physical activity on parent anxious intrusiveness.

Discussion

This study sought to explore the associations between parental physical activity and ADHD symptom expression in the child at home. Results revealed an indirect association through parent anxious intrusiveness. These findings were robust as several important covariates in the literature were included. These findings highlight the role of parent exercise as a key target for intervention and prevention, which will be discussed further.

This study is amongst the first to explore the role of parent physical activity in child ADHD symptoms. Whereas previous research has emphasized the importance of child exercise in managing ADHD symptoms, no known research has linked lower ADHD symptom expression with parent exercise. Additionally, this association occurred through the parent's anxious intrusiveness. Anxious intrusiveness encompasses frequent worrying about the child's emotional well-being when the child is not present, meeting the child's desires before they ask for it, and attempting to shield the child from negative emotions. Our findings highlight that parent physical activity is associated with lower parent anxious intrusiveness and lends credence to the important role of exercising in managing behavior and mood states (Rebar et al., 2015).

The relationship between lower parental anxious intrusiveness and lower hyperactivity-impulsivity highlights the importance of parental stress and the secondary effects on the child's behavioral patterns. This finding is also supported by current treatment recommendations in parental training programs for ADHD. Specifically, when parents are more confident in their abilities, they are more likely to demonstrate research-supported parenting practices (CDC 2020; Eyberg & Robinson, 1982).

Implications

The findings from this study have important implications for prevention and intervention programming. First, while many programs may incorporate and suggest child physical activity, our results suggest that including a parent may also have effects on the child's ADHD symptoms. As such, interventions including parents and family members may show lasting improvements. Second, parent anxious intrusiveness was the mechanism linking parent physical activity and child hyperactivity-impulsivity. As such, these findings support the importance of parental behavior management, specifically through internal anxiety management related to parenting. Although further research investigating these additions to programs are necessary, our findings nonetheless are promising.

Four additional parenting behavior clusters were examined in addition to anxious intrusiveness and they did not yield a significant relationship to the other investigated variables. This outcome may shed light on the relationship between parent physical activity, stress, and parenting behaviors. Three of the four additional parenting behavior clusters focused on different aspects of positive parenting or external parenting techniques encouraged by clinicians. It could be the case that lower parental stress primarily affects internal aspects of parenting or that it aids in lowering maladaptive parenting techniques and does not hold much influence on increasing positive behaviors. Anxious intrusiveness specifically encompasses behaviors that stem from internal fears and a lack of confidence in parenting. None of the other parenting clusters included in this study tap into parents' thoughts quite like this variable, which could be why physical activity was only associated with anxious intrusiveness. However, more information and research is needed to understand this relationship of health practices and parenting practices.

Limitations and Directions for Future Research

This study, however, is not without its limitations. First, it is important to note that participants were recruited via snowball sampling techniques. This involved participants sharing this study to others who may be interested and qualified to participate. Other recruitment techniques may have yielded more representative samples. Additionally, participants were asked about various health habits of their family. It is possible that their health habit responses and behavioral patterns might have looked different outside of the COVID-19 pandemic. Future research can aim to replicate this study with more representative samples outside of the pandemic, as well as include additional health habits such as nutrition, sleep habits, and more that may be associated with the internal anxiousness of parents. Furthermore, the specific relationship between parental anxious intrusiveness and child hyperactivity-impulsivity behaviors necessitates a deeper understanding. Future research can investigate the psychological mechanisms of this relationship, possibly by looking at parental-child behavioral attentiveness when anxious intrusiveness is higher or at changes in other parenting behaviors when parents experience more internal anxiety towards their parenting. This study did not inquire on past or current ADHD treatment program involvement. Future research can also explore how the improvement of the daily health habits of parents may affect or elevate progress in behavioral treatment programs.

This study did combine the amount of time the parent participates in physical activity alone and with the child to give the overall total amount of time the parent engages in physical activity. Future research may isolate these two subcategories of physical activity, which may shed light on other possible relationships, such as the parent-child bonding from physical activity playing a significant role in reducing anxious intrusiveness. Future research should also use more established measures of physical activity, including reliable self-reported but also observational or actigraphy data. Our data were cross-sectional and future research should investigate the associations across time. Finally, all data were self-reported and are subject to bias. Future research should include more objective measures such as third party and observational reports on the variables of interest.

Conclusion

This study sought to understand the possible relationship between parent physical activity and child ADHD symptom expression through the mechanisms of various parenting behaviors. Results indicated that higher amounts of parent physical activity are associated

with lower child hyperactivity-impulsivity through lower parent anxious intrusiveness. Exercise has been shown to decrease internal anxiety and increase parental self-efficacy while parental stress has been shown to predict hyperactivity-impulsivity behaviors in children with ADHD. Future research is warranted in order to further understand this relationship.

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IRB Approval

This study was approved by the Auburn University Institutional Review Board, Protocol #20-419 EP 2010.

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Table 1. Demographic Information for Parents
(N=95)

Variable	*n*	%
Child Gender		
Male	24	25.3
Female	3	3.2
Child Age		
2-5 years old	41	43.2
6-10 years old	41	43.2
11-13 years old	7	7.4
14-19 years old	6	6.3
Time since child's diagnosis		
0-3 months	3	3.2
3-6 months	23	24.2
6-12 months	52	54.7
1+ years	17	17.9
Child on ADHD medication		
Yes	80	84.2
No	4	14.7
Prefer not to say	1	1.1
Racial Background		
American Indian/Alaskan Native	12	12.6
Asian American or Pacific Islander	3	3.2
African American (Black)	4	4.2
Latino/Hispanic	5	5.3
White	71	74.7
Bi-racial/Multi-Racial	0	
Highest Education completed		
Less than High School	0	
High school or GED	7	7.4
Some college, not graduated	7	7.4
Associate's degree	53	55.8
Bachelor's degree	26	27.4
Graduate or professional degree	2	2.1
Yearly Income		
None	0	
Under $20,000	0	
$20,000-$39,000	18	18.9
$40,000-$59,999	36	37.9
$60,000-$79,999	21	32.6
$80,000-$99,999	6	6.3
$100,000 and above	4	4.2

Table 2. Variable correlates and Descriptive Statistics (N=94).

Variables	1	2	3
1. Anxious Intrusiveness	--		
2. Parent Physical Activity	-.274**	--	
3. Hyperactive-Impulsivity	.355***	-.082	--
M	2.74	2.66	21.96
S. D.	.81	1.69	4.27

Note: *p<.05,**p<.01, ***p<.001.

Investigation of the Function of the Putative Type VI Secretion System Effectors of the Plant Pathogen *Xanthomonas*

Kylie Weis, Abigail Conroy, Tyler Smith, Parker King, Neha Potnis

Abstract

An analysis of the putative effectors of the type VI secretion system of *Xanthomonas perforans, Xanthomonas euvesicatoria,* and *Xanthomonas vesicatoria* was conducted to elucidate the conservation and function of these effectors. The type VI secretion system's function is currently not well defined in Xanthomonads but is inferred to play a role in epiphytic fitness. Computational methods, literature reviews, and in-lab toxin assays in both prokaryotic and eukaryotic organisms were used to access the putative effectors of this secretion system. Initial findings suggest these effectors are conserved and serve diverse functions including virulence, pathogenicity, prokaryotic competition, predation defense, and nutrient acquisition.

Introduction

Xanthomonas perforans (Xp), Xanthomonas euvesicatoria (Xe), and *Xanthomonas vesicatoria (Xv)* cause bacterial leaf spot disease on tomato and pepper plants, both economically important crops. These pathogens use a type III secretion system to inject virulence and immune suppression effectors into the host plant (Üstün & Börnke, 2014). The type IV secretion system delivers toxins to kill neighboring bacteria to decrease competition (Sgro et al., 2019). The function of the type VI secretion system (T6SS) in *Xp, Xe,* and *Xv* is not as well characterized. While many proteobacteria pathogens have a T6SS, the function of the secretion system and its effectors may differ between species. In *Pseudomonas aeruginosa*, the T6SS shows anti-bacterial capabilities, injecting toxin into other bacteria (Hood et al., 2011). *Vibrio cholerae's* T6SS targets both prokaryotes and eukaryotes (Crisan, 2020). A serine/threonine kinase of the T6SS of *Xanthomonas citri* decreases predation by amoebas (Bayer-Santos et al., 2018).

The type VI secretion system consists of core genes encoding for proteins that form a complex similar to a syringe with a spike-tipped rod in a contractile sheath (Zoued et al., 2014). Within the cluster of core genes are additional genes believed to be effectors due to their proximity to the core genes. Effectors are proteins that are secreted by the system, usually by attaching to the tip or spike protein VgrG. Knowing the function of these effectors is essential to ascertaining the purpose of the T6SS in *Xanthomonas* species affecting tomato and pepper.

Methods

The computational analysis utilized the Alabama Supercomputer to run BLAST (basic local alignment search tool) on all strains of *Xp, Xe,* and *Xv* available in the National Center for Biotechnology Information (NCBI) database to assess conservation of the putative effectors across strains and between species. The program Bastion 6, a T6SS effector predictor based on genetic markers from a database of known effectors (Wang et al., 2018), was used to gauge the likelihood of the secretion of the putative effectors. A phylogenetic tree based on the gene BJD13_RS18385 in the T6SS cluster was made using MEGAX: Molecular Evolutionary Genetics Analysis across computing platforms (Kumar et al., 2018). EasyFig was used to construct figures showing the conservation of the T6SS clusters. Annotations and protein predictions for the putative effectors were found by running BLASTx (Altschul et al., 1990) through NCBI (https://www.ncbi.nlm.nih.gov/), the Joint Genomic Institute's Integrated Microbial Genomes & Microbiomes system (JGI/IMG) (Chen et al., 2021), UniProt (Bateman et al., 2021), and PaperBLAST (Price et al., 2017). Annotations of genes with high identity and coverage percentage in other species were also considered.

Toxin assays were conducted by first designing primers spanning the open reading frame of each putative effector. These putative effector genes from *Xp* strain AL65 were then amplified through polymerase chain reaction (PCR) using Taq polymerase and confirmed

by length in an agarose gel. Taq polymerase leaves a single nucleotide (A) on the 3' end of the PCR product. The PCR products were cloned into pBAD TOPO and pYES TOPO vector plasmids by matching the overhanging nucleotide on the PCR product with an overhanging (T) nucleotide on the liner vector plasmid. These plasmids were then transformed into *Escherichia coli* and plated on selective media. Growth on the selective plates indicated presence of the plasmid. PCR with the gene specific primers and gel electrophoresis was used to confirm presence of the gene of interest in the plasmid. A miniprep was done and the extracted plasmids sent for Sanger sequencing to confirm correct orientation of the gene within the plasmid. pBAD plasmids with genes in the correct orientation were then transformed into BL21 cells. pYES plasmids with genes in the correct orientation were transformed into yeast strains W303a and BY4741a. The BL21 cells were dilution plated on LB media with 0.2% glucose (inactive promotor with gene off), 0.2% arabinose (gene on with araC promoter), 0.002% arabinose, and 0.0002% arabinose. A negative control with a gene in the incorrect orientation was used. The yeast strains were dilution plated on SC-U media with 2% glucose (gene off) and 2% galactose (gene on with ga11 promoter). A negative control with a gene in the incorrect orientation was also used in addition to a positive control containing the gene *cidB* encoding a protein toxic to eukaryotes. The yeast was incubated at 28°C. If no toxic phenotype was seen, the assay was conducted again at 37°C, as heat stress on the yeast may exacerbate a toxic phenotype.

Results

The computational analysis showed a high degree of conservation of putative effectors between strains and species. Some variation was seen between *Xp* and *Xv*; however, these species are more evolutionarily distant. EasyFig figures showed the synteny of the T6SS clusters was also conserved between strains (data not shown). The phylogenetic tree revealed that a gene located in the cluster follows the evolutionary lineage of genomic core genes as the strains were grouped according to the those outlined in Newberry et al. (2019). Annotations and protein predictions for the putative effectors are shown in Table 1. BJD13_RS18380 and BJD13_RS18385 (yapH) are not part of the T6SS according to Bastion 6. Additionally, they are characterized as a two-part autotransporter for adhesin (Thieme et al., 2005). An assay for toxicity of gene BJD13_RS18315 in prokaryotes (BL21 E. *coli*) is shown in Figure 1. No significant difference was seen between the negative control and the putative effector. Genes BJD13_RS18250 and BJD13_RS18310 also did not show a toxic phenotype or decrease in growth. Prokaryote toxin assays were also conducted on genes BJD13_RS18270, and BJD13_RS18340. These assays showed a slight decrease in colony diameter (1mm) compared to the negative controls. An assay for toxicity in eukaryotes (W303a/BY4741a *Saccharomy cescerevisiae*) is shown in Figure 2. This figure shows the putative effector BJD13_RS18340 having a toxic phenotype with decreased growth on the 2% galactose plate.

Discussion

The conservation of the putative effectors suggests they impart an essential function to the pathogen, or they would tend to acquire mutations. Annotations and protein predictions reveal the diverse functions of these effectors. The jacalin-lectin domain containing protein likely prevents recognition by the plant's immune response. The Zn-binding protein has the potential to have a variety of functions (Sharma et al., 2019). In addition to showing a toxic phenotype in yeast, BJD13_RS18340 or oxidoreductase may be used to degrade toxins from competing microorganisms (Taylor et al., 2006). The serine/threonine kinase likely protects against amoeba predation as seen in *X.citri* (Bayer-Santos et al., 2018). Additionally, the hypothetical proteins, DUF4124 domain containing protein, intramembrane metalloprotease, and predicted methyltransferase are possibly prokaryoteor eukaryote toxins.

The slight decrease in colony diameter in the prokaryotic toxin assay may be due to the stress of producing a large amount of protein with the promoter turned on in the presence of arabinose. While the eukaryotic toxin assay of gene BJD13_RS18340 shows a toxic phenotype, the mechanism by which it inhibits grow is unknown.

While toxin assays still need to be conducted on the remaining putative effectors, initial findings suggest that the effectors and the T6SS may have a diverse array of functions important to the survival of the pathogen. Further understanding of the T6SS in *Xanthomonas* is pertinent to mitigating the devastation caused by bacterial leaf spot disease on tomato and pepper.

Table 1. Shows the gene locus tag of the putative T6SS effectors and the annotation or protein prediction from NCBI, JGI/IMG, UniProt, or PaperBLAST.

Gene locus tag	Annotation/protein prediction	Gene locus tag	Annotation/protein prediction
BJD13_RS18245	Hypothetical Protein	BJD13_RS18325	Hypothetical protein
BJD13_RS18250	DUF4124 domain containing protein	BJD13_RS18330	Type VI secretion system associated FHA domain containing protein (TagH - NCBI) (ImpI -JGI/IMG)
BJD13_RS18255	CPBP family intramembrane metalloprotease	BJD13_RS18335	DNA-binding LysR family transcriptional regulator
BJD13_RS18260	Putative secreted protein	BJD13_RS18340	Aldo/keto reductase family oxidoreductase -NCBI dehydrogenase-like oxidoreductase - JGI/IMG
BJD13_RS18270	Jacalin-like lectin domain-containing protein	BJD13_RS18365	Serine/threonine phosphatase
BJD13_RS18305	Serine/threonine kinase	BJD13_RS18375	Hypothetical protein
BJD13_RS18310	Zn-binding PAAR domain containing type VI secreted protein	BJD13_18375	Histidine-type phosphatase -NCBI 4-phytase / acid phosphatase -JGI/IMG
BJD13_RS18315	Predicted methyltransferase	BJD13_RS18380	ShlB/FhaC/HecB family hemolysin secretion/activation protein
BJD13_RS18320	Type VI secretion system secreted protein VgrG	BJD13_RS18385	filamentous hemagglutinin N-terminal domain-containing protein, *yapH*

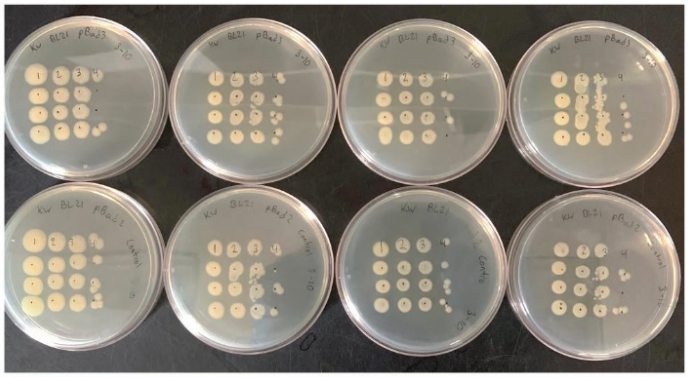

Figure 1. Shows aprokaryotic toxin assay. The top row of plates is BL21 E. coli cells with gene BJD13_RS18315. The bottom row is a negative control containing a plasmid with the gene in the reverse orientation. The first column of plates has 0.2% glucose (gene off), the second column has 0.2% arabinose (gene on), the third column has 0.002% arabinose, and the fourth column has 0.0002% arabinose. There are four replicates on each plate and four 1/100 dilutions from left to right. No toxic phenotype was seen.

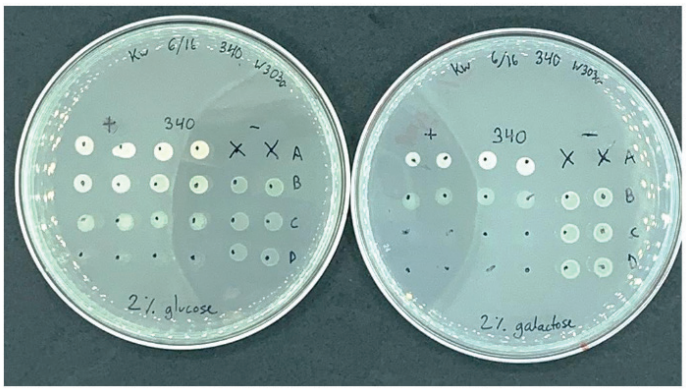

Figure 2. Shows the eukaryotic toxin assay in yeast. The plate on the left contains 2% glucose (gene off) and the plate on the right contains 2% galactose (gene on). There is a positive and negative control on each plate with the gene of interest, BJD13_RS18340 in the middle 2 columns. There are 2 replicates of each group on both plates with four 1/10 dilutions from top to bottom. A toxic phenotype is seen.

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Transcriptomic Analysis to Identify Links Between the Consensus Molecular Subtypes of Colorectal Cancer and Obesity

Peter Abraham, Michael Greene, Elizabeth Lipke, and Peyton Kuhlers

According to the World Health Organization, over 650 million adults age 18 and older were obese in 2016 [1]. Within the United States, the prevalence of obesity has increased from 30.5% in 1999-2000 to 42.4% in 2017-18[2]. Furthermore, obesity has been linked to many diseases such as cardiovascular disease, diabetes, and cancer. Thus, it is important to understand the role of obesity in developing these health outcomes. This project focused specifically on colorectal cancer (CRC), which has been shown to be associated with obesity. However, CRC is a heterogenous disease that differs genetically from patient to patient, resulting in a variety of patient outcomes. Recently, CRC was subdivided into four molecular subtypes, formally called the consensus molecular subtypes (CMSs), based on distinguishing genomic characteristics [3]. The primary goal of this work was to examine the links between the consensus molecular subtypes of colorectal cancer and obesity utilizing transcriptomic data.

Transcriptomic data were acquired from The Cancer Genomic Atlas (TCGA), an online cancer genomics database generated by the TCGA Research Network that contains RNA-sequencing samples and associated patient information. For this project, CRC RNA-sequencing data were utilized along with patient height and weight data from which body mass index (BMI) was calculated. Patients were then categorized as normal, overweight, or obese. The RNA-sequencing samples were classified into the CMSs using the CMS caller package [4] available in the R programming environment.

With the samples categorized as normal, overweight, or obese and as CMS1-4, the data could be analyzed further. First, Gene Set Enrichment Analysis (GSEA), a software developed by the Broad Institute, was utilized to examine whether obesity was affecting known biological pathways differently between the four CMSs [5]. It was observed that inflammatory pathways such as TNF-alpha signaling were enriched in obese samples compared to normal samples in CMS1, the immune-infiltrated subtype, while mesenchymal-associated processes such as epithelial mesenchymal transition were enriched in obese samples compared to normal samples in CMS4, the mesenchymal subtype. These results-suggest that obesity has CMS-specific effects on CRC.

Using the R package DESeq2, obese and normal samples were compared for each CMS, and the top significantly upregulated differentially expressed genes were utilized to create CMS-specific obesity-associated gene signatures [6]. With PROGgene V2, an online prognostics software [7], these gene signatures were evaluated, and high expression was found to result in significantly decreased survival in certain cohorts, suggesting that these genes may have prognostic value for CRC patients in a clinical setting.

In conclusion, the results indicate that obesity enhances distinct CMS characteristics such astheimmune-infiltration of CMS1 tumors and the mesenchymal nature of CMS4 tumors. Obesity-associated genes for each CMS were also identified and found to have prognostic value. Taken together, obesity has CMS-specific effects on the CRC tumor transcriptome. Further analyses are underway to uncover the effect of obesity on the CMSs with respect to drug sensitivity. Future work will aim to validate these results in another CRC cohort.

Statement of Research Advisor

Peter has performed key analyses demonstrating that obesity affects CRC in a consensus molecular subtype specific manner. Having planned an experimental project that had to be postponed due to COVID, Peter adapted his plans quickly and learned an entirely new skill set to take on this research. Focused and persistent, Peter developed his understanding of the field through

reading the literature and has strong problem-solving abilities. His contribution was critical to elucidating this novel understanding of how obesity is linked to CRC.
–Michael Greene, Nutrition, Dietetics, and Hospitality Management, and Elizabeth Lipke, Chemical Engineering

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Understanding the Causes and Exploring Remedies for Food Waste and Food Loss

Roshell Rosales Aguilar, Ruiqing Miao, and Norbert L. W. Wilson

When food items are purchased and food labels are not regulated, the consumer may have different interpretations of the food item's quality after or at a certain date based on the date label, such as "date-only," "best-by," and "use-by." One may wonder whether these food labels affect consumers' waste. This question is important to help reduce food waste and food loss. According to the Food and Agricultural Organization (FAO) of the United Nations (Nations, 2011), not only is one-third of food being wasted, but in middle to high income countries, most of that food is wasted at the consumption stage. United States legislators have considered regulating food date labels to help reduce food waste (e.g., H.R. 3981 –Food Date Labeling Act of 2019). In this study, we focus on three food items (spaghetti sauce, deli meat, and eggs) and how date labels may affect consumers' decision about whether to consume the food that is one-day past the expiration date printed on the date label.

To address this question, we first set up a conceptual framework analyzing a consumer's decision regarding whether or not to consume a food item. We assume that the food about to be consumed is either high-quality or low-quality. High-quality will be food items that are less likely to lead to negative health repercussions. This leads to high-quality food to be associated with a "good-health-outcome" and low-quality food with "bad-health-outcome." To demonstrate how a consumer's decision is impacted by their ambiguity preferences (a measure of people's tolerance to uncertain situations), an α -MaxMin 2 model (Dimmock et al., 2015) is used.

For the regression analysis, our main focus is on willingness to pay (WTP), percentage of unconsumed (1 –CONS), also known as (WASTE), and willingness to waste, measured as WTP * (1 –CONS). The equation used for the regression analysis is

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X1X2 + \beta 4X,$$

where Y can be WTP or WASTE; X1 is the ambiguity preference; X2 is the date label; and X includes some other control variables, such as food items dummies and socioeconomic variables.

The data were collected through a series of experiments, whose results are summarized in Table 1. Most participants were women, with an average age of 40. Most (85.92%) have at least a bachelor's degree and over half (69.39%) are white. Overall, about (71.28%) of the participants have a minimum yearly household income of at least $80,000 and have a low household size, (2.76). Even lower are the number of children in the household under eighteen years old (0.495). The food shopping percentage done by the participant is about 71.77%, indicating they do most of the household food shopping. The willingness to pay (WTP) is low, at about (2.9), which continues to be low even with the standard deviation of 6.78. Data showed participants consume a high percentage of spaghetti sauce (76.26%). However, this percentage has a large standard deviation, which shows great variability. The waste variable, defined as *WTP* * (100 –percentage consumed), explains the average value of waste. The two food items reviewed (spaghetti sauce = 1 and deli meat = 0) are defined by using spaghetti sauce as a dummy variable. The labels "best-by," "use-by," and "no-date" are also dummy variables. To show the focus on date labels and ambiguity aversion (AA), Table 2 shows results from the spaghetti sauce and two other food items.

Results of the study suggest that the "use-by" date label has a positive association with discarding food items, especially with deli meat and spaghetti sauce. This result can be expected, since eggs have a longer shelf life than deli meat; however, spaghetti sauce still has a longer shelf life than eggs. Based on the AA index, there is a positive and statistically significant coefficient for deli meat, indicating that for deli meat with "use-by" date labels, the consumer who is more ambiguity averse will be more likely to throw away the food. The interaction

term coefficient is not statistically significant for eggs and spaghetti sauce.

In conclusion, the regression performed for this study has shown that date labels have statistically significant impacts on food waste of deli meat and spaghetti sauce, but not eggs. Since food waste continues to be a global issue, further study is needed. Legislators are interested in the importance of standardizing food labels and how that change can reduce food waste. It would be beneficial to conduct larger studies where consumption and waste behaviors are monitored. Another approach would be to use more inclusive variables, such as income and education levels, and include both rural and urban areas, along with different household sizes. To help address this issue further, it would be beneficial for these results to be compared with other countries. This comparison could show similarities that could further increase interest in standardizing food date labels to reduce food waste, both nationally and globally.

Statement of Research Advisor

Roshell's work explored the role of ambiguity aversion in determining the impact of date labels on food waste. She contributed to the project by conducting a literature review, processing the data, and running regressions. Future work can be done to refine the analysis and to probe the robustness of the results.
-Ruiqing Miao, Agricultural Economics and Rural Sociology

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Table 1: Summary of socio-economic and participants' consumption variables.

Socio-economic variables	Observations	Mean	Std. Dev.	Minimum	Maximum
male	1,218	.3054187	.4607737	0	1
age	1,188	40.47475	14.13904	20	73
bachelors minimum	1,236	.8592233	.3479318	0	1
white	1,176	.6938776	.4610773	0	1
>80k min household income	1,128	.712766	.4526724	0	1
married	1,194	.6231156	.4848086	0	1
household size	1,200	2.76	1.560266	1	11
number of children under 18 y/o	1,236	.495	.8605766	0	4
food shopping percentage	1,236	71.76699	29.59654	1	100
Participants' consumption					
WTP	1,236	2.899992	6.779394	0	100
percentage consumed	1,236	76.2593	33.55005	0	100
waste	1,236	-210.2221	154.5151	-1185	4.99
spaghetti sauce	1,236	.5	.5002024	0	1
best-by label	1,236	.3333333	.4715953	0	1
use-by label	1,236	.3333333	.4715953	0	1

Table 2: Correlation and significance levels of various food items using different food labels.

Variables	Deli meat (1 : discard)	Eggs (1 : discard)	Spaghetti Sauce (1 : discard)
AA index	-3.478 *	2.086	0.974
	(1.821)	(1.919)	(1.809)
Use-by (1 : use-by; 0: best-by)	0.918 **	-2.349	1.675 **
	(0.396)	(1.705)	(0.733)
Use-by x AA index	3.887 **	2.870	-1.116
	(1.911)	(2.932)	(2.590)
Price (1: high price; 0: low price)	0.102	-1.771 *	0.995
	(0.376)	(1.036)	(0.859)
Socio-economic variables	yes	yes	yes
Observations	176	150	176
Number of groups	16	16	16
*** p < 0.01, ** p < 0.05, * p < 0.1			

Development of a Multi-Particle Spectometer

Davis Arthur, Guillaume M. Laurent, and Bree Tatum

Multi-particle imaging techniques are needed to properly unravel the dynamics of atomic and molecular processes at their natural time scale (femtosecond to attosecond). Cold target recoil ion momentum spectroscopy, or COLTRIMS, is an imaging technique that utilizes a uniform electric field and a uniform magnetic field to map the momentum-space distribution of a charged particle (electrons, recoil ions, molecular fragments) to a position on a 2-dimensional particle detector. By recording the position where the particle strikes the detector, as well as the particle's time of flight, the initial momentum of the particle can be reconstructed with unmatched precision and reliability (Ullrich et al., 2003). Over the last two decades, COLTRIMS has risen in prominence due to its application in the field of ultrafast science (Young et al., 2018).

While it is generally assumed that the magnetic field of the COLTRIMS spectrometer is uniform over the full spectrometer region, this assumption is only an approximation. In practice, the magnetic field is usually generated by a pair of Helmholtz coils much larger than the ultra-high vacuum (UHV) chamber enclosing the spectrometer. Induced currents in any conductive materials within the Helmholtz coils (including the frame of the spectrometer) will inevitably deteriorate the uniformity of the magnetic field. Thus far, COLTRIMS experiments have largely ignored such variations, since the induced magnetic fields can be difficult to predict or even measure. In this work, we proposed a novel COLTRIMS design that utilizes a solenoid magnetic field source rather than a Helmholtz coil. A solenoid more closely matches the geometry of current leading COLTRIMS designs, and it can produce a magnetic field with greater uniformity. We anticipate that by enclosing the solenoid within the UHV chamber, we can better shield extraneous magnetic fields from the spectrometer.

The theoretic spatial variation of the magnetic field of a finite solenoid cannot be easily determined using analytical methods. Therefore, in order to better analyze the viability of our design, we approximated the solenoid as a series of finite straight wires. To determine the magnetic field at a given point within our spectrometer, we calculated the magnetic field of each straight wire in the approximation and then applied the principle of superposition. From our approximation, we found that the magnetic field produced by a solenoid with a length to radius ratio of 6:1 will have a spatial variation of less than 5% within the centermost half of the spectrometer, as shown in Figure 1. When only the centermost quarter of the spectrometer is considered, the variation drops to less than 1%.

It is also worth noting that the spatial dependence of the variation near the center of a solenoid is relatively simple. Therefore, it may be possible to account for the non-uniformity in each particle's equation of motion. From our findings, we believe a solenoid is an excellent candidate for the magnetic field source of a COLTRIMS device. We believe that using a solenoid in our spectrometer design will allow us to improve spectrometer resolution by minimizing the effect of extraneous magnetic fields. We have begun preliminary construction of our spectrometer and hope to take our first measurements in the near future.

Statement of Research Advisor

Davis has designed a novel configuration for multi-particle spectrometers used in atomic and molecular experimental physics. To that purpose, he first developed a simulation package to mimic the trajectories of charged particles in the spectrometer. He then used his package to optimize the spectrometer configuration (length, diameter, number of wire loops and shape). Once the design completed, he built and assembled the spectrometer, which will be used in our laboratory over the summer.

–Guillaume M. Laurent, Physics

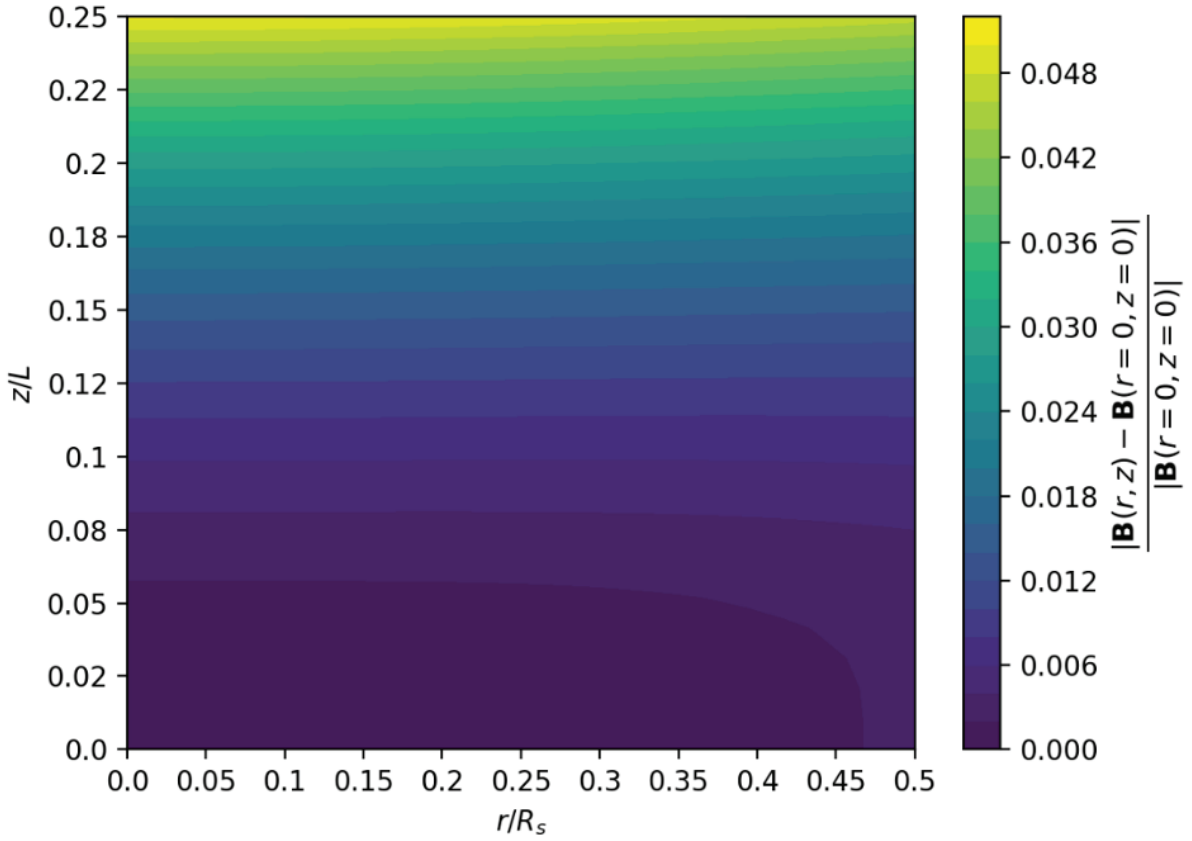

Figure 1: Simulation of the magnetic field uniformity of a finite solenoid with a length (L) to radius (Rs) ratio of 6:1. The coordinate (z=0,r=0) indicates the center of the solenoid. The magnetic field vector at a given radial and axial position is denoted by **B**(r,z).

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Efficacy of Pellet Count Surveys to Estimate Density of White-tailed Deer *(Odocoileus virginianus)*

Sarah A. Cain, Chad H. Newbolt, Robert A. Gitzen, William D. Gulsby, and Stephen S. Ditchkoff

Accurate density estimates are critically important for managing many species of wildlife, as management is often based on achieving a goal of increasing, decreasing, or maintaining a certain population density. White-tailed deer, the most sought-after game species in North America and the foundation of the North American Model of Wildlife Conservation, is a species for which accurate population estimates are important. Population estimates are critical for the implementation of proper management of the species, for the analysis of birth and death rates, and for monitoring population development. Pellet count surveys, although an often overlooked and dated technique, have been previously suggested to be ineffective for determining density (Fuller, 1991). However, pellet count surveys have rarely been applied to populations of known density, which limits understanding of the accuracy of this technique (White, 1992). As seen in White's comment in 1992 to Fuller (1991), an accurate conclusion on the efficacy of pellet count surveys cannot be made unless the density estimate is compared to the true density of white-tailed deer in the area.

The Auburn University Captive Deer Facility, a 174-hectare high fence facility located in Camp Hill, Alabama, offers a unique, controlled environment for examination of pellet count surveys. Specifically, the high number of tagged individuals (~80%) in the facility provides an opportunity to generate accurate estimates of density using photographic data and mark-recapture models. During fall through winter of 2020-2021, we systematically established 684 points across Auburn University's Deer Research Facility using the Avenza Maps® application (Avenza Maps, Avenza Systems, Toronto, CA; accessed January 2020). Each point was systematically established using a 50-m grid across the entire facility. Any point located within 2 m of the fence line, in a body of water (creek, etc.), in a food plot, on a road, or within 50 m of a feeder was excluded. Beginning in October 2020, a circular plot of 1.5-m radius was set up at each point and centered on a pin flag. Using a stake centered on the flag that was attached to a 1.5-m string, the plot was carefully walked in a circle and cleared of any fecal pellets. In November 2020, December 2020, January 2021, and February 2021, plots were revisited and checked for fecal pellet groups using the same method as when plots were first established. If a pellet group was found during a survey, it was counted and subsequently removed from the plot. To compare estimates from pellet count surveys, we used camera trap data from marked, known-age deer to identify the true density of the population.

If proven to be accurate, this method will help land owners generate accurate estimates of white-tailed deer on their land without having to invest extra time or money in more expensive population estimation techniques. Additionally, the generation of more accurate population estimates will enable more refined management and improve quality of the herd.

Statement of Research Advisor

Sarah's research examines a long-overlooked density estimation technique that could change the manner in which deer biologists manage their herds.
-Stephen Ditchkoff, Forestry and Wildlife Sciences

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Visitation of Hymenopterans to Seasonal Honeydew Produced by Crape Myrtle Bark Scale (Hemiptera: Eriococcidae)

Elijah P. Carroll and David W. Held

Crape myrtle bark scale (CMBS) is an exotic scale insect first detected in the United States 17 years ago (Gu et al., 2014) and infests crape myrtle trees, one of the most dominant trees in southern landscapes. Infestations result in high amounts of honeydew (their protein and sugar-rich excrement), reduced flowering, aesthetic loss, and in extreme cases, death to the tree. Over time, honeydew promotes the growth of sooty mold fungi, which produce darkened leaves, branches, and trunks. Honeydew is also an important carbohydrate resource for bees and wasps (Order: Hymenoptera) and is a preferred sugar resource for some species of parasitoid wasps (Lenaerts et al., 2014). Previous literature has shown that unmetabolized systemic insecticides can translocate through phloem-feeding pest insects and into the environment via honeydew at levels toxic to non-target insects (Calvo-Agudo et al., 2019; Quesada et al., 2020). However, previous studies have not evaluated whether production of honeydew and utilization of honeydew by other insects is seasonally variable. This study seeks to determine seasonal changes in honeydew production by CMBS and visitation by species of wasps and bees to infested crape myrtle trees to help with understanding the risks of systemic insecticide usage for non-target insects.

To quantify seasonal honeydew production, paper plates (Chinet©) lined with plastic wrap were wired to a PVC pipe staked into the ground underneath four infested landscape crape myrtles for 48 hours. The plates were returned to the lab, acetone washed into a centrifuge tube, and dried under a nitrogen blanket. Dry mass for each monthly sample of honeydew was recorded. To evaluate how honeydew may alter hymenopteran visitation to infested trees, pairs of infested and un-infested potted crape myrtles (n=20), 1.8 to 2.2 m tall, were placed at two sites with 3 m between the paired trees, and 15 m between each replicate. Trees were placed on each site 48 hours before data were collected to allow insects time to discover the trees. The number of hymenopteran insect visiting trees were determined by two observers (one per tree) at times 0600, 0900, 1200, and 1500 for two consecutive days. Observers would watch a tree for 5 min and then record the types and numbers of insects observed. Hymenopterans were included in the data if they landed on the tree within the 5-min observation period. Representative insects were captured during these observations and brought to the lab to confirm their identifications.

Our results show that the presence of CMBS and the associated honeydew can change the community diversity of bees and wasps (Figure 1). Of the hymenopterans collected, all species were beneficial insects, i.e., species that provide important ecological and economic services such as pollination and pest control. Most were yellow jackets, paper wasps, and wasps that predate or parasitize other insects, and a few were bees. The wasps collected were not natural enemies of CMBS, so we assumed most were attracted to the honeydew and not directly to the scale insects. Significant differences in hymenopteran visitation were observed during the months of June, July, and September, hot and dry months when nectar and other sugar sources are limited. Additionally, we observed significant differences in seasonal production of honeydew in October, with an average recorded mass three times greater than average masses during the previous months combined (Figure 1).

The results of our experiment add to existing literature of honeydew utilization by other insect species. Trees infested with CMBS will attract beneficial wasps and bees. If an infested tree is treated with systemic insecticides, the insecticide residue may pass into the honeydew and inadvertently expose beneficial insects. Our experiments show high honeydew production but virtually no wasps or bees on trees in October. This may

provide an opportune time to treat infested trees while reducing the risk of exposure to non-target insects.

Statement of Research Advisor

Elijah Carroll conducted experiments to determine when honeydew is produced by CMBS and how that may influence beneficial insects using that resource. Honeydew, the sugary excrement of sap-sucking insects, has been reported for many years as useful carbohydrate sources for other insects. More recently, honeydew was identified as a possible route of exposure for non-target insects. This work helps us to understand how systemic insecticides, widely used to manage CMBS, may be delivered to beneficial insects and even natural enemies of CMBS. Elijah took ownership of this project and demonstrated the ability to mobilize a research team as well as work independently.
-David Held, Entomology and Plant Pathology

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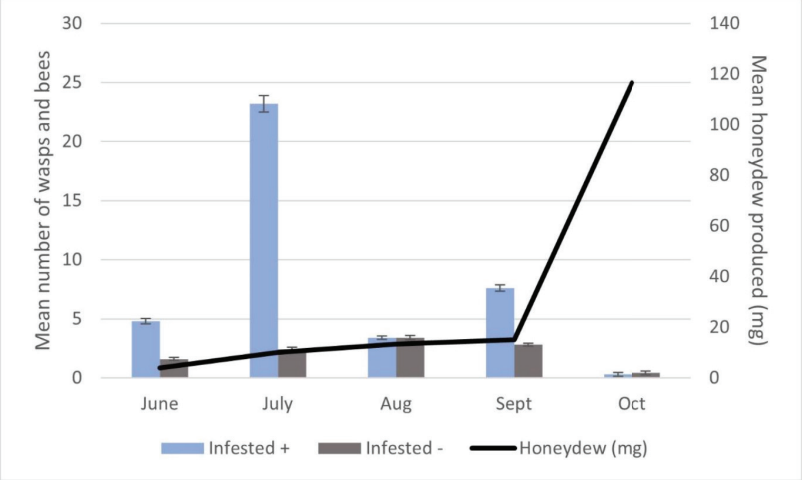

Figure 1. Seasonal visitation of *hymentopterans* (bar) and the seasonal mass of collected honeydew (line).

Electromyographic Analysis of Shoulder Rotation Strength Testing Positions

Molly Cassidy, Nicole Bordelon, Kyle Wasserberger, Kevin Giordano, and Gretchen Oliver

Shoulder strength is important to stability and function of the glenohumeral joint. Muscular weakness surrounding the glenohumeral joint can lead to shoulder instability and increase susceptibility to shoulder injury. Therefore, clinicians perform shoulder rotation strength tests at various positions to assess measures of function, including peak torque and muscle activation. However, shoulder function may vary across positions. The purpose of this study was to compare measures of shoulder function (peak torque and muscle activation) between twoc ommonly used shoulder rotational strength testing positions.

Eighteen physically active individuals (12 females, 6 males, age: 21.2±2.9 y, height: 170.7±8.3 cm, weight: 73.8±9.3 kg) participated in this study. Participants performed isometric shoulder internal and external rotational strength tests using an isokinetic dynamometer in two different positions: (1) supine with arm abducted at 90° in the frontal plane, and (2) seated with arm abducted at 90° in the frontal plane and internally rotated 45°. The elbow was flexed 90° in both positions. Electromyographic data were collected for the posterior (PD) and anterior deltoid (AD) muscles, since they produce a force couple. Maximum voluntary isometric contractions (MVICs) were then performed to establish baseline muscle activation to which the trials were normalized.

A 2 (position) x 2 (direction) repeated measures analysis of variance (RM·ANOVA) compared torque values between testing positions for external and internal rotation tests. A second 2 (muscle) x 2 (position) RM·ANOVA compared muscle activation (%MVIC) between testing positions for AD and PD muscles. The first RM·ANOVA did not reveal a significant position-by-direction interaction. The second RM·ANOVA did reveal a significant muscle-by-position interaction [$F(1, 17) = 5.414$, $p = 0.033$]. Post hoc analysis showed a difference between supine (mean: 25.2, SD: ± 3.3 %MVIC) and seated (mean: 32.2, SD: ± 3.8 %MVIC) positions for AD activation, where greater activation was measured in the seated compared to the supine position ($p = 0.025$). Figure 1 shows a comparison of muscle activation at each testing position.

Since there were no differences in peak torque between positions, greater AD activation in the seated position-may suggest the AD has greater contribution to overall shoulder strength in the seated compared to supine position. The findings from the current study are significant since they show how two commonly utilized shoulder rotational strength tests can differ in muscle activation. Clinicians should consider how different testing positions may vary in muscle activation function. Future research should assess other testing positions and muscles surrounding the glenohumeral joint.

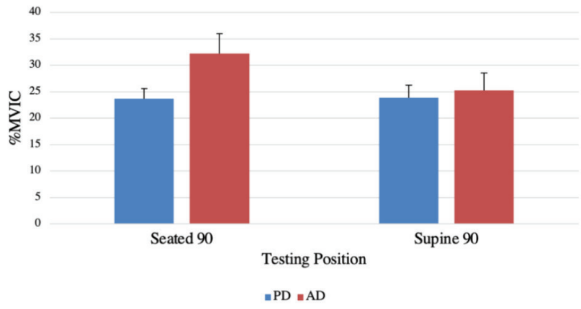

Figure 1: Percent maximum voluntary isometric contractions (MVIC) at both testing positions. AD denotes anterior deltoid and PD denotes posterior deltoid muscles.

Statement of Research Advisor

Molly's work highlights two common testing positions that are utilized in the clinical setting. These findingsare important for clinicians when assessing individual muscle strength and activation throughout the rehabilitation process. This work should be furthered based on Molly's findings.

-Gretchen D. Oliver, Kinesiology

Effects of Previously Playing an Overhead Throwing Sport in Shoulder Range of Motion, Strength, and Humeral Retroversion

Abigail M. Cramer, Jessica L. Downs, and Gretchen D. Oliver

Humeral retroversion (HR) is the twisting of the proximal humeral head about the long axis. [1,2] Research has shown that repetitive stress from playing an overhead (OH) sport increases HR on the dominant side. [3] The OH motion produces torque and distraction forces about the throwing shoulder joint, causing soft tissue and osseous changes to occur, resulting in a bilateral difference. [4] Previous research suggests while increased external rotation (ER) can be protective in an active OH athlete, excessive HR may contribute to upper extremity injury. [1,3] There is a paucity of data regarding the effects of this adaption. Therefore, the purpose of this study was to investigate the effects of prior OH sport participation compared to no OH sport participation on glenohumeral range of motion (ROM), strength, and HR.

Fifty-one college-aged individuals participated. Participants were split into two groups: (1) those with previous participation in an OH sport (n= 23, 20.2±1.04 yrs, 167.0±14.5 cm, 70.9±13.3 kg) and (2) those with no previous participation in an OH sport (n = 28, 20.6±0.88 yrs, 168.8±6.3 cm, 68.5±14.9 kg). Inclusion criteria were pain, injury, and surgery free for at least the past six months. Following a health history questionnaire, we measured bilateral shoulder internal (IR) and ER ROM using an inclinometer, isometric shoulder strength using a handheld dynamometer, and HR using an ultrasound machine (Figure 1). For bilateral shoulder passive ROM, isometric strength and HR testing, the partipants were positioned supine on a treatment table with 90° of shoulder abduction and elbow flexion. The ROM inclinometer and isometric dynmometer were positioned in the same place for both tests. Placement was on the dorsal side of the distal ulna styloid process for IR and on the ventral side for ER. For HR, the examiner rotated the partipant's humerus so that the bicipital groove appreared in the center of the ultrasound image. Another examiner then placed a digital inclinometer along the ulnar border with the forearm kept in neutral rotation and recorded the ulnar inclination angle with respect to the horizontal line. All testing measurements were recorded for three trials and averaged for analysis. Data were non-normally distributed; therefore, a Mann-Whitney U test was used to determine group differences with an alpha level set apriori, p=0.008. A Wilcoxon T-test was used to analyze bilateral differences within each group with an alpha level set a priori, p=0.0167.

Results showed no significant differences between groups for all dependent variables, and no significant bilateral differences for any variable for the non-OH sport. The Wilcoxon T-test revealed a significant bilateral difference between the dominant and non-dominant in the OH group for HR (Z=-3.118, p=0.002) and IR ROM (Z=-3.423, p=0.001).

The bilateral difference found in the OH sport group for HR is significant as it indicates prior sports participation may have residual osseous effects that clinicians need to consider when evaluating shoulder injury or pain in adults. Understanding if there are residual effects from playing an OH sport could help examine injury risk later in life.

Statement of Research Advisor

Abigail's research has established normative data on a small subset of overhead athletes that will allow for more in-depth exploration into humeral retroversion and long-term osseous effects with upper extremity injury susceptibility.

-Gretchen D. Oliver, Kinesiology

Figure 1: Analysis of humeral retroversion using ultrasound machine; internal rotation represents the positive direction and external rotation represents the negative direction.

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3D Printer Accessory That Prints Multiple Polymers While Being Able to Manipulate Their Concentration

Calvin Dulaney and Edward Davis

The new growth and development in 3D printing is grabbing the attention of many mechanical, chemical and material engineers who are fascinated with photo-polymerizing types of printing that are used in tissue engineering, surgeries and drug delivery. Being able to control the resin concentration of a print would allow for many new possibilities and avenues for 3D printing in the areas of medical, mechanical, and chemical engineering. New 3D printing developments bring forth the question: Is there a way to control the absolute concentration of the resins going into the printers? The purpose of this project was to coat and aid the transportation of drugs in the medical field.

Investigating this topic requires an understanding of Stereolithography (SLA) 3D printers and how they crystallized resin through a untraviolet laser to illuminate the surface of a material. From this information, I constructed a bread board circuit in which three individual pumps control the concentration of resin from a single Arduino program. The Arduino program is able to control the stepper motors (pumps) by assigning each pump its own voltage output. The voltage output is exponentially proportional to the output mass flow rate of resin. The pumps allow each individual resin to transport separately in their own respective tubes, where they will enter a mixing chamber and finally be transported to the SLA printer.

Results from this study showed that the different types of resins have different viscosities, which change the mass flow rate required to pump out the needed amount of resin. Thus, in future applications, each specific resin must be separately evaluated. In addition, the results indicate that Arduino Nano is able to control the voltage of the pump at a cheaper cost than an Arduino Uno but has the flaw of being slightly less reliable. To determine whether the Arduino Nano is able to complete the job at the same rate as an Arduino Uno, we tested each by running 24 volts through both circuit boards and found that neither malfunctioned. This study shows that both circuits have the ability to run the operation at full capacity; therefore, the deciding factor between the two is cost.

The crucial impact of this research is to offer a cheap and efficient way to control and manipulate the concentration of SLA printers. The findings from this experiment are that the ability to control resin concentration is possible with a very inexpensive system, and that separate studies need to be done on each resin based on their color and brand due to their difference in viscosity. The next step in this research will be to finalize a link between Arduino and MATLAB™ which will allow for easy transfer into MATLAB™ for use in controlling the pumps for concentration.

Statement of Research Advisor

Calvin has designed and developed a system to augment the capabilities of a commercial SLA printer designed to print one resin at a time. He has constructed a system capable of producing blends of two printing resins and varying the overall composition during the print. The system enables the printing of gradient structures. My research group is looking forward to utilizing the equipment to study how gradient systems can control degradation and controlled release behavior of additively manufactured bioimplants.
-Edward Davis, Mechanical Engineering and Materials Engineering

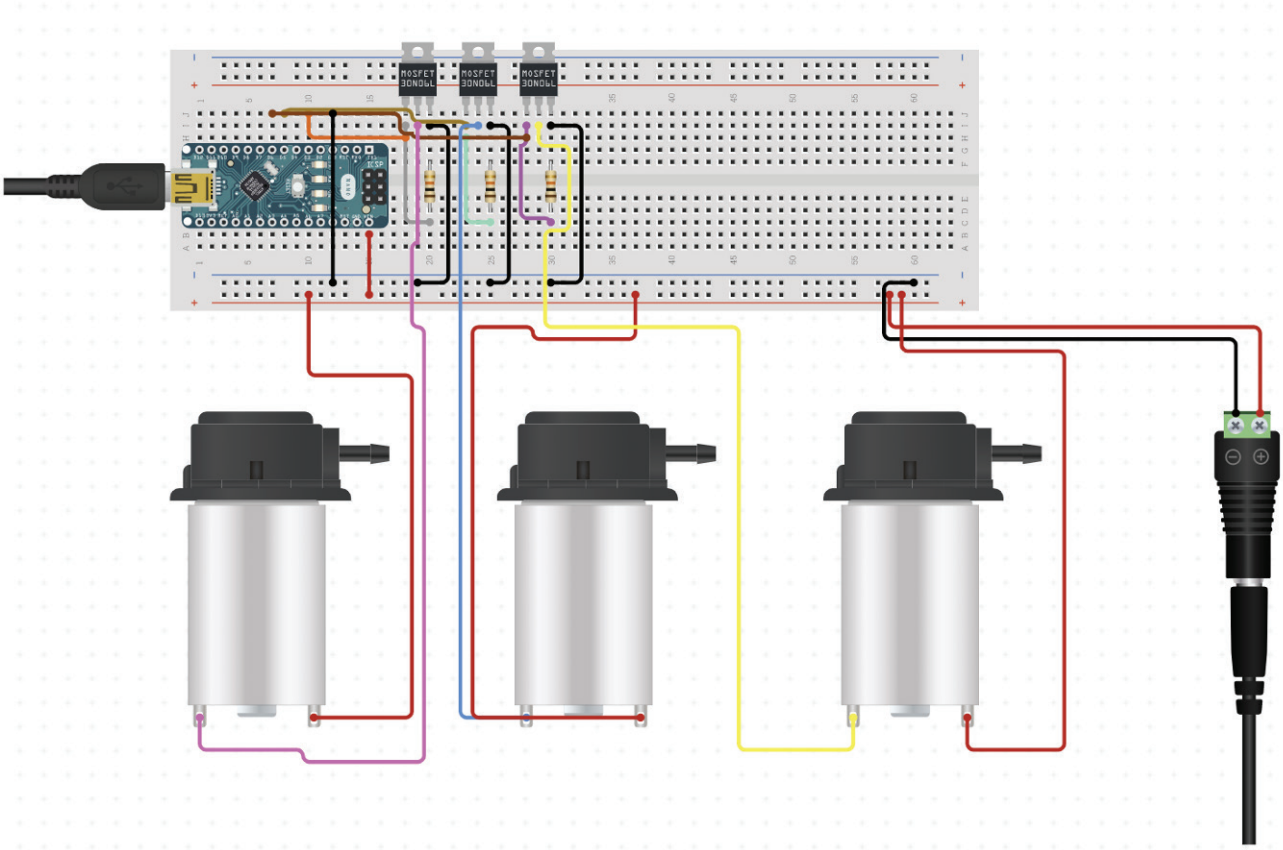

Figure 1. Final bread board circuit to control concentration of resin.

A Specialized Sex Eductation Program for Adjudicated Male Youth

Hannah Rae Evans and Kelli R. Thompson

Sex education is a critical feature of treatment programs for adolescents adjudicated for illegal sexual behavior (AISB) (ATSA, 2017). Many AISB have cognitive distortions and misinformation concerning sexual topics, making it difficult to establish appropriate boundaries and form healthy relationships (Dwyer & Boyd, 2009; Seto & Lalumiere, 2010). Data recently presented from this population showed those AISB who reported the highest amount of child sexual abuse indicated they had learned about sex through witnessing or experiencing a sexual act, potentially a sexually abusive act (Evans & Thompson, 2020). Yet, most standard comprehensive sex education curricula for teens are inadequate at meeting the unique clinical needs of this specific population, making clear the need for a more tailored approach to sex education for AISB. This research project summarizes these needs and introduces a newly implemented approach for use in secure residential facilities called the HEalthy Adolescent Relationship Training (HEART) curriculum.

The HEART curriculum was designed to meet the needs of this clinical population by fitting within a larger mental health treatment model including additional group formats for social skills building and emotion regulations alongside intensive individual therapy sessions. According to best practices in the field, this type of multifaceted treatment program should include trauma-focused therapy, applied behavioral analysis, cognitive-behavioral therapy, and family therapy to meet the diverse clinical needs of AISB (ATSA, 2017). This allows youth to gain basic knowledge and skills about healthy sexuality at a similar rate to other cognitive and emotional issues being addressed in treatment at large.

While a group format for sex education serves as an ideal means to build social skills and a source of peer critique and input that is critical for this population (Dwyer & Boyd, 2009), many residential facilities were unable to conduct group formats during the COVID-19 pandemic due to enhanced safety protocols. Table 1 summarizes topics covered and learning goals for the HEART curriculum with optional activities that can be completed in either group or individual sessions as needed. An important feature distinguishing this program from other sex education curricula is its focus on appropriate media use and establishing healthy boundaries with pornography and masturbation. A recent fact sheet on pornography summarizes best practices in regard to this debated topic (ATSA, 2020). Exposure to pornography and masturbation are common experiences for adolescents (Lim et al., 2017). While pornography can influence sexual behaviors, practices, attitudes, and perceptions of what "sex looks like," its role in developing and maintaining abusive sexual behavior remains unclear (Pratt & Fernandes, 2015). Responses to pornography and masturbation with this population must be realistic, balanced, rational, and individualized (Prescott & Schuler, 2011). Thus, a psychoeducational approach that focuses on teaching healthy sexual boundaries and positive practices, as shown here, is encouraged over an abstinence-based approach (ATSA, 2020). Overall, this research highlights the need for a tailored approach to working with AISB and one creative solution to providing sex education in this type of setting.

Statement of Research Advisor

Hannah's research was supported by a year-long undergraduate research fellowship awarded through the College of Liberal Arts and the Office of Undergraduate Research. Our research lab, The Juvenile Delinquency Lab, is supported by a more than 20-year public-public partnership with the Alabama Department of Youth Services. Her research highlights some of the creative work from the Accountability Based Sex Offense Prevention Program (ABSOPP), an evidence-based treatment program for youth adjudicated for illegal sexual behavior in the state. Plans for Hannah's fellowship required adjusting due to COVID-19 and the increased risk of spread in residential settings. Hannah met this challenge and assisted the ABSOP Program by trans-

lating the above described group psychoeducation curriculum into one that could be used entirely during individual therapy sessions. This required her to become somewhat of an expert in the content covered. She took great care to ensure all topics were covered in a new and creative way and was of great service to the therapeutic team at the facility in doing so. Like many researchers and mental health professions during the pandemic, she learned an entirely new set of skills in a short period of time.
-Kelli R. Thompson, Psychology

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Table 1. Summary of topics covered in HEART curriculum.

Topic	Learning Goals	Optional/Sample Activities
W1. Sexual Values & Decision Making	Define values and how it influences sexual decision-making; recognize and accept others with different values.	1.1 Intro/Pretest 1.2 Ice Breaker: *Get On The Bus* 1.3 Game: *The World Around Me* 1.4 Wrap up and Homework
W2. Talking Sex & Basic Anatomy	Use medically accurate terminology associated with reproductive systems and identify functions associated with these body parts	2.1 Intro/Review Homework 2.2 Ice Breaker: *Sexual Anatomy Scattergories* 2.3 Craft: Making Anatomical Models 2.4 Wrap up and Homework: *STI PSA*
W3. Sex, Gender, Orientation, & Expression	Learn sex, gender, sexual orientation, gender identity terms, and gender expression, learn that sexual identity is on a continuum and how gender stereotypes and expectations can be harmful	3.1 Intro/Review Homework 3.2 Ice Breaker: *Gender-Bread Person Poster* 3.3 Game: *Coming-Out Stars* 3.4 Wrap up and Homework
W4. STIs & Healthy Sexual Practices	Correctly identify facts about common STIs and healthy sexual practices, such as condom usage	4.1 Intro/Review Homework 4.2 Ice Breaker: *The Handshaking Game* 4.3 Demonstration: *Condom Confidence* 4.4 Wrap up and Homework
W5. Masturbation & Appropriate Media Use	Establish a healthy relationship with masturbation, develop healthy relationships to pornography use, and learn facts about harmful pornography use and appropriate boundaries	5.1 Intro/Review Homework 5.2 Ice Breaker: *Relationships in Media:* 5.3 Activity: *Media Case Study* 5.4 Wrap up and Homework
W6. Affirmative Consent & Boundaries	Establish a firm understanding of affirmative consent and the responsibility to understand clearly what a partner wants	6.1 Intro/Review Homework 6.2 Ice Breaker: *Consent & Boundaries Games* 6.3 Activity: *Scenario Board* 6.4 Wrap up and Homework
W7. Romantic Relationships & Effective Communication	Establish a firm understanding of what is and what is not a healthy attachment or romantic/sexual relationship with a partner	7.1 Intro/Review Homework 7.2 Ice Breaker: *Celebrity Relationship Worksheet* 7.3 Communication Activities/Games 7.4 Wrap up and Homework
W8. Birth Control Basics & Family Planning Options	Understand basic birth control methods, family planning options, and be able to discuss the steps needed to prepare to have a family	8.1 Intro/Review Homework 8.2 Ice Breaker: Timeline Activity 8.3 Birth Control Discussion & *Two Truths and a Lie* 8.4 Abortion Discussion 8.5 Wrap up and Homework
W9. Review & Wrap-Up Party	Group post-test to determine Acquisition of Skills and Knowledge over the topics that have been presented, and an opportunity to answer any remaining questions	9.1 Intro/Review Homework 9.2 Post Test 9.3 Game: *SexEd Jeopardy Challenge* 9.4 Wrap-up

Streptomyces poriferae sp. nov., A Novel *Streptomyces* Species From Marine Sponges That Produces Metabolites That Inhibit The Growth of Methicillin-Resistant *Staphylococcus aureus*(MRSA)

Dorelle V. Fawwal, Megan Sandoval-Powers, Stanislava Králová, Kristin F. Degnes, Giang-Son Nguyen, Alexander Wentzel, and Mark R. Liles

Antimicrobial resistance of pathogens is a growing public health threat.[1] Because the efficacy of our current antibiotics to treat infections and disease is declining, there is a societal need to identify new antibiotic compounds with unique mechanisms of action. Microorganisms have historically been a rich source of therapeutic drugs, including antibiotics, anticancer, and antifungal compounds. *Streptomyces* species are well-known microbial producers of medically relevant antimicrobial compounds that are important for bacterial survival in natural environments.[2] Given the species' history of antimicrobial metabolite production, the discovery and characterization of novel *Streptomyces* species are a target of new antimicrobial research.[3] In this study, two marine sponge-derived *Streptomyces* isolates, P01-B04^T and P01-F02, were characterized and screened for their ability to produce antimicrobial compounds.

To address this objective, phylogenetic analysis using 16S rRNA gene sequences and genome-based analyses, including average nucleotide identity and DNA-DNA hybridization comparisons, were used to confirm the novelty of the *Streptomyces* isolates and distinguish them from their closest relatives. Bioinformatic analyses using draft genome sequences of each isolate were also performed to further explore the biosynthetic potential of the novel isolates by mining genomes for biosynthetic gene clusters (BGCs) that can encode natural products like antibiotics. Draft genome sequences were uploaded to the pipeline antiSMASH[4] and manually compared to predict the number and types of BGCs present in each genome. Additionally, to characterize the antimicrobial potential of strains P01-B04T and P01-F02, each isolate was grown in various growth media and screened for activity against bacterial and fungal pathogens.

Phylogenetic analyses showed that the ANI and DDH values between the novel isolates and their closest *Streptomyces* relatives were below the species threshold values confirming that the two isolates represent novel species. Additionally, the two isolates showed nearly identical 16S rRNA gene sequences (99.93%), and ANI and DDH relatedness values were determined to be 99.96% and 99.6%, respectively. These data suggest that these isolates are affiliated with the same species, which is hereby named *Streptomyces poriferae*. The antimicrobial activity assays demonstrated that supernatants from the S. poriferae isolates inhibited the growth of Gram-positive pathogens including methicillin-resistant *Staphylococcus aureus* and plant pathogens (Table 1). The bioactivity of the isolates was dependent on the duration of incubation and the media used. Furthermore, genome analyses revealed that the isolates harbored on average 30 BGCs, many of which were predicted to be uniquely present in these *S. poriferae* strains.

These results suggest that strains P01-B04^T (the type of strain for this novel species) and P01-F02 produce many bioactive metabolites that may contribute to the chemical ecology of their host sponges, as well as have potential clinical efficacy against a multidrug-resistant human pathogen. These newly discovered antibiotics may have applications in human medicine, veterinary medicine, and agriculture. Ongoing work to determine the structure of these antibiotics will allow assessment of their clinical potential.

Table 1. Summary of antimicrobial activity of novel *Streptomyces poriferae* isolates, P01-B04^T and P01-F02, against bacterial and fungal strains. The fermentation media used for initial culture of isolates is shown and the degree of inhibition of tester strains. "+++" ≥ 10 mm zone of inhibition (ZOI); "++" 6-9 mm ZOI; "+" ≤ 5 mm ZOI.

Isolate:	Activity against:	Fermentation media:	Degree of inhibition
P01-F02	*Curtobacterium flaccumfaciens subsp. flaccumfaciens* CV3	YEME	++
	Clavibacter michiganensis 89C-4	YEME	++
P01-B04	*Staphylococcus aureus* Xen29	YEME	++
	Staphylococcus aureus MRSA30	YEME	++
	Curtobacterium flaccumfaciens subsp. flaccumfaciens CV3	YEME	++
	Micrococcus luteus ATCC 10240	YEME, GYE, MF, TSB, ISP-2	+++
	Clavibacter michiganensis 89C-4	YEME	++

Statement of Research Advisor

Dory Fawwal has made very significant contributions in our understanding of the potential of members of this novel species *Streptomyces poriferae* to produce bioactive metabolites. The production of antibiotics by these bacteria, which Dory has demonstrated under lab conditions, may indicate that these bioactive secondary metabolites are important for the chemical ecology of the marine sponges that host these *Streptomyces* bacteria. Dory has therefore earned authorship on a manuscript that has been submitted for publication in the journal, *Systematic and Applied Microbiology*, which is the best indicator of her important contributions to this research project.

-Mark Liles, Biological Sciences

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Extreme Variation in Economic Expenditures on Invasive Species Management Across the United States

Allison Foster, Christopher A. Lepczyk, Jean E. Fantle-Lepczyk, and Daniel Rubinoff

Invasive species are an increasingly pressing global issue as they can wreak havoc on ecosystems and economies. In the U.S., invasive species like zebra mussels (*Dreissena polymorpha*), wild pigs (*Sus scrofa*), and Chinese tallowtree (*Triadica sebifera*) cause millions of dollars of damage annually by outcompeting native species, causing structural damage, and disrupting natural ecosystem services (Pimental et al., 2005). The goal of this project was to synthesize natural resource agency expenditures on invasive species management. While massive resources are expended to manage invasive species, there are few comprehensive syntheses of the economic expenditures associated with this management effort. We accomplished our goal by contacting natural resource management officials from all 50 states following a standardized protocol with contact tracing. We confined our data collection to natural resource agencies because departments such as agriculture, transportation, and health can have different definitions of invasive species.

A total of 48 states expended resources towards managing invasive species. The total spent on invasive species management in the U.S. was $3,839,365,065, with a per capita (U.S. Census, 2020) expense of $12.24 across all 48 reporting states. Management expenditures ranged from $8,400 (Connecticut) to $57,488,910 (Hawaii) per year. A total of 23 states reported spending less than $1,000,000 per year on invasive species (Figure 1). While all 48 states spent money on terrestrial species ($441,557,590), only 33 states reported spending money on aquatic invasive species, with a total of $603,471,468 spent on invasive species across environments. For this study, we grouped management actions into categories of control, detection, prevention, and eradication. Of the identified management actions, the most money was spent on control of invasive species ($4,626,388).

Most concerning, we found a lack of coordination in invasive species management within and between states. Understanding the true costs of invasives is difficult, as some states reported spending millions of dollars, while others reported little to no spending, likely as a result of not keeping track of their costs. While these results are most certainly a conservative estimate of expenditures, they point to a lack of coordinated accounting and represent only a fraction of the finances needed to address the large economic costs imposed by invasive species.

Statement of Research Advisor

Invasive species pose a significant threat to society, and understanding the degree to which natural resource agencies are responding in terms of dollars spent is very important for determining how seriously we are addressing the problem. Allison's work is a first piece in understanding the economics of managing invasive species by government agencies in the U.S. and will provide an important piece of information for policymakers and agencies to use.

-Christopher Lepczyk, Forestry and Wildlife Sciences

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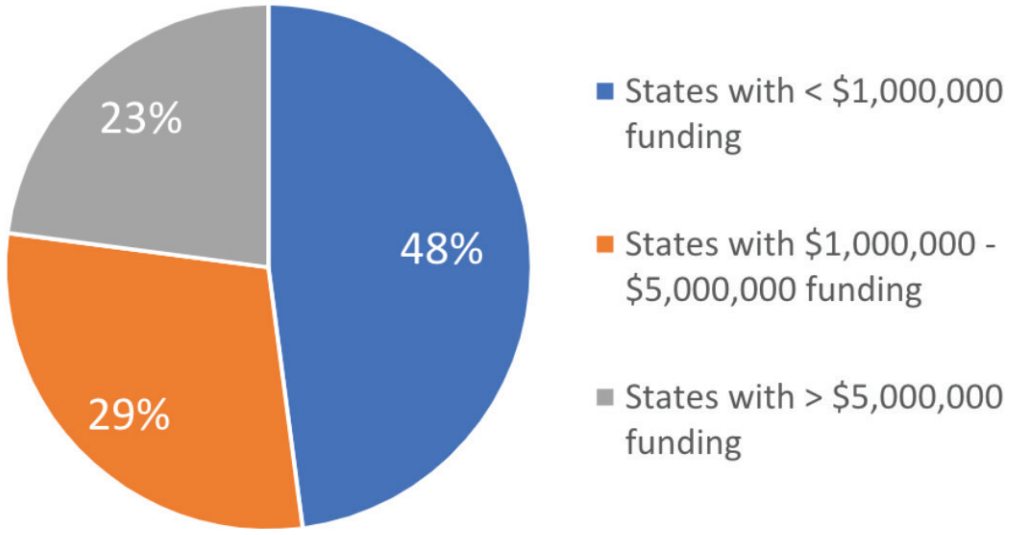

Figure 1: State expenditures on invasive species.

Strength at Impact Testing of Customized 3D Printed Guards

Grace Gray and Michael Zabala

The purpose of this study was to investigate the strength at impact of customized, 3D-printed guards for members of Auburn University's football team. The potential benefits of these guards are numerous, ranging from an increase in mobility due to the thin design (3 mm), to greater protection because of extreme customization that follows complex contours of the body.

The 3D printed guards were developed by first obtaining a 3D scan of the shoulder on a Body Opponent Bag (BOB)®. This scan was then used to create a virtual model of the negative of BOB's shoulder. The negative was 3D printed as a mold, which was filled with concrete to generate a replica of BOB's shoulder. Eight-millimeter-thick Shockshield® was overlaid on the concrete shoulder to replicate soft tissue. The shoulder scan was also used to generate a virtual model of multiple shoulder guards for testing. Three shoulder guards were modeled and printed: (1) a 3mm-thick guard with no offset and no padding, (2) a 3mm-thick guard with no offset and no padding and with the printer interrupted for 24 hours halfway through the print, and (3) a 3mm guard with a 3mm offset and 3mm-thick Ethylene-vinyl acetate (EVA) padding. All 3D printing was performed on a Raise 3D Pro2 printer using polylactic acid (PLA) as the material. A drop tower was also built to allow for a controlled helmet drop of approximately six feet, directly onto the guards. Each guard was placed on the concrete mold of the shoulder underneath the drop tower and was struck by a football helmet with added mass to total 9 kg. We hypothesized that for each guard design, the guard would not break after the first strike, but would break on or before the tenth strike. During each trial, a Vicon®motion capture system was used to record the velocity of the helmet through impact and two AMTI® force plates were used to record the impact force.

The results of this study provided valuable information on the strength of the 3D printed guards. Table 1 shows the force (N), momentum (kg-m/s), and the trial number in which the guard broke for each of the three guard designs. A fourth condition was added to testing after the third guard, a 3mm guard with 3mm-thick EVA padding, did not break during any of the ten impacts. For this fourth condition, the total helmet mass was increased to 10.8 kg. This increase in mass increased the momentum to 57.46 kg-m/s, higher than the estimated average NFL linebacker's head and helmet during a full-speed tackle [1].

The results of the initial three testing conditions demonstrated the durability of the guards. The additional fourth testing condition provided useful information on the strength limit of the guard. Notably, the helmet used for testing also broke on the same 17th strike. Overall, the testing conditions were determined to be more extreme than any hit experienced during a football game. This is because although momentum of the impact was matched, the guards were placed on a concrete shoulder that was set against an immovable surface, the ground. The high strength of the guards determined from this study indicates a good potential for use in sports.

Statement of Research Advisor

Grace contributed to this project by designing and building the test platform. She also conducted all of the impact testing, processed data, and aggregated the results.

–Michael Zabala, Mechanical Engineering

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Table 1: Impact Testing Results. *Indicates that this guard was impacted 10 times with a total helmet mass of 9 kg, then impacted seven more times with a helmet mass of 10.8 kg until a break occurred. On the 17th impact both the guard and the helmet broke.

	Force (N)	Momentum (kg m/s)	Break Impact Number
3mm (no padding)	**1656.72**	**46.63**	**NO BREAK**
3mm interrupted (no padding)	**2029.39**	**47.53**	**10**
3mm with 3mm EVA foam	**1749.23**	**47.53**	**NO BREAK**
3mm with 3mm EVA foam (additional testing with larger helmet mass)	**2036.65**	**57.46**	**17***

Appendix

Estimates

95th% male head: 5.377 kg (11.85 lb) head mass [1]

Assumed impact velocity of a tackle: 25.2 fps (7.7 m/s, 17.2 mph)

Momentum of head and helmet at impact: 5.377 kg*7.7 m/s = 41.4 kg m/s

Measuring Community Resilience

Molly Grubb and Alicia Powers

The Ebola crisis of 2014 propelled the public health world into the unknown. With 11,325 deaths (Alonge et al., 2019), the Ebola outbreak demonstrated immediate direct international aid was not the only necessity for a successful battle against a public health crisis (Centers for Disease Control and Prevention, 2019). Resilience also was critical as communities battled Ebola and faced recovery from its impact. Community resilience encompasses "notions of well-being, adaptability, and resourcefulness in the face of adverse conditions" (Nemeth, 2015). Resilience is directly tied to a community's ability to become independent post-crisis. The World Food Program describes community resilience in three aspects: availability, access, and utilization (*Resilience building*, n.d.).

International aid organizations play a critical role in supporting community resilience in areas faced with public health crises. For a community to excel in availability, access, and utilization, both the short-and long-term goal of international aid must be taken into consideration. Humanitarian relief organizations, like the World Food Program, are actively shifting focus to fostering resilience amidst humanitarian aid provision. In an interview with Anis Nasr, a World Food Program Operations Center team leader, he presented the World Food Program's Global Operation Response Plan for 2021. The second priority of this operation is to "Reinforce community-based resilience to promote recovery including through the safe return of children to school, smallholder farmer value chains and sustainable livelihoods." With these examples in mind, humanitarian organizations may improve their services and offer more resilient aid.

The objective of this research was to devise an evaluation framework to determine community resilience of an area that receives crisis support from international organizations. The evaluation framework findings may be used as a tool to guide aid organizations in their support to impacted communities. A literature review defined the primary pillars of community resilience, which are education, health, and economics. Within each pillar, valid and reliable measurement instruments necessary to operationalize characteristics of resilience, which are availability, accessibility, and utilization, were determined for each primary pillar of community resilience (*Resilience building*, n.d.). Within the health pillar, anthropometric measures, food intake, and access to healthcare are critical measures. Intake rates of primary education, net enrollment rate and attendance rate are suggested measures for the education pillar. Lastly, gross domestic product, employment rate, and labor force participation rate should be measured.

To ensure the evaluation framework is implemented in the most optimal way, each pillar of the assessment should be administered by specific authorities who have the most knowledge and connection to the specific pillar. Measurements should be completed prior to and following crisis support from international organizations.

Statement of Research Advisor

Molly conducted a comprehensive and critical review of literature to conceptually and operationally define community resilience amidst humanitarian aid. The resulting evaluation model, including proxy variables and specific instruments, will be utilized in a case study and pilot testing in conjunction with the World Food Programme. Following validation, the evaluation model will be implemented alongside communities to ensure communities benefit in the long-term after receiving short-term support from humanitarian aid providers. *-Alicia Powers, Nutrition, Dietetics, and Hospitality*

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Factors Associated with Preventive Cancer Screening Among Diabetic Patients as Compared to Their Non-Diabetic Counterparts

Hayleigh H. Hallam, Tiffany Cadwallader, Cassidi C. McDaniel, and Chia-hung Chou

The observed relationship between diabetes and cancer has drawn experts' interest because the two are often both diagnosed in an individual. While their specific relationship is rather complex, similar risk factors can likely explain their co-diagnosis. With age alone being a significant risk factor, the United States must prepare for challenges that its sizeable aging population will face.

Despite the risks associated with diabetes and cancer, existing literature lacks a systematic assessment of preventative measures exercised by patients with diabetes, specifically with their cancer screening practices for prevention.[1] Persons with diabetes have a higher risk for cancer and a poorer prognosis after diagnosis, so they must participate in proper preventative methods to improve their health outcomes. This study investigated cancer screening practices of patients with and without diabetes between 2012-2018 to understand their health behaviors. An unweighted population of 1,838,563 respondents was included in the original data set before our analysis.

We examined screening rates for four major cancer types, including colorectal (sigmoidoscopy), breast (mammogram), cervical (Pap/HPV test), and prostate (PSA test) cancers using data from the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is the nation's premier system of telephone surveys that collect state-level data about health risk behaviors, chronic health conditions, and the use of preventive services. We identified our study population using clinical guidelines established by the American Cancer Society (ACS) and only included respondents that fell into the standard biological sex and age recommendations for each screening. This included 1,330,658 males and females examined for colorectal cancer screening, 783,104 females for breast cancer screening, 782,713 females for cervical cancer screening using the Pap Test, 733,720 females for cervical cancer screening using the HPV test, and 548,119 males for prostate cancer screening.

At a national estimate, we found that persons with diabetes had a screening for each cancer at a higher rate than those without diabetes, except HPV test utilization used for cervical cancer prevention (Figure 1). While this population had higher cancer screening rates, these percentages do not always reach the national benchmarks for these practices. For example, in 2018, the cervical cancer screening rate using the HPV test was 37.48% for patients with diabetes and 46.43% for patients without diabetes compared to the national target of 80.5%.[2]

We also assessed if any regional disparities were present for each screening. After categorizing each respondent as living in the Northeast, South, West, or Midwest regions, we decided to narrow our focus to the states that can be defined as the "Deep South," including Alabama, Georgia, Louisiana, Mississippi, South Carolina, and Tennessee. Additionally, several factors that potentially influence the cancer screening behavior of these groups were identified, including race, sex, age, education, metropolitan status, employment, income, healthcare coverage, marital status, veteran status, general health, and ability to visit a physician's office alone.

We are currently in the process of analyzing each type of cancer screening using these parameters. These methods include running a logistic regression model to identify which factors have significantly impacted the screening practices of persons with diabetes. Our findings will serve as critical contributions to providers' knowledge about how to implement proper preventative behaviors for the most vulnerable populations of these patients. This information will allow for the ex-

ploration of appropriate initiatives to increase screening rates among these populations.

Statement of Research Advisor

Hayleigh's work aims to make greater strides in cancer prevention and early detection for individuals with an increased risk of cancer through a thorough examination of cancer screening practice among persons with diabetes. Her work also helps identify disparities in cancer screening observed in the Deep South of the U.S., and the findings will serve as foundational knowledge for policymakers and stakeholders to plan cancer screening and prevention strategies for the nation.
– *Chiahung Chou, Health Outcomes Research and Policy*

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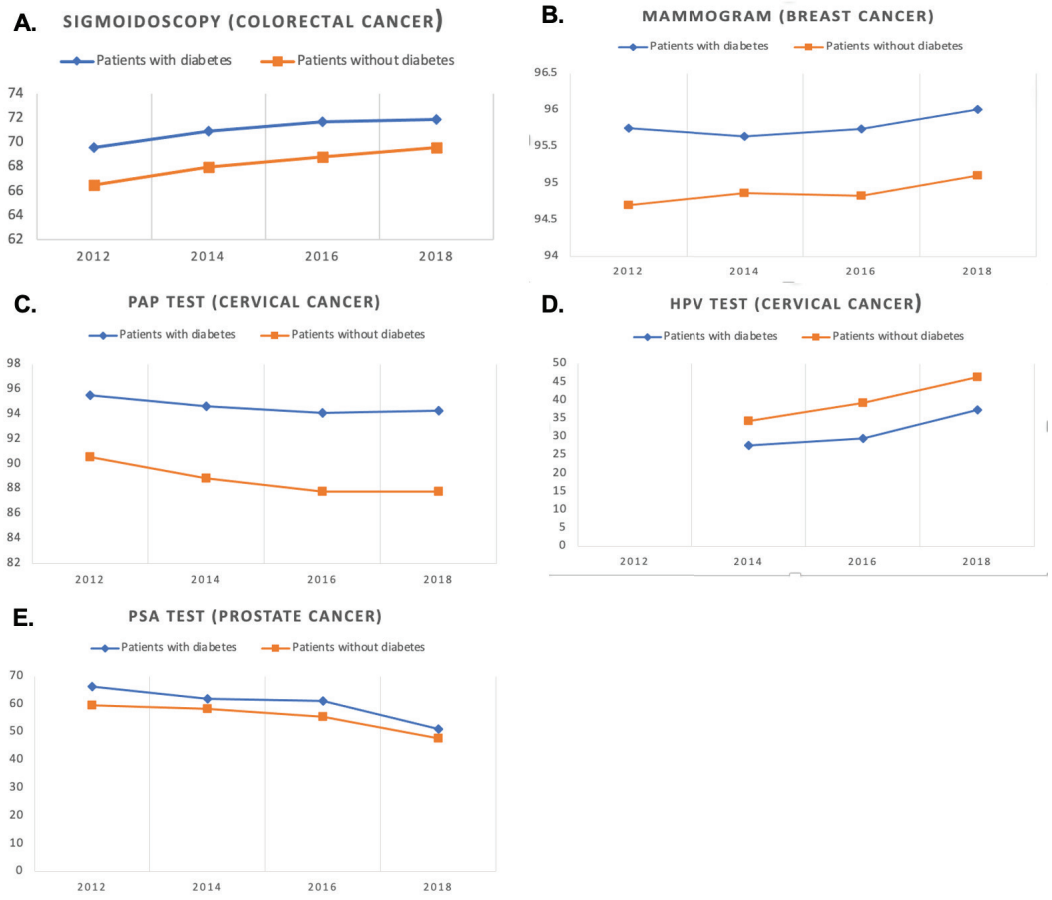

Figure 1. (A) Patients with diabetes are completing sigmoidoscopies at a higher rate than patients without diabetes. (B) Patients with diabetes are completing mammograms at a higher rate than patients without diabetes. (C) Patients with diabetes are completing Pap tests at a higher rate than patients without diabetes. (D) Patients with diabetes are completing HPV tests at a lower rate than patients without diabetes. (E) Patients with diabetes are completing PSA tests at a higher rate than patients without diabetes.

The Effects of a Yoga Intervention on Quality of Life, Anxiety, and Pulmonary Function in a Pediatric Population

Emily Claire Herring and Linda Gibson-Young

The purpose of this study was to explore the pulmonary function, quality of life, and anxiety levels in a rural youth pediatric population living with and without asthma. Yoga and mindfulness interventions were implemented with the population in response to an analysis of data collected. Movement and relaxation therapies, including yoga, are relatively easy and inexpensive to implement and may prove beneficial as preventative and complementary treatment in rural communities. This study aimed to optimize strength, flexibility, stress management, and confidence in the population using a yoga and mindfulness intervention.

The instruments for preliminary data collection included a demographic survey with a self-reported asthma diagnosis metric, the Youth Quality of Life-Short Form (YQOL) and the Generalized Anxiety Disorder 7-item scale (GAD-7). Pulmonary function testing was done with an EasyOne®Air Spirometer; however, it was difficult to obtain reliable readings because the environment was loud and some participants were too young to understand the breathing directions. Pediatric spirometry testing may be more successful when done in a private room with visual aids.

The target population included 16 participants, all both African American and female. The age range was 5 to 11 years (mean = 7.56, SD= 2.266), and the grade range was kindergarten through 6th grade (mean = 2nd grade, SD = 2.007). The percentage of study participants who self-reported a diagnosis of asthma was 47%, which is well above the national and Alabama state average (Figure 1). The GAD-7 is scored on a scale of 0 to 15; as shown in Figure 2, the mean score in our population was 9.2, and the standard deviation was 3.936. The distribution of scores on the GAD-7 placed half of participants in the moderate to severe anxiety categories, 38% and 12%, respectively (Figure 2). Mild anxiety scores were reported in 44% of participants, while 6% reported no anxiety (Figure 2). Though not significant, the mean GAD-7 score was 3.37 points and trended higher in participants with self-reported asthma ($F = 1.020$, $p = 0.331$) (Figure 3). The range of the YQOL was 120-150. The mean for YQOL score was 141.29 (range 120-150), and the standard deviation was 8.965 (Figure 4). Interestingly, though not statistically significant, youth living with asthma had higher overall YQOL-SF scores than youth without asthma (142.29 with asthma [n= 7], 140.29 without asthma [n = 7]). Overall, the YQOL-SF scores indicated a high quality of life across the population studied.

After baseline data were collected, the yoga intervention took place four times over a 6-week period and was taught by a Registered Yoga Teacher (RYT 200HR). Each 45-minute session included 10 minutes of breath work, 25 minutes of active postures, and 10 minutes of relaxation. Individual sessions focused on topics including strength, flexibility, stress, and confidence. The yoga intervention was completed in a dance studio, and because of COVID-19 precautions, participants remained on separated mats and wore masks. Masks presented a small barrier to assessment of breathing. Therefore, to overcome this challenge, tactile and visual strategies were incorporated. The addition of more game-like activities between breathing exercises is recommended for similar studies in the future, especially when the population includes children ages 7 and younger. In the United States, complementary treatments including relaxation and movement therapies have become increasingly popular, but there is still much to explore regarding the efficacy of therapies in rural populations.

Statement of Research Advisor

Emily Claire Herring was an exceptional undergraduate research fellow. She completed a thorough review of the literature and identified all proposal components for submission to the Institutional Review Board of Au-

burn University. While in the community setting, Ms. Herring was well prepared for data collection and intervention and bonded with the participants and family. As a team, we analyzed the data and prepared for dissemination. Ms. Herring won the college award for this poster presentation with the Auburn Research Student Symposium 2021.
-Linda Gibson-Young, Nursing

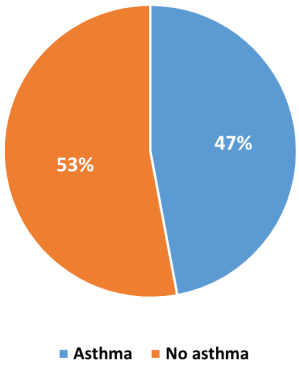

Figure 1. Participants who self-reported a diagnosis of asthma and participants who did not self-report an asthma diagnosis.

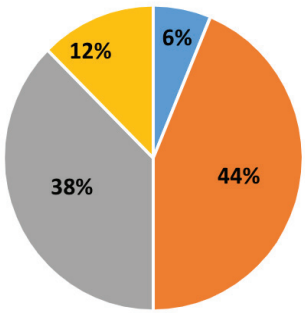

Figure 2. Percentage of participants with mild, moderate, and severe anxiety as classified by the GAD7 Survey.

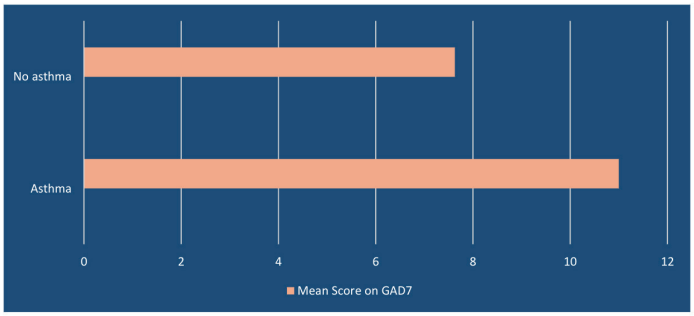

Figure 3. Comparison of participants self-reported asthma data with mean scores on the GAD7 survey. Participants who self-reported an asthma diagnosis reported scores on the GAD7 that correlate to more severe anxiety, although these data are not statistically significant.

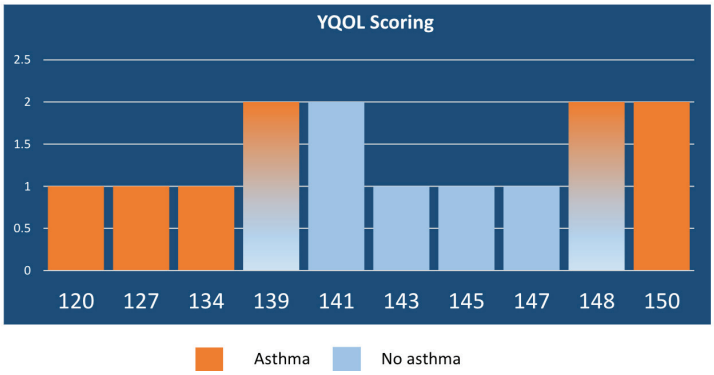

Figure 4. Participant scores on the Youth Quality of Life Survey and self-reported diagnosis of asthma.

In Vitro Tissue-Engineered-Based Model to Mimic Obese and Non-obese Colorectal Cancer Microenvironments

Grace E. Hester, Iman Hassani, Benjamin Anbiah, Bulbul Ahmed, Michael W. Greene, and Elizabeth A. Lipke

According to the CDC, 42% of adults in the United States are considered obese. Obesity is a growing public health concern, especially in Western and Western-influenced countries. Obesity-linked insulin resistance remains a risk factor for certain types of cancer including colorectal cancer (CRC). The precise molecular mechanisms involved in obesity-induced tumor growth remain unclear partly due to a lack of relevant experimental models. The purpose of this research was to develop an *in vitro* model for examining the link between obesity and CRC.

In this study, we have developed an *in vitro* three-dimensional (3D) engineered CRC (3D-eCRC) tissue model using HT-29 colon cancer cells co-cultured with insulin sensitive (IS) and insulin resistant (IR) adipocytes to recapitulate the native non-obese versus obese microenvironment. Mature adipocytes were obtained by differentiating 3T3-L1 fibroblasts over a period of 10 days. The mature adipocytes were either left untreated or treated with hypoxia (HYP) or/and TNF-α (TNF) for 24 hours to generate IS and IR models. These adipocytes were then co-cultured with engineered tissues to investigate the impact of non-obese and obese microenvironments on cancer cells. Phase contrast images of the tissues were taken on days 8 and 15 to monitor and quantify tissue growth. Images were analyzed using ImageJ [1] software to measure tissue area and protrusiveness. To investigate the increase in CRC cell number, 3D-eCRC tissues were dissociated, and the viable cells in each tissue were counted using a hemocytometer and trypan blue staining.

Results for this model demonstrated its ability to mimic non-obese and obese CRC microenvironments. Oil Red O staining showed that the adipocytes lost lipid content over 3 days when treated with HYP and TNF as compared to the control group, whereas untreated adipocytes did not. This loss of lipid content is indicative of an IR cell phenotype (Figure 1). Expression of the insulin sensitive gene markers, *adipoq* and *Slc2a4*, was significantly downregulated in adipocytes treated with HYP and TNF as compared to untreated adipocytes, which is indicative of IR conditions. Interestingly, the 3D-eCRC tissues cocultured with IR adipocytes demonstrated significantly higher tissue area, tissue protrusiveness, and viable cell numbers on Day 15 as compared to those cocultured with IS adipocytes, thereby mimicking the obese and non-obese CRC microenvironments (Figure 2).

In conclusion, we have developed an *in vitro* 3D-eCRC tissue model cocultured with IS or IR adipocytes and demonstrated the ability of our model to mimic non-obese and obese CRC microenvironments. We plan to use our *in vitro* model in the future to answer mechanistic questions on the link between obesity and CRC.

Statement of Research Advisor

Grace has been instrumental in driving our *in vitro* obesity model project forward. Grace has demonstrated a high capacity for problem solving and critical thinking in the lab environment. She asks thoughtful questions about her research and is consistently furthering her understanding of the work being done. Even with the changes to her project mandated by the COVID-pandemic, Grace persisted and adapted. Her contributions were critical to developing this novel *in vitro* obesity-linked CRC model.

-Elizabeth Lipke, Chemical Engineering, and Michael Greene, Nutrition, Dietetics, & Hospitality Management

Reference

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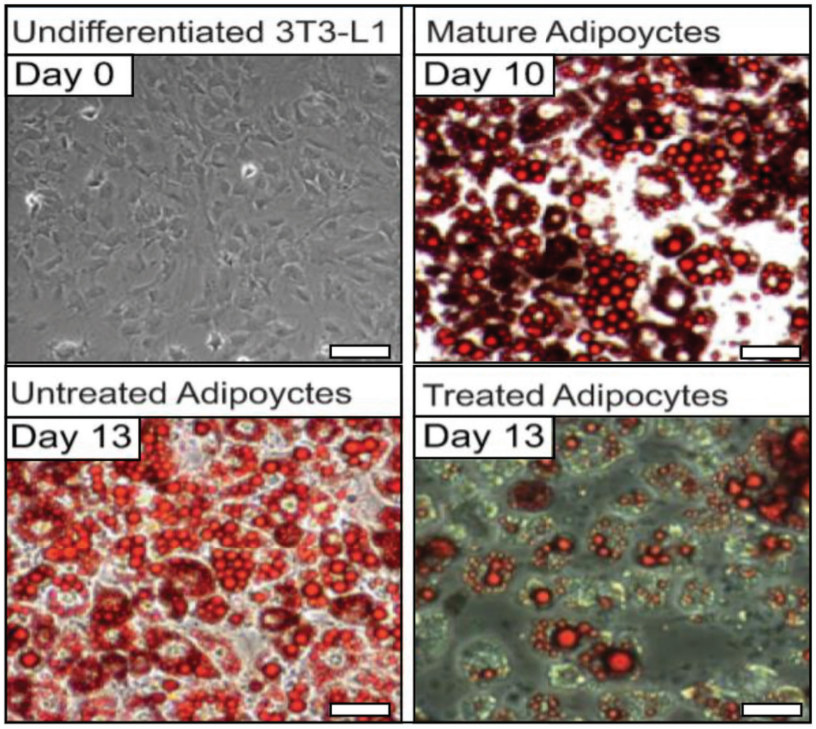

Figure 1: Insulin resistance induces a loss of lipid content in differentiated 3T3-L1 adipocytes. Undifferentiated 3T3-L1 fibroblasts (upper left panel) differentiate into mature adipocytes over a period of 10 days (upper right panel). The mature adipocytes were treated without (lower left panel) or with TNFα and hypoxia (lower right panel) and then stained with a red lipid dye and imaged (scale bar = 100μm) three days post-treatment. Lipid content was found to be lower in insulin resistant (treated) adipocytes than insulin sensitive (untreated) adipocytes, which indicates that the treatment induced insulin resistance.

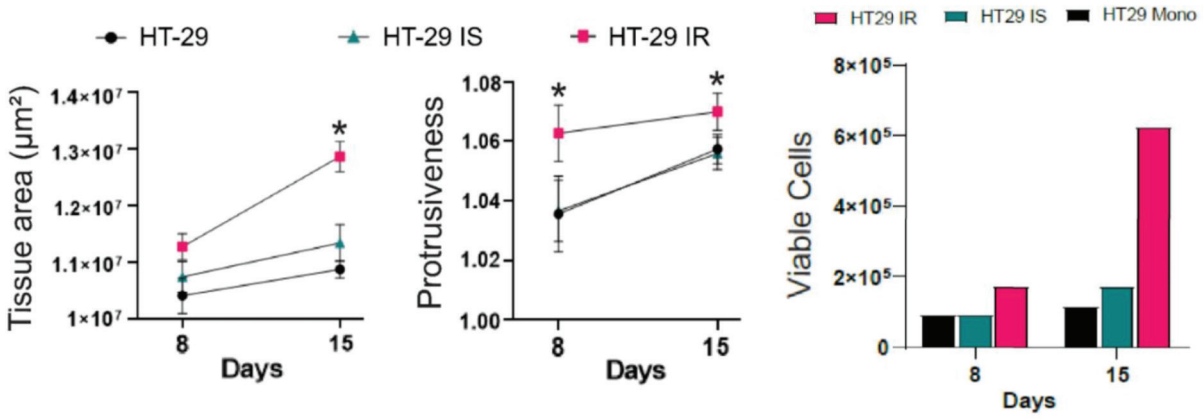

Figure 2: Insulin resistant adipocyte co-culture with 3D engineered colon cancer (HT-29) tissues stimulates colon cancer tissue growth. After 15 days of co-culture tissue area (left panel), tissue protrusiveness (middle panel), and viable cell numbers (right panel) were significantly higher for insulin resistant (IR) HT-29 as compared to insulin sensitive (IS) HT-29 tissues and HT-29 tissues cultured in the absence of adipocytes (Mono). *Indicates significant differences in theHT-29 IS group ($p < 0.05$).

Unwitting Patriots: The Cultural Influences Affecting America's First Missionaries

Nathan Holden and James Ryan

As a member of the first American foreign missionary cohort and the longest-tenured of the group, Adoniram Judson became the model for all missionaries sent from the United States. After nearly forty years in Burma (present-day Myanmar), Judson had translated the Bible into the Burmese language, started a relatively large local church, and become an American celebrity. However, not all missionaries of the nineteenth century were seen as celebrities; popular writers of the period as well as later historians heavily criticized the movement. By engaging with a wide range of primary texts and secondary works by both historians and literary scholars, this study investigates the underlying causes of the discrepancy between religious people's enthusiasm for missions and the secular world's condemnation of them. It concludes by linking the issues of the later missionary movement to what some might call a relatively minor and understandable flaw in Judson's character: cultural pride.

The supposedly apolitical missionary's support of the 1824 British invasion of Burma as "the best, if not the only means of eventually introducing the humanizing influences of the Christian religion" creates a striking conflict with his deeply held New England theology of the gospel's sufficiency to save anyone regardless of cultural position (qtd. in Trager, ix). As one of the first scholars to critique the Burmese Christian mission, Helen G. Trager claims that Judson's negative view of the Burmese was a result of reading British missionary reports on Burma. According to the British, Burma was heathen, corrupt, and essentially unsavable. By reading their writings, Judson developed a preformed conviction that the Burmese were more depraved than his fellow Americans, and as historian Jon Butler often notes in *Awash in a Sea of Faith*, this spiritual and cultural pride came easily to American Christians because of the widespread belief in American morality and goodness.

Just as Judson studied the British reports, so did the next wave of American missionaries study and follow Judson's writings. His writings unintentionally insinuated the superiority of American culture and implicitly gave license to Judson's followers to project American values onto other societies. This attitude of superiority quickly spiraled into missionaries seeming more like self-appointed American ambassadors than the divinely called messengers they claimed to be, a fact that became widely known only after the nation's literary authorities (such as Herman Melville and Sinclair Lewis) heavily criticized foreign missions.

Christian missionary enterprises will always be a contentious topic: Those holding the required theological beliefs praise such efforts as not only acceptable but necessary and urgent undertakings, while theological outsiders consider them quixotic at best, paternalistic and damaging at worst. By pairing the perspectives of both missionaries and of secular on lookers through historical and literary scholarship, this study helps create a less biased and more balanced understanding of missionaries' accomplishments and unintended consequences.

Statement of Research Advisor

Along with a full semester of research preparation in early American literature and Christian writing (1620-1900), Nathan also studied a range of contemporary scholarship focused on American religious history. His final written study, focused on Adoniram Judson (1788-1850), an important Christian missionary to Burma, develops an original perspective on the moral outlook and political tendencies of Christian foreign mission activities through examination of Judson's life, work, and continuing influence on the evangelical missionary project.

–James Ryan, English

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Numerically Optimizing Solar Cell Design

Nathan Holden and Junshan Lin

With solar energy becoming an increasingly popular and widespread power source, optimizing the design of solar cells to absorb as much as light as possible has surfaced as an important and vital area of interdisciplinary research. This study describes a three-phase numerical approach to designing optimized solar cells given any sequence of pre-existing materials.

In the first phase, we investigate light's behavior as it moves from layer to layer in any given structure. Using electromagnetic principles, we apply the transfer-matrix method to derive a system of equations that describe the wave and amplitude of light in any layer. These equations also provide reflectivity and transmission coefficients (r and t), which denote how much light is being reflected out or travelling through each layer, respectively.

After slight manipulation, the model of light in the second phase outputs only the reflectivity coefficient, and since the reflectivity and transmission coefficients have the convenient relation $r^2+t^2=1$, by minimizing the output r^2, we equivalently maximize the light travelling through the structure. Our minimization problem, then, can be expressed as:

$$\text{(A)} \begin{cases} \min r^2, \\ \text{subject to } w_i(x) \geq 0,\ i \in [1,n], \\ \text{and } 0 \leq t \leq L, \end{cases}$$

where w_i is the width of layer i for all layers 1 through n, t is the total width, and L is the maximum structure width.

In phase three, we solve the optimization problem (A) by adapting a Sequential Quadratic Programming (SQP) algorithm. To do this, we first create a quadratic approximation of our original function (by estimating the multi-variable light model as a function in the form $f(x)=\frac{1}{2}x^TGx+xc$) at an educated starting point. Then, we develop a quadratic program to minimize this localized approximate function. After a minimum is found, the SQP input is updated to have a new starting point with a new approximated quadratic function. This new function is next minimized, and the process is repeated until a universal minimum is reached. After altering the typical SQP algorithm to account for specific difficulties arising from the nature of our model, such as its non-universally positive-definite Hessian, we arrive at a program that efficiently minimizes the percentage of light reflected.

While the algorithm is scalable to any n number of layers, we provide an example in Figure 1 of the program's results on a three-layer structure. As shown, in just a few algorithmic iterations, the amount of reflected light decreases dramatically; by the tenth iteration, r^2 is reduced from an initial value of 0.199 to 0.002. Though the given maximum structure width in this example is 6 units, the width of the three layers after the tenth iteration is 4.71 units, which is important to note, as the algorithm does not simply reduce the total sum to zero nor cling to the maximum, but rather finds the truly optimal structure.

The key impact of this research is the application of an advanced, purely numerical optimization method to the design of solar cells that provides large increases in light absorption efficiency with minimal impact to the cell structure.

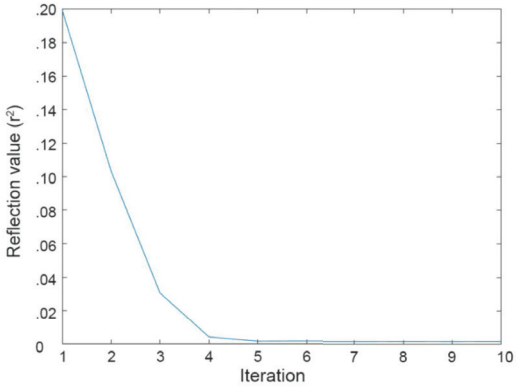

Figure 1: Results of sequential quadratic programming (SQP) optimization algorithm on reflected light. By the tenth iteration, the squared reflection value is reduced from .199 to .002.

Statement of Research Advisor

Nathan's research seeks to develop computational approaches to model and design the multi-layered solar cells. He applied the so-called transfer matrix method to solve the differential equation model for optical light propagation in the multi-layered media and developed the sequential programming method to solve the underlying optimization problem. His study for the specific optical structure demonstrates that the computational methods are useful in guiding the design of the solar cells for realistic applications. It also sheds light on how one can increase the light absorption for more complicated solar cell structures.

-Junshan Lin, Mathematics and Statistics

Validation of Reference Genes for Gene Expression Profiling in Bovine Tissues

Rachel A. Hollingsworth, Lauren V. Rutledge, and Paul W. Dyce

In the cow-calf segment of beef production within the animal agriculture industry, reproductive success and efficiency are vital to sustainable production of beef. Recent studies have indicated that mRNA transcripts are useful in determining the fertility status of heifers. The aim of this study was to identify reference genes that can be used as endogenously expressed controls in bovine tissues to research the potential of mRNA transcripts to identify heifers that exhibit good or poor reproductive performance.

Primer sets for *Tbp* and *B2m* were designed, and specificity and efficiency tested. *Tbp* and *B2m* were then compared to the *Gapdh* reference gene, which was previously identified, and specificity and efficiency tested. Expression levels of two previously designed and validated target genes, connexin-43 and pannexin-1, were compared following normalization using the reference genes. RNA was isolated from three sets of eight bovine tissues including ovary, heart, muscle, skin, pancreas, kidney, liver, and spleen. The isolated RNA was checked for quality and concentration and used to synthesize cDNA. The cDNA was used to perform quantitative real time PCR, and the results were analyzed using the delta-delta Ct comparison method to determine which reference genes followed the same trend across the tissues (Figure 1). The PCR products from the ovary tissue were run on a gel electrophoresis to confirm the product size and specificity of the generated product for each primer to insure the validity of our results.

Gapdh and *B2m* generally followed the same trend across the tissues, whereas *Tbp* had tissues with differing results. The average cycle threshold for the three reference genes was compared across tissues with *Tbp* being significantly higher than *Gapdh* and *B2m* in muscle ($P<0.05$). In the heart tissue, there is a significant difference between *Tbp* and *Gapdh* only ($P<0.05$). This result indicates that *Tbp* might not be as reliable as *Gapdh* and *B2m* as reference genes. *Tbp* demonstrated significant differences from *Gapdh* and *B2m* in the heart tissue, when comparing the ΔCt normalizations of Connexin-43 to the three reference genes ($P<0.05$). *Tbp* was also significantly different from *B2m* in the spleen tissue ($P<0.05$), but not significantly different from *Gapdh* ($P>0.05$). The general trend of the reference genes was similar across the tissues, when comparing the normalization of Pannexin-1 to the three reference genes. However, *Tbp* again showed a significant difference from *B2m* in the spleen tissue ($P<0.05$).

As predicted, the results indicated varying expression of the reference genes in the tissues tested, but the expression of the *Gapdh* and *B2m* reference genes followed the same general trend across the tissue types. However, there are significant discrepancies in the expression of *Tbp*, which raises the question of the validity of the use of *Tbp* as a reference gene in certain bovine tissues. *B2m* and *Gapdh* would potentially be suitable reference genes in the tested bovine tissues. The data generated for each potential reference gene in bovine tissues will allow for further study of the specific mRNA transcripts valuable in identifying heifers that will demonstrate either good or poor reproductive performance.

Statment of Research Advisor

Rachel's project goal was to develop markers able to increase the reliability of mRNA data in our lab. Her work resulted in tools that will benefit transcriptional data analysis in studies looking at developing heifer fertility markers.
-Paul W. Dyce, Animal Science

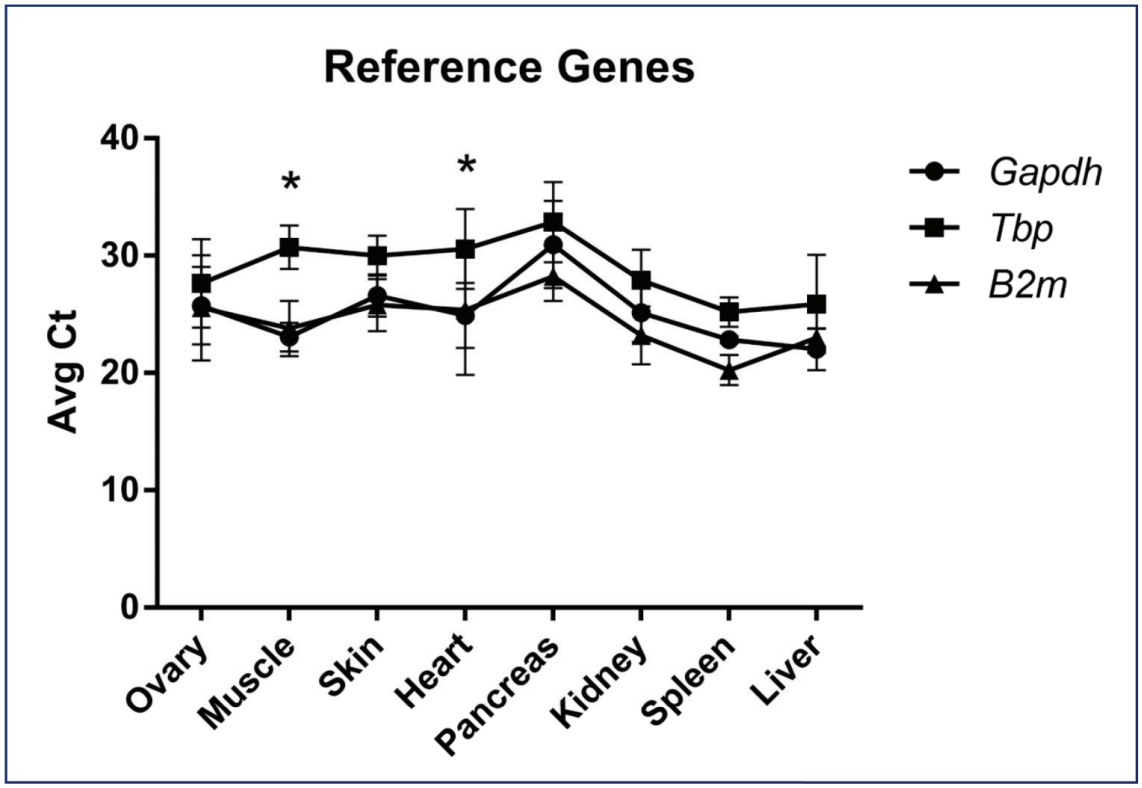

Figure 1. Reference Genes: The average Ct (cycle threshold) of the three reference genes across three trials was compared and graphed. *Gapdh* and *B2m* follow the same trend across the various tissues. This is fairly consistent with the trendline of *Tbp*; however,the muscle and heart tissues show statistically significant differences in expression. In muscle, the average Ct of *Tbp* is significantly different from both the *Gapdh* and *B2m* average Ct. However, in the heart tissue, the average Ct of *Tbp* is only significantly different from *Gapdh*. *$p<0.05$ statistically significant.

Chord Diagrams as a Visual Tool in Chemistry Education Research

Emily Kable and Jordan Harshman

Chemistry education presents challenges to students in large part due to content relationships across multiple semesters of instruction. For instructors to improve their assessment, they need a tool that allows them to visualize how their students are thinking. Time-and resource-intensive qualitative research is the gold standard for these types of analyses, leaving many instructors without the possibility of in-depth assessment of their large classes for short answer questions.

Historically, word clouds have provided a solution to this problem and are used to represent key connections between concepts. This graphical representation of qualitative data displays the frequency of concepts by the size of the words under the assumption that the larger words are ideas more commonly raised. However, word clouds lack context between question and student responses and are only useful for one-word responses. If words need to be grouped together, the responses need to be hyphenated, making it harder for the reader to comprehend.

A novel alternative to the word clouds are chord diagrams. Chord diagrams arrange data around a circular axis showing links across different related entities. These connections are shown through different colored arcs that connect pieces of the data together. The chord diagram improves the visual representation of the data by showing the context and relevance of the data through data point connections. Chord diagrams can also accommodate more than one-word responses on the radial graph.

To compare these graphical methods, we surveyed a sample of students taking Fundamentals Chemistry I. The survey involved 10 questions covering electrolytes and the quantum mechanical model of the atom, and required students to respond in short phrases. Each question was exported and presented as a word cloud and a chord diagram to determine overall effectiveness of each.

Once the survey responses were recorded, the data were cleaned and exported through Microsoft Excel® to R studio® to generate a chord diagram and word cloud. Data cleaning entailed spellchecking, removing general outliers, stemming of words that had the same contextual meaning, and removing words that provided no contextual importance to the chord diagram or word cloud. Once the data were cleaned, the chord diagram was generated using R, and the word cloud was generated using www.wordclouds.com.

Figure 1 shows the word cloud and Figure 2 shows the chord diagram generated from the question: "What is the difference between a strong and weak electrolyte?" From analyzing the word cloud, the largest terms seen are "complet," "strong," "water," and "dissoci." The word cloud provides no real context for how the students were answering the question. When looking at the chord diagram, the thickest arcs connecting between two points are "strong" to "completely" and "weak" to "partial." Much thinner arcs connect "strong" to "partial" and "weak" to "completely," providing context for an instructor to understand that majority of the students are responding to this question in a similar and accurate way of thinking.

Our results showed that chord diagrams drew easier-to-understand connections between the data collected from the survey to analyze student responses. Chord diagrams are a useful graphical tool to represent student thought processes in how they answer a question, while they also highlight common misconceptions. Word clouds lack the ability to show the connections between the data sets for a particular question and cannot highlight the frequency of correct versus wrong in one graph.

Statement of Research Advisor

Emily showed a passion for taking on a complex statistical programming language and was successfully able to understand the code well enough to manipulate basic characteristics of the code. Her contributions will hope

fully lead to innovation in the ways that instructors can receive immediate feedback for student submissions to open-response items.
–Jordan Harshman, Chemistry and Biochemistry

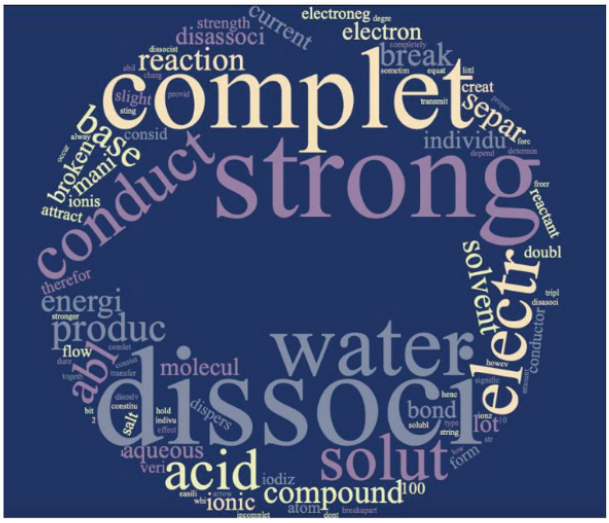

Figure 1. Question 1 Word Cloud. The larger the size of the terms, the higher the frequency of the terms used in responses.

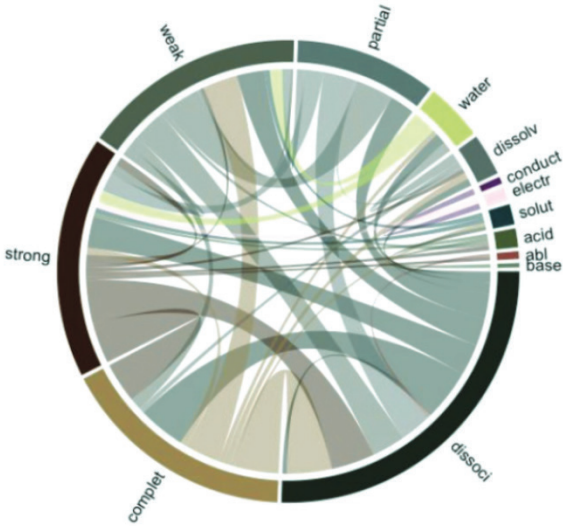

Figure 2. Question 1 Chord Diagram. The thicker the arc between two terms, the higher the frequency the students responded connecting those sequences of terms.

Association Between Long Head Bicep Tendon and Shoulder Range of Motion and Isometric Strength

Caroline Kirkham, Abby Brittain, and Gretchen Oliver

The windmill softball pitch is a dynamic upper extremity movement that requires the arm to accelerate in a 360° arch of motion prior to ball release for the overall goal of producing ball speed, movement, and accuracy. Great stress is placed on the anterior shoulder, similar to those stresses occurring in baseball pitching.[1-3] Thus, the mechanics of the windmill softball pitch predispose softball pitchers to great stresses on the long-head biceps tendon (LHBT) and long-term range of motion (ROM) compensation could result in additional stress to the LHBT. Due to the repetitive nature of the windmill softball pitch and the high force loads at the LHBT, anterior shoulder pain and injury are of primary concern in youth softball pitchers. Additionally, it has been reported that those pitching with upper extremity pain have altered pitching mechanics compared to those pitching without pain.[3] Understanding the association of upper extremity ROM and LHBT physiological responses after a bout of pitching could prove beneficial to comprehending injury pathology in youth softball pitchers. The purpose of this study was to identify functional measures, rotational ROM and isometric strength (ISO), of the upper extremity that are associated with changes in LHBT physiological changes following a simulated game.

Eleven youth softball pitchers (12.5± 2.3 years; 162.7 ± 9.7 cm; 57.6 ± 17.9 kg) volunteered to participate. Inclusion criterion required the participants to be actively competing on a team roster as a pitcher. The Institutional Review Board of Auburn University approved all testing protocols and parental and participant informed written consent and assent was obtained. Dominate shoulder ROM, ISO and LHBT ultrasound measurements (transverse width, transverse depth, and longitudinal depth) were taken prior to and following the participant pitching a simulated game. Shoulder ROM and ISO were assessed utilizing previously established methods.[4-8] The average differences of each LHBT measurements from pre to post pitching were used for analysis. The examiner performed bilateral shoulder ROM and ISO with the participant supine, shoulder abducted to 90° in the frontal plane and elbow flexed to 90°. A digital inclinometer was placed on the forearm and the examiner measured shoulder internal and external rotation ROM. For ISO, a handheld dynamometer was placed on the forearm. Participants were instructed to push against the examiner in the direction of internal rotation and external rotation. The average differences of each LHBT measurements from pre to post pitching were used for analysis. Ultrasound measurements were obtained using a 4-12 MHz linear array transducer in B-mode using previously established methods.[9,10] Three ultrasound images per measurement (transverse width, transverse depth, and longitudinal depth) were averaged and the difference of each measure from pre to post pitching was utilized for analysis. Pearson product correlations were run between pre-simulated game domination shoulder ROM and ISO and the average difference of each LHBT measure.

No significant correlations between internal and external ROM and ISO were found with the changed LHBT measures ($p > 0.05$). Means and standard deviations of all LHBT measures may be found in Table 1. The lack of significant relationships in shoulder ROM and ISO and acute changes in the LHBT may be partially explained by participant's total pitch count, age, and experience level. Further investigation into changes of the LHBT, ROM, and ISO pre and post pitching a simulated game is warranted. Softball pitchers are continually reporting high prevalence of pain in the throwing arm. With previous work reporting changes in LHBT pre to post simulated game, there is reason to believe intrinsic factors such as ROM and ISO may be related to increased pain and changes in the LHBT. While the current study included youth pitchers, research on older and more experienced athletes, specifically collegiate and profes-

sional softball pitchers should be considered as it may present contrasting results.

Table 1: Means and Standard Deviations of LHBT measures pre and post pitching a simulated game.

	Pre Simulated Game	Post Simulated Game
Transverse Width	5.81 ± 0.47 mm	6.24 ± 0.38 mm
Transverse Depth	3.30 ± 1.10 mm	3.70 ± 0.35 mm
Logitudinal Depth	4.52 ± 0.42 mm	4.79 ± 0.65 mm

Statement of Research Advisor

Caroline's work highlights the importance of shoulder ROM and strength in softball pitching and injury prevalence. Though we had a lack of significant association between shoulder ROM and strength biceps tendon responses following a pitching outing, these findings highlight the need for further investigation into the repetitive nature of windmill softball pitching and the residual effects occuring at the biceps tendon.
-Gretchen D. Oliver, School of Kinesiology

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Development of Cascaded Control and Path-Planning Algorithms for Autonomous Aerial Vehicles

Yevhenii Kovryzhenko and Ehsan Taheri

With rapid developments and an increase in demand for unmanned aerial vehicles (UAVs), control and guidance techniques have become critical for the safe and efficient operation of UAVs. In this work, we (1) develop a six-degree-of-freedom (6DoF) control system algorithm in SIMULINK™ and MATLAB™ environments, (2) implement a path-planning algorithm for near-optimal trajectory generation purposes, and (3) experimentally validate the suitability of the proposed methods using our in-house custom-built quadrotor UAV. We consider a quadrotor UAV that is required to fly from a known initial position through a specified set of waypoints to a target destination using a pre-generated path. The path-planning algorithm generates smooth reference trajectories that follow through a corridor between the waypoints. These reference trajectories are feasible for the required level of inertial acceleration, position, and velocity vectors making them realizable by the quadrotor. An optimal flight trajectory generation method based on minimizing the fourth derivative of position squared over a fixed time interval (i.e., the minimum-snap trajectories) was tested against flight trajectories generated using a Finite Fourier Series (FFS) shape-based method. The FFS method is based on approximating time histories of coordinates using truncated Fourier series. The coefficient of the resulting Fourier series is optimized using a non-linear programming problem solver to generate minimum-acceleration trajectories. MATLAB™ built-in non-linear programming problems solver, *fmincon*, is used for finding the coefficients of the Fourier series. Both methods aim to minimize the control effort (RPM of the four propellers) and to increase the operational range of the vehicle. Early results show performance evaluation of the control system following square- and circular-type reference trajectories within the simulation using both methods. Minimum-snap trajectories were also flight tested and validated experimentally (Figures1-4).

As part of this research, a 6DoF dynamical model of the quadrotor had to be developed to capture a more accurate representation of the complex dynamics and motion. A cascaded 6DoF feedback control system was implemented with direct control of quadrotor position and attitude. Using step response and simple trajectories, all feedback control layers were tuned to achieve an acceptable time-domain performance. Necessary software tools and lab infrastructure were developed for experimental testing on in-house quadrotors (Figure 5), including the radio telemetry link implemented in both C and MATLAB™ and remote feedback control-gain-tuning technique. A manually tuned direct position and attitude feedback control structure was used for all the proceeding studies, but preliminary steps for an automated gain-tuning routine were completed and additional research and development may lead to better results for both control structures when completed.

A general approach to flight-path planning has been developed by incorporating the user-specified waypoints or "locations of interest" and flight corridor constraints to ensure the vehicle stays within the required bounds. Since the flight path was computed outside of the simulation without the knowledge of the actual dynamics of the system, the resulting path was assumed to be feasible for the quadrotor to follow. The simulation results have proved minimum-snap optimized trajectories to be both feasible and efficient given appropriate corridor constraints on acceleration, velocity, and position. Since the FFS method is affected by the number of Fourier terms, our preliminary results indicate that the minimum-snap method offers a simpler approach from the user standpoint and requires less computational power. However, the range of change of the RPM values is smaller in the FFS method (Figures 6 and 7), which should lead to lower power consumption in practice.

Statement of Research Advisor

Jack has contributed substantially to the development of a multi-rotor flight firmware (called rc_pilot) to implement and investigate different control and path-planning algorithms on different small unmanned aerial vehicles. The theoretical and experiment results of his research constitute the content of his extended abstract that has been submitted to *SciTech 2022- AIAA Science and Technology Forum and Exposition*.
-Ehsan Taheri, Aerospace Engineering

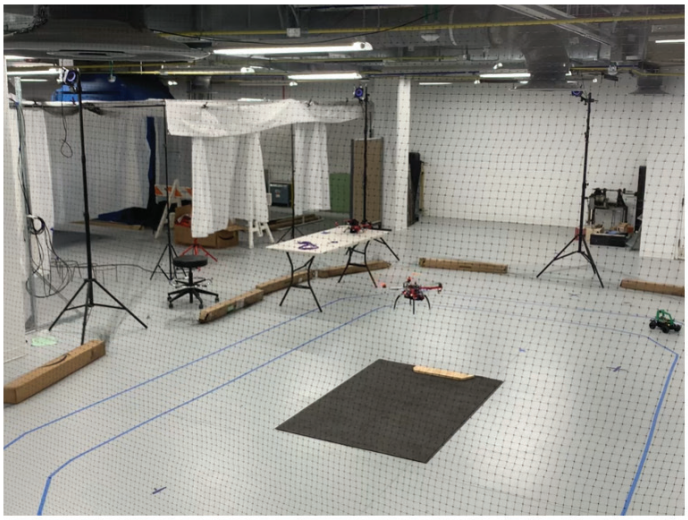

Figure 1. Snapshot of our demo flight of a circular trajectory. Picture taken while the drone is ascending, before starting the circular trajectory itself.

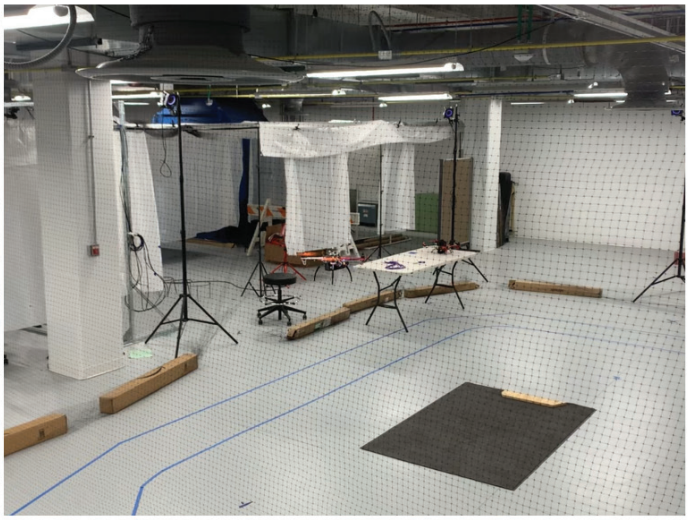

Figure 2. Snapshot of our demo flight of a circular trajectory. Picture taken at approximately ¼ of a revolution.

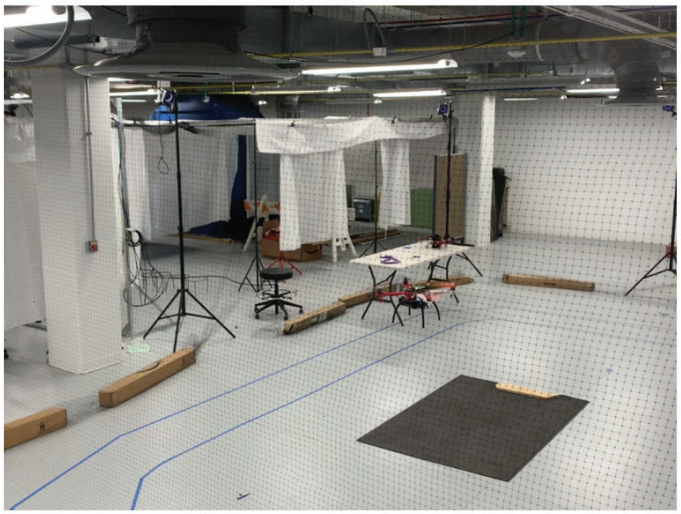

Figure 3. Snapshot of our demo flight of a circular trajectory. Picture taken at approximately ½ of a revolution.

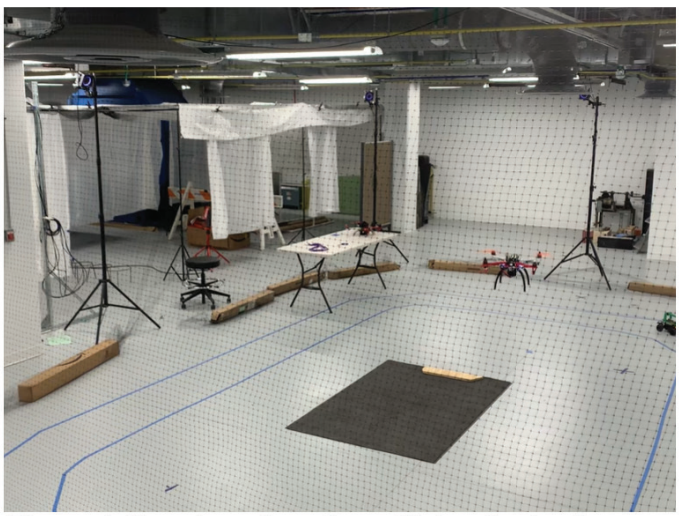

Figure 4. Snapshot of our demo flight of a circular trajectory. Picture taken at approximately ¾ of a revolution before landing.

Figure 5. In-house assembled, soldered, and flight-tested quadrotor UAV with custom designed 3D printed parts and our own *rc_pilot* firmware.

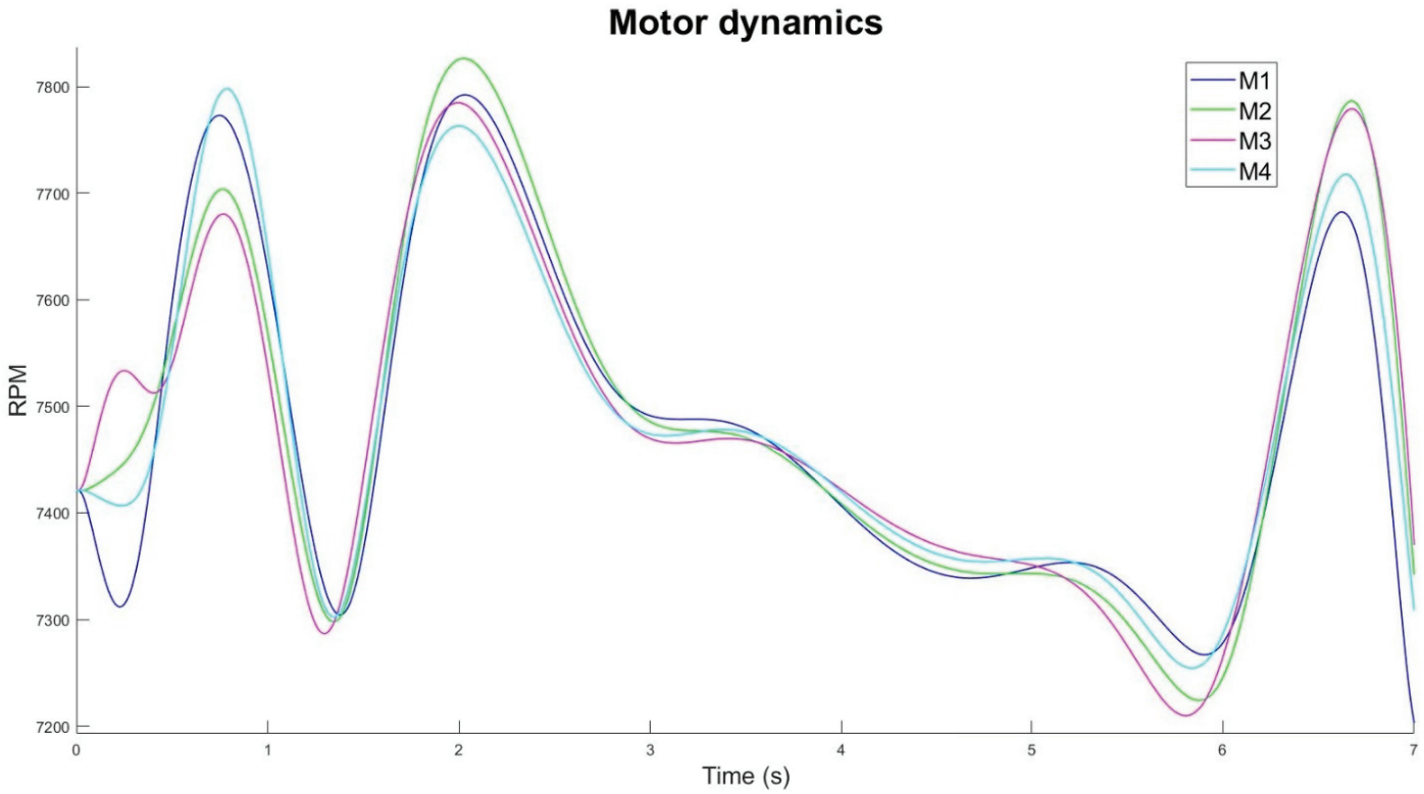

Figure 6. A resultant motor speed of a simulated flight over a simple two waypoint trajectory generated using minimum-snap method is shown. Note the RPM range is between approximately 7250RMP and 7800RMP as well as three district oscillations are present (indicate sharp change in motor speed and result in higher power consumption).

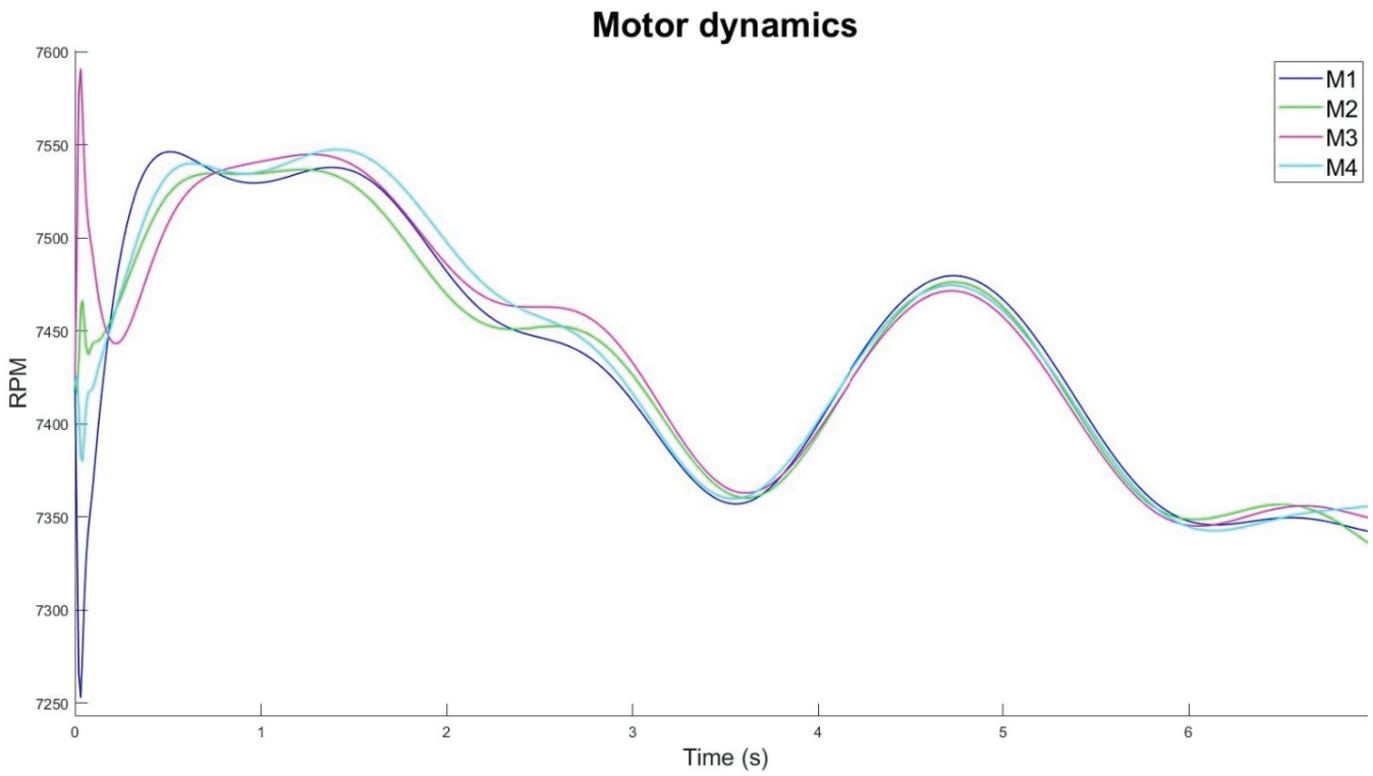

Figure 7. A resultant motor speed of a simulated flight over the same two waypoints as on Fig. 6 now generated using FFS method is shown. Note the RPM range is smaller, between approximately 7250RMP and 7600RMP (if counting in the initial anomaly) as well as only two district oscillations with far smoother (more constant) change in motor speed in between.

The Impact of Document Design on Alcohol-Harm Awareness

Katie Martin

This project examines how the consequences of alcohol consumption could be more effectively communicated to college students in written media. It analyzes documents about alcohol use and abuse and explores how document design impacts the reader's perception of the message.

Every year, an estimated 1,800 college students die because of an alcohol-related accident or injury. [1]Alcohol is involved in almost 97,000 college sexual assaults and nearly 700,000 college verbal or physical assaults[2], yet nearly 80% of college students drink alcohol, and half of those individuals also participate in binge drinking.[3] These facts indicate that a disconnect exists between the statistics on alcohol harm and students' attitudes toward intoxication.

To study possible solutions for this disconnect, I analyzed current health and wellness campaigns, created two proposed campaigns (consisting of websites, flyers, t-shirts, and stickers) on the topic of alcohol use and abuse, and hypothesized that students would prefer a more lighthearted campaign since it brought unexpected levity to a serious topic. To test this hypothesis, I recruited current Auburn students to give feedback on the designs in an IRB-approved study (Protocol #18-291 EX 1810). Although I visited four different classes at Auburn University to recruit participants, I had a low turnout (four participants). I gathered qualitative data from the participants by observing them interact with a display of the documents, conducting individual interviews, and collecting written responses via an online survey.

Campaign 1 had bright yellows and greens, a cartoon character, and decorative fonts, aimed to evoke feelings of humor and interest within the reader, and Campaign 2 had calm blues and whites, images of water, and sans-serif fonts, which aimed to evoke images of tranquility and professionalism. Three out of four participants stated that they preferred to engage with Campaign 2. One student noted that they were initially attracted to Campaign 1 because of the bright colors, but said that its content was "childish," whereas Campaign 2 was professional. Another participant stated that Campaign 1 "didn't look childish, but it looked like it was aimed for a younger audience." The participants based their comments on font, color, and tone, noting that the blues in Campaign 2 made it seem "calm" and "professional."

In addition to these data, the participants provided feedback on specific elements of each campaign (such as content, genre, use of images) and whether those elements contributed positively or negatively to their impression of the documents. However, further research with increased participants will be needed to detect conclusive trends. These initial findings suggest that college students prefer documents that maintain a professional voice, but more research is needed to validate this conclusion. The data did reveal that document design plays an important role in receptiveness to content, and further research might focus on how participants' genders, backgrounds, and viewpoints on alcohol also affect their interactions with the documents' designs.

Statement of Research Advisor

Ms. Martin has conducted extensive primary research, including observations, interviews, surveys, and artifact analyses. She took the initiative to pursue Institutional Research Board (IRB) approval because she sought feedback from human subjects through a focus group. Her methods and her findings make an important contribution to the field of rhetoric and composition in the areas of document design, visual rhetoric, and usability studies.

–Diana Eidson, English

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Bio-Based Coagulation and Flocculation Systems to Treat Contaminants in Concrete Washwater

Philip S. McMichael, Maria Celeste Iglesias, Jacob Johnston, Paul Holley, Maria S. Peresin

Worldwide, concrete is the most commonly used construction material. The United States Environmental Protection Agency prohibits the discharge of wastewater from washout of concrete, unless managed by an appropriate control.[1] Concrete washwater contains high levels of alkalinity, due to the dissolution of the limestone used in cement production.[2] Concrete washwater contains high levels of chlorides and heavy metals, derived from its cement, slag, and stone components, as well as its additives, which can include plasticizers, chloride accelerators, water reducers, and air entrainers. The Alabama Department of Environmental Management lists specific standards for discharge of effluents and includes specific regulations on pH (between 6.0-8.5) and Total Suspended Solids (TSS) (no greater than 50 mg/L).[3] Materials like bentonite and polymeric flocculants like polyaluminum chloride (PAC) and polyacrylamide (PAM) are used to flocculate undesirable particulates from the washwater mix, allowing for easier separation and disposal. While effective, these materials are derived from inherently unsustainable mining operations and energy-intensive refining methods.[4]

In a continuation of previous research on the composition of concrete washwater,[2] an analysis was performed on the potential for citrus-derived pectin to serve as a flocculant for concrete washwater. Pectin is a complex polysaccharide that can be found in the cell walls of plants, and commercially, is often derived from citrus plants like oranges. Citric acid is a weak acid that is naturally occurring in citrus fruits, especially lemons and limes, as well as oranges and grapefruits. A crucial aspect of this research was mimicking the construction job-site environment on a laboratory scale. A custom-built, scaled-down concrete hopper was used, along with an electric concrete mixer, and a pressurized water sprayer to wash down the hopper. Washwater was extracted using a vacuum pump and washwater characterization was carried out within 7 days of concrete batching. Measurements of pH, TSS and total dissolved solids (TDS) were conducted on samples. The flocculation ability of dry citrus pectin was compared with bentonite in powder form, and citric acid was utilized to neutralize solutions.

A variety of arrangements of citric acid and flocculant (bentonite or citrus pectin) additions were tested, in varying orders. It was found that both bentonite (BTo) and citrus pectin (CPo) did have a flocculating effect of the concrete washwater, though not to a sufficient extent to reduce TSS below the regulated maximum of 50 mg/L (Figure 1). Additionally, citric acid (CA+BT-seq) appeared to prevent settling of the concrete washwater suspension, countering the flocculant effectiveness and inhibiting the natural settling of the solution. Neither bentonite nor citrus pectin was found to have any significant effects on washwater pH. It was found that by utilizing a two-step additive process of flocculant addition, then sample extraction followed by citric acid addition (BT-sep-CA and CP-sep-CA), washwater could be both effectively flocculated and neutralized to TSS and pH values within the regulated standard ranges (Figure 1). A better understanding of the interactions between pectin, the many components of concrete washwater, and the washwater alkalinity may allow for a more finely tunable procedure for concrete washwater remediation.

Statement of Research Advisor

During this project, Philip has investigated colloidal stability and bio-based flocculation strategies for concrete washwater in lab settings. This work really advances our understanding of the system so we can move forward with field trials that has great potential for alleviate environmental concerns related to the construction industry.

-Maria Soledad Peresin, Forestry and Wildlife Sciences

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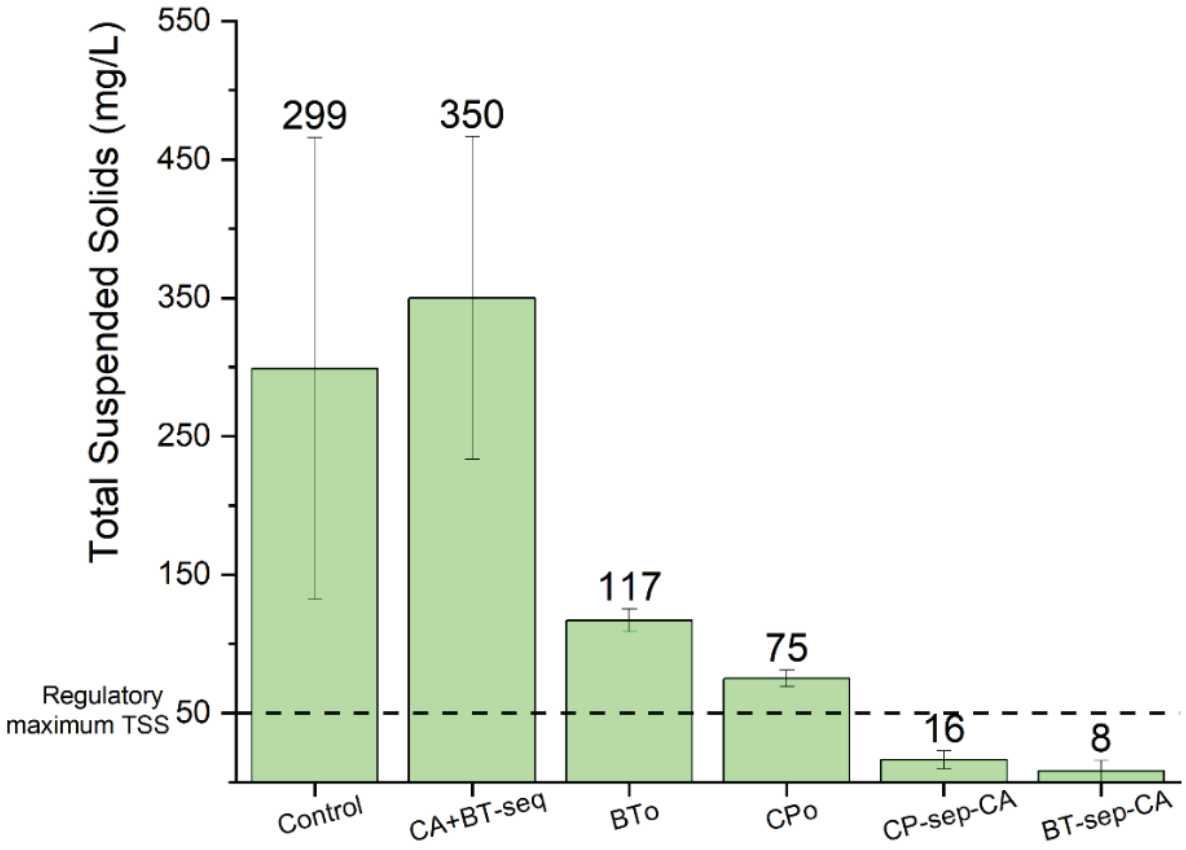

Figure 1: Total Suspended Solids of selected samples – (CP: citrus pectin, BT: bentonite, CA: citric acid).

In Vitro 3D Colorectal Cancer Model Using PEG-Fibrinogen Hydrogels

Andrew Moore, Iman Hassani, and Elizabeth Lipke

In areas such as drug study, results show that a 2D environment for cancer cells does not supply an accurate representation of a cancer tumor. In order to provide an appropriate system for drug studies, a 3D model must be fabricated to mimic a true cancer tumor. In this project, 3D colorectal cancer tissues using three different cancer cell lines (HCT 116, HT 29, and SW480) were created and tested over the course of 29 days to determine if this fabrication method was a successful model.

Cancer tissues, or hydrogels, were created using an encapsulation process, where cancer cells were mixed with a photo crosslinking mixture composed of poly (ethylene glycol) fibrinogen (PEG-fibrinogen), n-vinylpyrrolidone (NVP), triethanolamine (TEOA), and EoSinY. Ten microliters of this mixture were pipetted into a polymer mold. The mixture was then photo crosslinked for two minutes using a fluorescent light source. The light emitted interacts with the photo initiator, in this case EoSinY, to produce free radicals that initiate the polymerization of the hydrogels.The hydrogels were kept in media that was changed every other day to let the tissues grow and proliferate. Various batches of hydrogels for each of the three cell lines were encapsulated in order to perform separate experiments throughout the project.

Multiple tests and experiments on the hydrogels were performed on days 1, 8, 15, 22, and 29, with day 0 being the day of encapsulation, to determine the viability and success of the tissues in mimicking known characteristics of native cancer tumors. Phase contrast images were taken using 2X, 4X, 10X, and 20X magnification to monitor growth and morphological changes. To see the number of live cells, dead cells, and nuclei, a series of images were taken from top to bottom of the hydrogel after a live/dead stain was performed. Mechanical stiffness testing was done using a microsquisher device to track the differences in stiffness over 29 days.

Immunostaining using several primary antibodies (Ki67, CD44, N-cad, E-cad, alpha SMA, Ck20, SNA1, Vimentin, twist) was used to visualize certain aspects such as proliferation, migration, and cell-cell adhesion. Flow cytometry was carried out to see the percentages of various cell populations within the hydrogels. Tissues were fixed for later testing with scanning electron microscopy and histology to gather morphological, compositional, and anatomical information; tissues were also flash frozen using optimal cutting temperature molds while others were frozen for gene expression testing.

So far, results for colony growth within the hydrogels show an increase in area over time, indicating the viability of the model. Phase contrast images also show a dense outer rim forming as time progresses, attesting to the proliferation and migration of the cells from the hydrogels. Data analysis for colony area, live/dead, mechanical stiffness, and flow cytometry is still ongoing. Results from these experiments will be compared with cancer tumors from literature to fully determine the success of this 3D model for the three cell lines.

The importance of this research project is its potential-impact on cancer research in areas such as drug studies. An *in vitro* 3D model can provide more accurate results for these studies if it can successfully mimic native tumors. This project has helped create a base model for HCT 116, HT 29, and SW480 cells that hopefully closely imitate cancer tumors.

A Systematic Review of the Relationship Between Physical Activity and Sleep in Children With and Without Developmental Disabilities

Alice Northcutt, Danielle Carabello, Emily Munn, and Melissa Pangelinan

Physical activity (PA) and sleep are critically important for physical and mental health. However, only 40% of middle schoolers and 30% of high schoolers achieve recommended nightly sleep hours.[1] Moreover, only 26.1% of adolescents meet recommended PA Guidelines.[1] The problem of achieving recommended PA and sleep is exacerbated for youth with developmental disabilities, creating even greater physical and mental health disparities.[2] However, a systematic investigation of the achievement of PA and sleep recommendations in youth with and without developmental disabilities has not been conducted. Further, the relationship between PA and sleep has not been systematically examined. Thus, the present study aimed to systematically and critically review the literature related to PA and sleep in youth with and without disabilities.

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PubMed (MEDLINE), Academic Search Premier, APA PsycArticles, and SPORTDiscus were queried using the following search strategy: (child* OR youth OR teen*) AND (physical activit*) AND (sleep*). Studies were excluded based on the following criteria: if articles did not record sleep or physical activity, they were the incorrect population, they were not in English, or they examined cancer/ asthma/ or sleep apnea. The search was limited to articles published between October 2019 and August 2020.

A total of 349 abstracts were obtained and after removing all duplicates, the titles and abstracts of 197 articles were reviewed. A total of 91 articles were excluded based on the title/abstract review; 106 articles underwent full text review. A total of 24 articles did not meet inclusion following full text review. A total of 82 studies were included in the subsequent data extraction and analysis.

Various assessment tools were used to quantify PA and sleep, including accelerometers, parent or self-report data, surveys, and semi-structured interviews with parents. Because of the variability in measuring PA and sleep, we were unable to conduct a meta-analysis. Thirty-three percent of the studies included data from the United States or Canada. Of the 82 articles, only nine included youth with developmental disabilities. Most of the studies included a large age span, with only a few including the early childhood and middle childhood age range.

With respect to the primary aims, less than half of the studies reported that at least 50% of their sample met PA or sleep recommendations. Meeting PA recommendations was less likely in studies with individuals with disabilities, those with a large age range, and those with typically developing older children and teenagers. Meeting sleep recommendations was less likely for studies of youth with disabilities and those with typically developing infants, older children, and teenagers. It was not possible with the present studies to directly evaluate the relationship between PA and sleep.

Additional studies are needed to objectively measure the relationship between PA and sleep. More studies with objective measures are also needed in youth with developmental disabilities as well as young children. However, the lack of studies of youth with disabilities and young children may be due to compliance issues with objective measures (e.g., wearing accelerometers).

Statement of Research Advisor

Alice (Ali) Northcutt is an undergraduate research fellow (2020-2021) in the Pediatric Movement and Physical Activity Lab. Ali was involved in stages of this substantial undertaking. Ali developed the ability to critically evaluate research literature, extract relevant

data, create summaries of study findings, and interpret study results. She presented her results at the Student Research Symposium at Auburn University as well as the annual meeting of the North American Society for Psychology of Sport and Physical Activity.
-Melissa Pangelinan, School of Kinesiology

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Correlation of *Mt*SK Inhibitory Activity with Chemical Constituents in *Alpinia galanga* Identified by LC-MS

Madison Patrick, Yilue Zhang, and Angela I. Calderón

Alpinia galanga, a plant in the Zingiberaceae family, has been reported to be active against *Mycobacterium tuberculosis*. Galangal has been used traditionally to treat many bacterial infections and a variety of other ailments by boiling the rhizome to make a tea or grinding it into a paste.

Among the compounds reported in galangal, 1'-s-1' acetoxychavicol acetate (ACA) is a known antitubercular compound. Based on the literature reports, hexane and dichloromethane (DCM) extracts of galangal were prepared and tested in this study for inhibition of the *Mycobacterium tuberculosis* shikimate kinase (*Mt*SK). *Mt*SK catalyzes the fifth reaction of the *Mt*SK pathway to produce shikimate-3-phosphate (S3P). S3P production was measured using Liquid Chromatography-Mass Spectrometry Quadruple-TOF (LC-MS Q-TOF). These extracts, along with ACA standard compound and rottlerin, a known SK inhibitor, were tested for their inhibitory activity against *Mt*SK at concentrations of 50 µg/mL and 50 µM, respectively. The hexane extract displayed the highest *Mt*SK inhibition of 47% whereas DCM extract, rottlerin and ACA were all categorized as inactive with *Mt*SK inhibition rates less than hexane extract. The screening results suggest that ACA may not work through this mechanism of action. The focus of the research was then transitioned to identifying putative, previously undocumented compounds in *A. galanga* that work within ACA's molecular network. This information will assist future researchers assessing ACA's antitubercular properties.

The documentation of these compounds was performed through a variety of software and experimentation. A combination of Global Natural Products Social Molecular Networking and Mass Professional Profiler (MPP) software was used in the chemical profiling of the potential compounds, otherwise known as bioactives. The MPP analysis was able to produce a Venn Diagram displaying the number of unique compounds in each extract and which were present in both extracts. This is shown in Figure 1. Twelve known compounds have been potentially identified in the extract. Among them, six compounds (genistein, pinocembrin, kaempferide, naringenin, 4-hydroxybenzaldehyde and 3-*O*-acetylepinobaskin) occurred in *A. galanga* and *A. katsumadai*. The remaining compounds have not been previously documented as being present in *A. galanga* or its family, and three compounds (acacetin, naringenin, and alantolactone) have been selected for confirmation of presence in the extract. LC-MS-based chemical fingerprinting and profiling of the bioactives is in progress for comparison against standard compound spectra to confirm the presence of these chemical constituents in *A. galanga*. The major impact of this work in natural products drug discovery is that it serves as an example of the combined application of mass spectrometry and chemoinformatic tools to identify bioactives, with the broad goal being the identification of new antitubercular compounds that could be used to treat multi and extensively drug resistant strains of *Mycobacterium tuberculosis*.

Statement of Research Advisor

Madison had to carry out extensive literature searches to design the extraction procedure of *A. galanga* to obtain extracts rich in the antitubercular constituents, perform *Mt*SK inhibitory activity screening, and identify bioactives using mass spectrometry and chemoinformatic tools. She has established a platform for more detailed studies on natural products biochemometrics of *A. galanga*.
–Angela Caldéron, Drug Discovery and Development

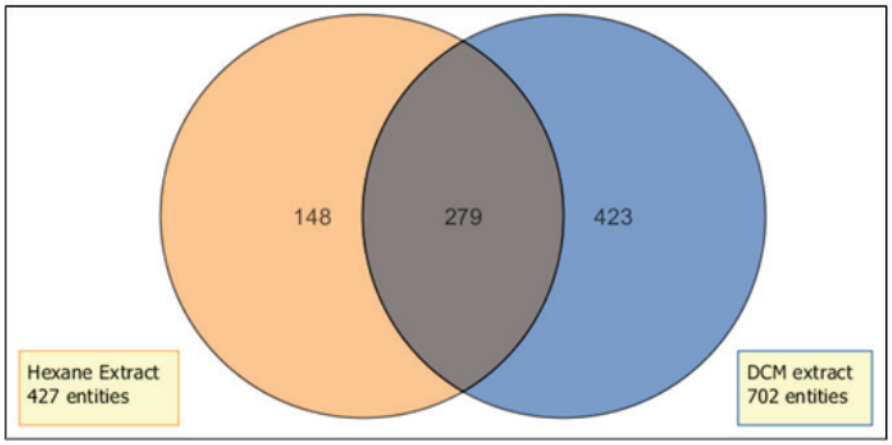

Figure 1: Identification of unique bioactive compounds in the hexane extract of *A. galanga* using Mass Professional Profiler software.

Effects of Sodium Bicarbonate on Hydroponic Growth, Quality and Nutrient Solution pH

Mackenzie Pennington and Daniel Wells

The purpose of this study was to determine effects of various rates of sodium bicarbonate on hydroponic nutrient solution pH and on growth and nutrient uptake of butterhead lettuce grown for 24 days in a nutrient film technique (NFT) system. This study is necessary for growers using low alkalinity municipal water sources, at high risk for extreme pH fluctuations in hydroponic greenhouses. This challenge is relevant to areas where water is low in water hardness. Keeping pH at a set range for optimum plant growth is crucial for successful hydroponic farming. As population and water scarcity increase, agricultural advances will become increasingly more important. Hydroponic farming will be part of the future of food because of its efficiency in water conservation. Studying hydroponic limitations, such as locations with low water alkalinity, could be crucial in placements and advancements where hydroponic farms will be placed in the future.

In this experiment, *Lactuca sativa* ('Rex' butterhead lettuce) seeds were germinated in rockwool cubes and grown for two weeks prior to transfer into NFT systems. Each NFT systems was 8 ft long and contained 5 lettuce plants (CropKing, Lodi, OH™). Nutrient solutions contained a complete fertilizer including N, P, K, and all essential micronutrients (Jacks's 5-12-26) at a rate of 80 mg/L N, calcium nitrate fertilizer containing N and Ca (15.5-0-0) at a rate of 70 mg/L N, and magnesium sulfate fertilizer containing Mg and S (10% Mg) at a rate of 40 mg/L Mg. A control treatment consisted of municipal water and nutrient solution above (0 mg/L HCO_3). The other three consisted of the same nutrient solution and rates of HCO_3 from sodium bicarbonate: 15, 30, and 45 mg/L HCO_3. All solutions containing bicarbonate were pH adjusted to 5.8 using a 35% sulfuric acid. Each was evaluated for pH and electrical conductivity (EC) daily for 24 days using a handheld meter (Hanna™). After 24 days, the lettuce plants were measured for leaf greenness (SPAD-502, Konica Minolta). Lettuce plants were removed from NFT, then roots and shoots were weighed separately to determine biomass. Foliar samples were dried in a forced-air drier and later analyzed for nutrient content (Waters Agricultural Lab, Camilla, GA).

Results showed that there were no statistical differences in nutrient solution pH (Table 1). Treatments of sodium bicarbonate did resist a drop in pH. There were no significant differences in foliar nutrient content, plant biomass, leaf greenness, or tipburn, indicating that additions of sodium bicarbonate at rates between 15 and 45 mg/L HCO_3 did not inhibit nutrient uptake or reduce plant quality. Growers should be prepared for pH shifts and adjust them when necessary. It is not critical to establish a buffer capacity prior to a pH shift. Sodium bicarbonate is inexpensive and can provide an effective method of pH adjustment when needed. A 50lb bag of sodium bicarbonate can be bought for approximately $25, and at 15 PPM, it can be used to grow approximately 6,680 heads of lettuce. Sodium bicarbonate is both effective and efficient when used at 15 PPM.

Statement of Research Advisor

Mackenzie conducted research that will be applicable to controlled environment farming, especially in urban areas that rely on municipal water sources. Using sodium bicarbonate (baking soda) to establish a pH buffer in low alkalinity water will reduce costs by allowing for use of a readily available, inexpensive product.
-Daniel Wells, Horticulture

Table 1. Effects of nutrient solution with varying rates of sodium bicarbonate on foliar nutrient concentrations, leaf greenness, biomass, and tipburn rating of 'Rex' butterhead lettuce grown in nutrient film technique for 24 days.

HCO_3 (PPM)	Nutrient Solution[x]		Foliar Nutrient concentrations					Lettuce Growth and Quality			
Treatment[y]	pH	EC	N (%)	P (%)	K (%)	Mg(%)	Ca(%)	SPAD[v]	Shoot biomass (g)	Root biomass (g)	Tip burn
0	5.94	2.58	5.80	0.95	9.61	0.62	0.57	27.56	138	209	0.47
15	6.55	2.74	6.19	1.05	9.71	0.71	0.71	26.99	78	171	0.13
30	6.11	2.55	6.20	0.99	9.62	0.61	0.57	25.1	100	174	0.40
45	6.38	2.65	5.67	0.96	9.23	0.64	0.55	28.35	116	190	0.00
P-Value	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sig.[z]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] Data were subjected to analysis of variance (ANOVA) in SAS using PROC GLIMMIX.
[y] Treatments are mg L^{-1} HCO_3 from $NaHCO_3$.
[x] Nutrient solution contained (Jacks's 5-12-26), Calcium nitrate (15.5-0-0), and Magnesium sulfate (10% Mg). NS=No significant trends are observed.
[v] SPAD Index is a measure of leaf greenness. Tipburn was rated using a subjective rating scale averaged together by each subsample. Root biomass was the weigh in grams of all roots in each replicate. Shoot biomass is the weight in grams of lettuce shoots from each replicate averaged together for the whole treatment.

Optimization of Biodegradable Resins for Additive Manufacturing

Ernest Porterfield and Edward Davis

The purpose of this study is to evaluate the properties of custom resins to optimize them for use in a FormLab Form 2© Stereolithography (SLA) printer. The resins used various ratios of poly (ethylene glycol) diacrylate (PEGDA, Mn 700) and poly (ethylene glycol) (PEG, Mn 300). PEG is a biocompatible polymer used in biomedical applications, and PEGDA is a form of PEG that is used in many drug delivery applications. The ratios under investigation were 3.5:6.5, 6.5:3.6, and 9:1 where PEGDA: PEG. Diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide was used as the photoinitiator added at 1 g/L. These custom blends were then used in the Form 2 to print test shapes; however, the resulting prints were not fully polymerized and did not maintain shape. By comparing the custom resins to resins produced by FormLab, it was hypothesized that there were differences in particular properties.

The two properties that were selected for testing were the energy released during polymerization and viscosity.[1] The three custom ratios (3.5:6.5, 6.5:3.5, 9:1) were tested against the white and clear resins supplied by FormLab. In addition, the concentration of photoinitiator in the custom resins was varied during the differential scanning calorimeter (DSC) testing (photoinitiator concentrations: 10%, 25%, 50%, 75%, 100%). No photoinitiator was used in the resins that underwent viscosity testing because of light sensitivity concerns. Viscosity is hypothesized to be critical because of the way the printer operates. Since the printer wipes the resin off the window before lowering the stage again, the viscosity could impact the amount of resin that flows into the printing area. The viscosity was measured using a Rheometer with 60 mm steel concentric plates at 1° with a gap distance of 27μm. These results are presented in Figure 1.

Heat flow of the resin was tested using a DSC (Texas Instruments DSC Q100©). The samples were polymerized using a Novacure 2100 Q Series PCA©. The two sets of data obtained are presented in Figures 2 and 3. Roughly 25g of resin was polymerized in hermetic aluminum pans. The DSC was programmed to maintain 30°C for these runs. The printer operates at about 31°C. The DSC would equilibrate at 30°C and then remain isothermal for 15 seconds before turning on the light source.

Each sample was run twice on the DSC. Note that the isothermal step resulted in the zero slope lines (Figure 2). Peak heat flow occurred at the same time for both the 100% and 50% photoinitiator concentrations. Thesetimes were much quicker than those for the standard resins (0.437 min for clear and 0.463 min for white). The other ratios exhibited similar reaction times to the 100% and 50% concentrations.

It was observed that viscosity and heat flow of the custom resins did in fact vary significantly in most cases. More trials are needed to confirm observed trends and identify any outliers. Future testing will explore the effects of higher molecular weight as a solution to the differences in viscosity.

Statement of Research Advisor

Steven's work focused on identifying the window of fundamental resin properties that enable printing on commercial SLA printers. His findings laid the groundwork required to engineer SLA printable biodegradable resins for a range of biomedical applications.
-Edward Davis, Mechanical Engineering

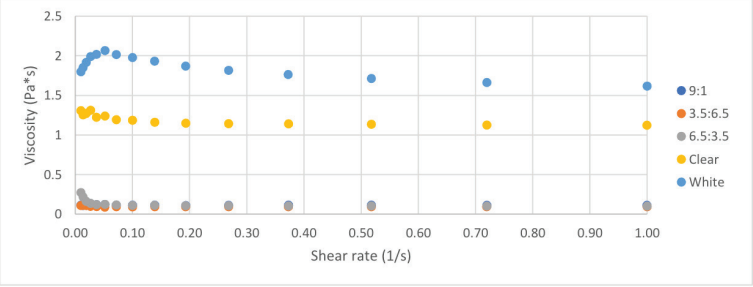

Figure 1: Viscosity vs shear rate of resins; custom resins contain no photoinitiator.

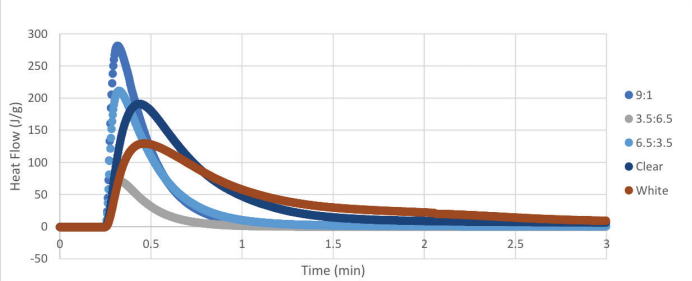

Figure 2: Heat flow vs time of resins with 100% photoinitiator concentrations.

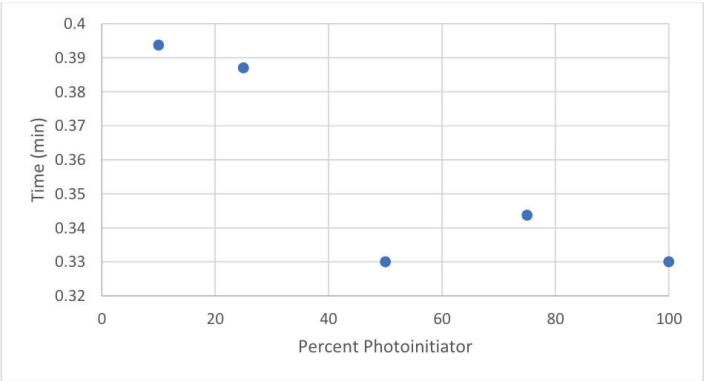

Figure 3. Time at max heat flow for various photoinitiator concentrations of the 3.5: 6.5 blend.

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Effectiveness of Measuring the Turbidity and Total Suspended Solids of Waterways with Multispectral Imaging Obtained by Unmanned Aerial Vehicles

Elizabeth M. Prior, Frances O'Donnell, Christian Brodbeck, Wes Donald, G. Brett Runion, Stephanie Shepherd

This study investigated if multispectral imagery from an unmanned aerial vehicle (UAV) could be used to monitor turbidity and total suspended solids (TSS) of streams. This technique has been used in a large river but not in streams (Larson et al., 2018). Nonpoint source pollution is a global issue with sedimentation at its core (Duda, 1993; Rabeni and Jacobson, 1999). Sedimentation/siltation includes solids that enter into a waterway, and has the potential to increase the turbidity and total suspended solids (TSS) concentration. This can occur as runoff from agriculture, roadways, construction sites, forestry, mining operations and, when no infrastructure is in place, sewage (Brown and Froemke, 2012; Cooper, 1993; Perez et al., 2014). To a certain extent, all of these activities either disturb land cover that then loosens soil and could be transported as runoff by precipitation (Poesen et al., 1996).

UAV multispectral imagery was collected at three sites using four bandwidths: green (530 –570 nm), red (640 –680 nm), red edge (730 –740 nm), and near infrared (770 –810 nm). The average pixel value (within a one-meter radius of each sample location) was compared to turbidity and TSS datasets. Single band and band ratios were tested as predictors of turbidity and TSS using linear regression. The first site was a restored reach of Moores Creek, Lanett, Alabama. In addition to the spectral bands, water samples (surface, middle, and bottom of the water column) were collected before and after rain events and turbidity and TSS of water samples were measured. Linear regression models relating multispectral bands to turbidity and TSS were developed. Imagery was captured using a multispectral sensor attached to a quad-copter UAV. Immediately after the flight, water samples were collected at 15 locations along the creek. Three sample sets were collected (February 2019, March 2019 and July 2019) for turbidity and TSS at three depths (i.e., surface, middle, and bottom of the water column). To test the models at other sites, water samples and UAV imagery were also collected at Moores Mill Creek in Chewacla State Park, Alabama.

To assess how high sediment levels influence UAV imagery, a large-scale sediment basin study was conducted at the Auburn University Erosion and Sediment Control Testing Facility (AU-ESCTF). The basin was filled using controlled sediment introduction and flow rates; automatic samplers collected water (three depths and two basin locations) every 15 minutes for 6 hours with corresponding UAV imagery.

For the Lanett datasets, TSS and turbidity regression models for low flow had R2 values of 0.77 and 0.78, respectively. When sampling after precipitation, different single bands and band ratios were required for sufficient R2 values, suggesting separate models may be needed for high and low flow events. When the Lanett models were applied to Chewacla State Park datasets, predicted TSS and turbidity were not comparable to measured values indicating location-specific models may be required. For the AU-ESCTF test, R2 values for TSS and turbidity models were 0.96 and 0.93, respectively. Overall, red band values increased the most, indicating that this band could be used for threshold-based monitoring.

Current techniques rely on point sampling that are time consuming, non representative of waterways, and invasive due to sediment disturbance. There is potential to monitor TSS of a creek using a UAV, since it is quick, easy, site comprehensive, and does not disturb aquatic ecosystems. If standardized, this method could be used by state environmental departments and stakeholder organizations to monitor creeks.

(*National Soil Dynamics Laboratory, ARS-USDA, Auburn, AL)

Statement of Research Advisor

Beth is extending established research on UAV monitoring of water quality to small headwater streams that are important for aquatic habitat and water resources but where water quality is rarely monitored. Robust, low-cost monitoring methods, like the one Beth is developing, are needed to improve understanding and protection of water quality in small streams.
--Frances O'Donnell, Civil Engineering

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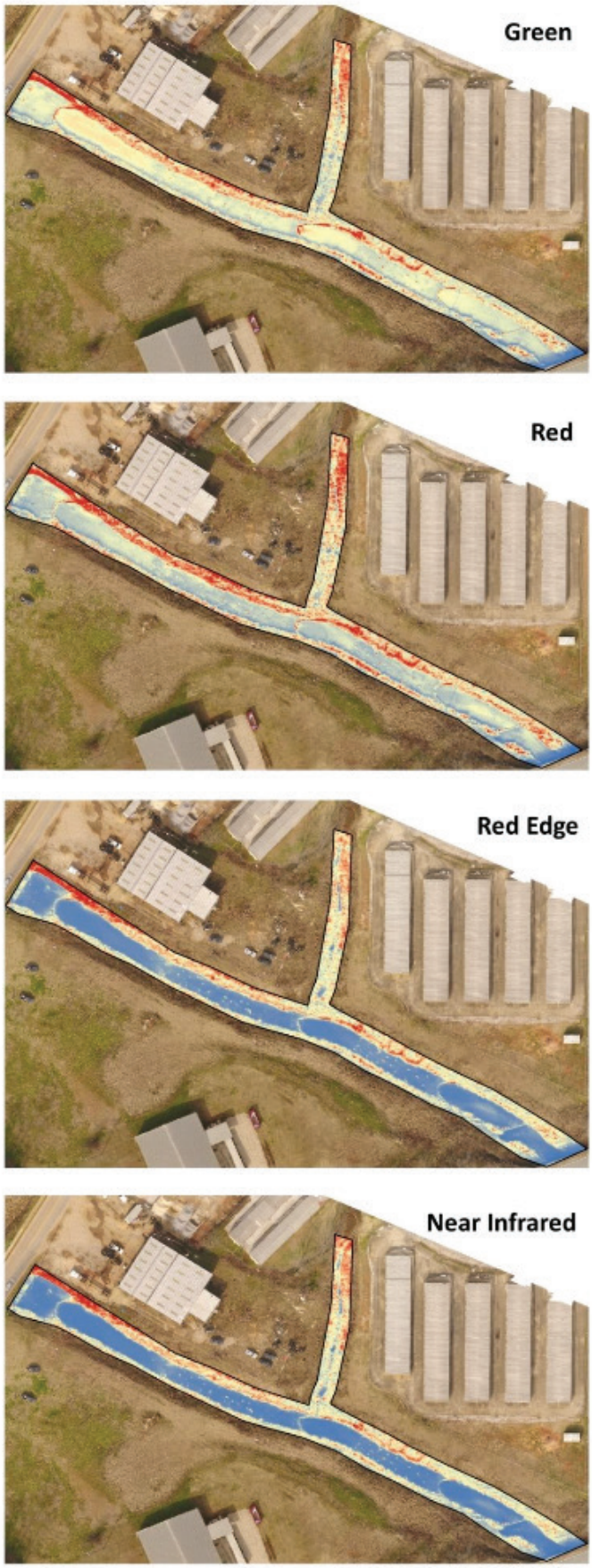

Figure 1. Multispectral aerial images from Moores Creek (red, green, red edge and near infrared)

Healthy Human, Healthy Dog, Healthy Nursing Student Volunteer

L. Caroline Richey and Morgan Yordy

Patients living with diabetes benefit from regular physical activity and health teaching regarding disease management (Fløde et al., 2017; Moore et al., 2019; Whitehead et al., 2017). In order to achieve physical activity requirements and better self-management, social support and proper education by healthcare professionals is needed. Unfortunately, many healthcare professionals are unprepared to promote a healthy lifestyle (Wills & Kelly, 2017). In a recent study, almost 80% of undergraduate nursing students did not meet the recommended weekly physical activity guidelines (Fitzgerald & Boland, 2018). In addition, many licensed nurses also report inactivity (Kime et al., 2020). In turn, health advice provided to patients may not be perceived favorably if a nurse does not meet the health expectations themselves (Wills & Kelly, 2017). Programs engaging college students in physical activity could impact future patient health outcomes (Fitzgerald & Boland, 2018). The aim of this study is to assess nursing students' stress levels and socialization in correlation with volunteer work with the community outreach dog-walking program. What was the reasoning for student involvement in joining the program? Due to participation, was knowledge about diabetes gained or physical activity increased? These questions are significant for society because remaining healthy via walking is a critical component of someone's lifestyle, whether that be the lifestyle of someone living with type II diabetes, a nursing student, or a volunteer.

Doggone Diabetes, a program integrating dog walking into an exercise program for patients living with type II diabetes, integrates animal-assisted interventions in healthcare and community settings to meet the needs of vulnerable populations. My study titled "*Healthy Human, Healthy Dog, Healthy Nursing Student Volunteer*" was created as an offshoot of the program in order to explore student involvement in community outreach. The study involved a literature review of student engagement with physical activity, specifically focusing on what motivates students to engage in physical activity. In addition, research was done to discover the motivating factors for people living with type II diabetes to take part in physical activity. There is a lack of current evidence connecting motivation factors to increasing physical activity among student nurses; therefore, the aim of the current research was to evaluate the reasoning behind student engagement to join a community outreach project. I hypothesized that students who joined the Doggone Diabetes program did so because they were motivated by the dogs, and not by their interest in diabetes.

Recruitment for student workers began fall of 2020. In January 2021, 32 students (n=32) expressed interest and attended a training session for Doggone Diabetes. Training included methods of obtaining patient biometric data (weight, body mass index, waist circumference, blood pressure, heart rate, and hemoglobin A1C) and discussing the dog walking portion of the study. Student worker responsibilities included walking with patients living with diabetes on frequent scheduled walks throughout the week and participating in monthly biometric data collection for the Doggone Diabetes participants.

The side study, "*Healthy Human, Healthy Dog, Healthy Nursing Student Volunteer,*" was initiated to determine the reason students became involved in community programs. Institutional review board approval was obtained for the study. All students employed by the Doggone Diabetes program were invited to participate in the "*Healthy Human, Healthy Dog, Healthy Nursing Student Volunteer*" study, but data were recorded only for those who consented to the study. Eleven students (n=11) consented and completed the Walking Survey Questionnaire (Figure 1). The Walking Survey Questionnaire was delivered via Qualtrics and data were de-identified. Descriptive statistics (mean, standard deviation) were used to determine scores in the Walking Survey Questionnaire. A comparative analysis then took place.

The results (Figure 2) in order of primary reason for

joining the Doggone Diabetes research program, were (1) this is a "paid employment," (2) "dogs were a part of the program," and (3) "diabetes was the topic." The results suggest that the initial study hypothesis was incorrect; the primary reasons for joining the Doggone Diabetes program were due to paid employment and therapy dog presence. Although paid employment was a reason for students to join a community program such as Doggone Diabetes, the impact of the dogs cannot go without notice. There was strong support for having the dogs involved in community outreach as a motivation factor.

A unique aspect of this study is the dogs' contribution to the study. Auburn University School of Nursing's trained canines helped to make this study possible, as well as appealing. Another unique aspect is the involvement from the community and the students. Without participation from the community members living with type II diabetes and from nursing students, this study would not have been possible. Further research should be aimed at student engagement in healthy living as it translates to future practice.

Statement of Research Advisor

Caroline's research illustrates the motivation behind student involvement in community outreach and as a faculty, a question I myself have often asked. She explored the incentives faculty can utilize when building projects that not only aid communities but grow future nurses. Covid-19 proved to add more challenges to this project, but Caroline prevailed, and her research lays the groundwork for future studies.
–Morgan Yordy, Nursing

Walking Questionnaire
(1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree)

a. Of the following choices, rank your *Primary* reason for joining this program with 1-as the primary reason to 3-last.

	Primary (first)	Secondary	Tertiary (last)
I joined Doggone Diabetes because the therapy dogs were present.			
I joined Doggone Diabetes because the research study topic was diabetes			
I joined Doggone Diabetes because this was a paid employment			

Figure 1. The walking survey questionnaire used in this study.

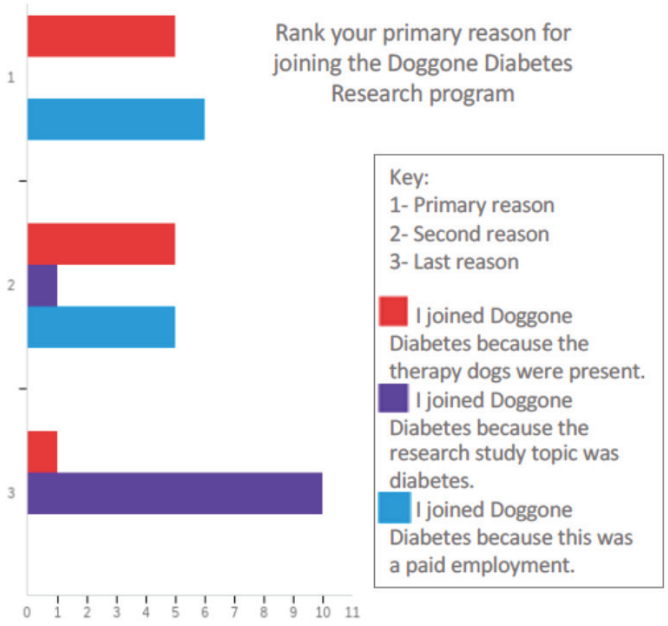

Figure 2. Results of walking survey showing reasons for joining the Doggone Diabetes study.

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Important Feature of Walking Adaptation: A Review of the Nervous System's Ability to Regulate and Maintain Sensory Input During Split-Belt Walking

Abbrianna A. Robert, Sarah A. Brinkerhoff, Mariane F.B. Bacelar, Patrick G. Monaghan, Jaimie A. Roper

Gait adaptation studies focus on the ways in which individuals adapt their walking pattern (gait) to a split-belt treadmill. Adaptation is defined as the modification of a movement from trial to trial based on error feedback (Bastian et al., 2008). A split-belt treadmill is a treadmill with two separate belts that can operate at different speeds. These studies are conducted for the purpose of determining body mechanisms responsible for gait and gait adaptation. Furthermore, these studies provide insights for rehabilitative innovations that are useful for populations with neurological deficits. We reviewed 42 studies to determine which measures to use for the characterization of gait adaptation on a split-belt treadmill.

Most commonly, gait adaptation is measured by the way an individual's step length asymmetry changes as they walk on the split-belt treadmill. Step-length asymmetry is defined as the distance between the ankles when the leading leg contacts the ground. Step length starts asymmetric, and over the course of adaptation, becomes more symmetric, even though the belts are moving at different speeds (Reisman et al., 2005). However, researchers have more recently focused on the way in which adaptation could be driven by changes in metabolic cost. Metabolic cost is defined as the energy used by the body during movement. It is thought that reductions in asymmetry, seen during adaptation, are driven by the body's ability to use external assistance from the treadmill to decrease metabolic cost (Roper et al., 2013; Sanchez et al., 2019).

Many studies have focused on split-belt treadmill adaptation in populations with neurologic damage.These studies have found that different parts of the nervous system are responsible for different aspects of gait adaptation, and impairments in gait adaptation are dependent on the type and extent of neurologic or musculoskeletal damage. These studies include populations of people post-stroke, with Parkinson's disease, and/or with essential tremor. In addition, some studies have focused on populations with musculoskeletal damage,-like amputees and those who have undergone anterior cruciate ligament (ACL) reconstruction.

Our review investigates common measures used to characterize gait adaptation on a split-belt treadmill. Understanding how step length, asymmetry and metabolic cost are influenced by neurologic and musculoskeletal damage allows researchers to inform rehabilitative innovations. Because most studies have focused on populations with degenerative disorders, further research regarding the peripheral nervous system in younger populations will provide a better understanding of how the nervous system controls gait adaptation. Furthermore, few studies have investigated the nervous system's role in tasks that involve all four limbs and there are few studies that investigate the nervous system's ability to control stability. Our findings suggest that more research is needed to determine potential modifications in gait adaptation for individuals with limb loss. Additional studies must be executed before we can truly understand the role of the peripheral and central nervous systemin gait adaptation for populations with limb loss.

Statment of Research Advisor

Abbrianna has gathered information from several studies that understand how people control their walking in new settings and how adjustments are made to ensure gait remains efficient and stable. Her work will have significant impact in identifying areas of focus for the future if the field and shed light on how we can use current findings to help populations with neuromuscular deficits walk better.

–Jaimie A. Roper, Kinesiology

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The Morphological Characteristics of Ant Communities Within Alabama

Joshua Semmes and Bill D. Wills

Ants are ubiquitous components of terrestrial ecosystems and play important ecological roles. They can serve as ecological engineers, indicators of ecosystem health (bio-indicators), and important predators (e.g., native and invasive). The functional roles ants play in ecosystems is driven in part by their body size, and recent evidence suggests that habitat type (between different continents) influences body sizes of ant species. The aim of this study was to explore how body size and morphology vary across local and regional habitats. In addition to providing insight into their ecological roles in these habitats, any patterns observed could also provide sources of developing hypotheses about evolutionary trends and species diversification.

To explore if there were differences in size and morphology among habitats in Alabama, we used a publicly available database, *www.anteweb.com*, to obtain measurements of the ten key morphological characters of each worker among all species in Alabama. From these data, there was no significant difference in ant size and shape across the different habitat types found in Alabama (i.e., temperate forest, open, urban, etc.). Field collection data were then used to test if the publicly available online specimens (e.g., *antweb*) were comparable to those found in the field. To do this, we narrowed the scope of sampling to 'open canopy' sites (e.g., grassy fields or fields without) and forested sites ('closed canopy'). These two habitats were most common among the collection descriptions of the online specimens. Additionally, based on previously published work, these samples were most likely to result in different morphologies and sizes if the local/regional patterns are similar to global patterns in body size. These samples were then weighed using a microbalance (most accurate measure of size) and measured for the same morphological characters (as above). Local variation of ants in different habitats were acquired and compared to publicly available images and body size data.

From the sites, we collected 60 bait traps, which includes 1,319 collected ants. However, due to COVID restrictions and lab closures, the data analysis is only partially complete. Currently, we are completing the morphological measurements to compare the morphological characters of Alabama ant species in open and closed canopy field sites. This comparison will help improve our understanding of global patterns in body size and their relevance to smaller ecological scales. In addition, these data provide a more complete data set for ant body size in Alabama that can be added to publicly available data repositories (*antweb.org, antwiki.org, antbase.org*, etc.). These data can then be used in conjunction with further research. For example, these data (in conjunction with publicly available datasets) could help explore how widely applicable global patterns in morphology and habitat compare to local scales, or if/how climate change might affect body sizes. Ultimately, this work will help document and describe phenotypic variation–one of the most fundamental questions in biology.

Statement of Research Advisor

This project is an exploration of the importance of scale in evaluating ecological patterns and hypotheses. The data collected by this project will be valuable to test if the ecosystem scale patterns align with local patterns. This project also builds a database of the species of Alabama, their habitat use, and morphological data, which will be of use for years to come.
-Bill D. Willis, Biological Sciences

Sustainability at Auburn University: Assessing Rooftop Solar Energy Potential with Remote Sensing and GIS

Victoria Stack and Lana L. Narine

Achieving sustainability has become an important goal for many people, companies, and institutions in the United States. One of the most effective ways for a company to achieve sustainability is to decrease their carbon footprint with the implementation of renewable energy. As an institution that is committed to sustainability and investing in the future by mitigating the effects of climate change, Auburn University is an ideal case study. In an estimation from the Auburn University Office of Sustainability, the total campus currently consumes about 190,000,000 kWh annually. In comparison, the current campus solar arrays account for only 0.0047% of this power. Auburn has grown substantially since 2017, increasing in enrollment, total buildings on campus, and electricity use. As the university grows, its carbon footprint and energy demand has and will continue to grow.

This study assessed rooftop solar potential, which is the estimated amount of solar electric energy that could be produced if all suitable buildings on campus had rooftop photovoltaic (PV) systems installed. Auburn's current energy provider is Alabama Power, which sources most electricity from fossil fuels. The study, completed entirely with publicly available data, follows a processing workflow shown in (Figure 1). To estimate the rooftop solar potential of Auburn University, a digital surface model (DSM) was derived from a point cloud of light detection and ranging (LiDAR) data by the United States Geological Survey (USGS) 3D Elevation Program in 2017, and visual assessment of National Agriculture Imagery Program (NAIP) orthophotos. The points from the aerial LiDAR sensor represent the elevation of objects along the surface of the earth. From these data, the slope, aspect, and total solar potential of the study area were calculated with individual pixels of a gridded raster. Using building footprint polygons to represent campus buildings, different structures on campus were ranked in suitability for rooftop solar arrays. The criteria for "suitable buildings" in this case was non-north-facing rooftops with a slope less than or equal to 47 degrees, with a solar potential that is less than or equal to 609kWh/m^2. North-facing rooftops, buildings with high slopes, and buildings too small (<10 m^2) to produce significant solar energy were removed from the campus-wide estimate.

With these criteria, there are an estimated 323 buildings of the 443 in the study area that were found to be suitable for rooftop solar arrays. The estimated solar potential of Auburn University is 27,068,555 kWh/m^2. In the year the data were collected (2017), the proposed solar arrays would have met up to 21.07% of annual building electricity requirements, and about 14.43% of total campus electricity required for all operations. At a residential pricing with Alabama Power, the initial installation would cost approximately $62,032,105.21, with an additional annual electric fee of $1,802,765.76. The workflow used in this study is easily adaptable to other universities that would want to complete similar assessments.

Statement of Research Advisor

In terms of contribution, Victoria performed research exceptionally. She completed research goals outlined in the initial report, specifically conducted a literature review, seamlessly integrated suggestions, and recommendations, further developed and implemented methods, interpreted findings, and developed a manuscript that will be finalized for submission soon.
—Lana L. Narine, Forestry and Wildlife Sciences

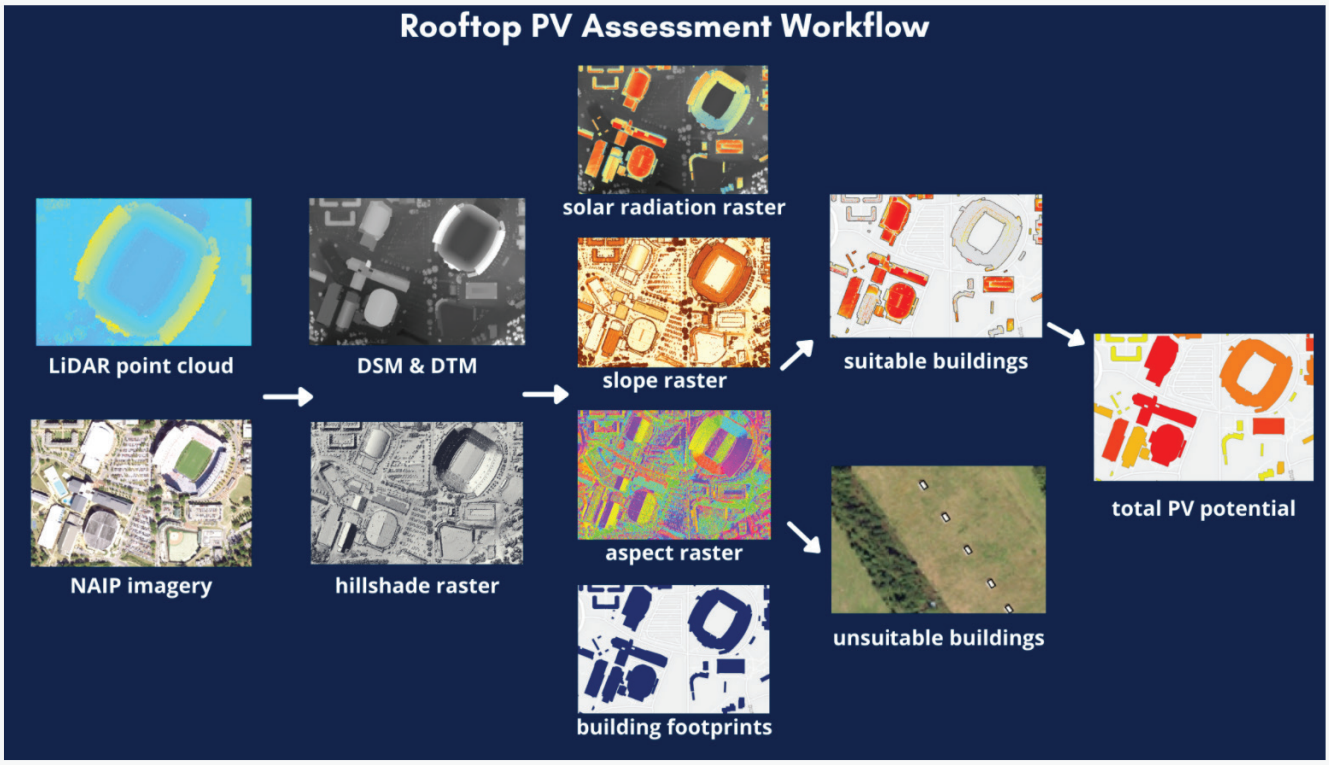

Figure 1. Workflow from Light Detection and Ranging (LiDAR) data and National Agricultural Imagery Program (NAIP) to Digital Surface Model (DSM) and Digital Terrain Model (DTM) to the final total Photovoltaic (PV) potential by building.

Wray v. Wray: Public Perceptions of Women's Health in the Antebellum Courtroom

Jessica Sullivan

This research covered the divorce case of Wray v. Wray in 1851 and the appeals of Mr. Albert G. Wray and Mrs. Susan M. Wray to the Supreme Court (Wray v. Wray, Montgomery County Chancery Court Record Book, 1851). There were many different facets of this court case. However, this research focuses on the effect of public viewpoints of women's mental health and hysteria in the eyes of the law. Due to the misunderstandings of mental health, the research hoped to prove that Susan M. Wray was able to use the diseases to her advantage, since her case of adultery was condemning due to witness testimonials and evidence letters.

The research started by reviewing and transcribing the court proceedings and appeals to identify mentions of mental derangement, hysteria, insanity, partial insanity, monomania, and melancholia and to determine the characteristics of each disease and how those diseases were being described in the court proceedings. Witness testimonials and evidence letters were also examined for any mention that Mrs. Wray had any of these diseases. The research also involved looking at other newspapers, court proceedings, and medical journals from this time period to get a basic understanding of these diseases. Most of the source material came from the court proceedings and appeals themselves. Differences in the idea of insanity and what made someone insane, partially insane, or hysterical widely changed throughout the case.

The lack of a publicly or medically accepted definition or distinction among hysteria, mental derangement, partial insanity, or insanity uncovered the underlying idea that insanity and mental health were still very much unprecedented topics. Mrs. Wray's legal team used this lack of understanding to her advantage to argue for her mental state and soundness of mind. Her attorneys' exploitation of her mental state in the case ultimately resulted in her legal win. The argument that she had lapses in time where she could not remember or comprehend what was going on in the world around her ultimately exonerated her on the moral and legal consequences of adultery. Because she was able to use a misunderstood disease to her advantage, this case exhibits the pitfalls and challenges the courtroom faced at the time in resolving disputes and finding justice. This case widens our perspective and knowledge on women's past experiences with legal and medical systems in Alabama, as well as our understanding of our modern legal and medical systems.

Statement of Research Advisor

Ms. Sullivan's research argues that debates around the use of an insanity plea helped change public perceptions of women's proper role in the home, the courtroom, and the asylum. Her project recognizes how ordinary Alabamians, like Susan Wray, interacted with the male-dominated legal and medical systems of the state to create lasting changes to these realms.
-Kelly Kennington, History

Optimizing the Restorative Potential of the Italian Renaissance Garden: A Pattern Library

Hollen Terry and Lindsay Tan

A Pattern Library is an organized set of patterns that can be adapted for use in many contexts as solutions to design challenges. Patterns are themes and concepts that can vary in meaning and appearance based on their setting. The purpose of our Pattern Library is to serve as a tool for those who will contribute to the design of a culturally meaningful, historically appropriate, and mentally and emotionally restorative outdoor greenspace to improve quality of life for participants of the Joseph S. Bruno Auburn Abroad program in a Renaissance-era Palazzo in Italy.

Existing literature (e.g., Kaplan and Kaplan, 1989; Pearson and Craig, 2014; Hartig et al.,1991) indicates that time spent outdoors positively impacts mental, physical, and emotional wellbeing; this project acts as a case study of how environmental factors promote mental and emotional health for students experiencing stress and fatigue. The Pattern Library utilizes Attentional Restoration Theory (ART) as its theoretical framework, aligning spatial design and landscape elements along with characteristics of Italian Renaissance gardens to ART's four principles: *fascination, being away, extent,* and *compatibility*. *Fascination* allows people to rely on effortless attention instead of exerting energy to fixate their attention on a scene. The experience of *being away* entails either physically or psychologically removing one self from one's everyday environment. *Extent* is the quality of having sufficient scope and coherence to allow a person to remain engaged with their environment. Finally, *compatibility* entails a fit between a person and their environment.

The result of this research is a series of books, each focusing on one principle of ART, describing techniques, concepts, and landscape features that can be used in virtually any combination to create a restorative outdoor space appropriate to its historic and geographic context. When an outdoor greenspace is developed that utilizes the patterns in the Library, Joseph S. Bruno program participants will have a place to go that helps them recuperate from study abroad stressors and optimally benefit from their experience in Italy. This Pattern Library is written specifically for the Joseph S. Bruno program's outdoor greenspace, but its core tenants can be applied to spatial design at large to develop built environments that are optimally restorative and healthful.

Statement of Research Advisor

Hollen conducted an emergent analysis of literature regarding restorative environments and the human connection to nature to identify emergent patterns and a suitable theoretical framework, then synthesized and distilled the complex concepts of the literature into simplified patterns that can be integrated into the Joseph S. Bruno program's outdoor greenspace renovation. She printed her volumes of The Pattern Library, hand-stitched the binding, and delivered the finished collection in a customized, handcrafted wood box set.
—*Lindsey Tan, Interior Design*

Analysis of Water Quality in Parkerson Mill Creek

Kerstin Glaser and Ann Ojeda

The headwaters of Parkerson Mill Creek are on the Auburn University campus, near Beard-Eaves Coliseum and Donahue Street in Auburn, Alabama. Parkerson Mill Creek flows south through Auburn until it reaches a confluence with Chewacla Creek, south of the Chewacla State Park. Parkerson Mill Creek is on the Alabama Department of Environmental Management 303 (d) list of impaired water bodies, meaning the creek does not meet water quality standards. Poor water quality in Parkerson Mill Creek could lead to poor water quality in downstream waterbodies as well. Our goal was to measure the spatial distribution of water quality and pesticide/herbicide concentrations along the creek to determine sources of contamination.

Sample sites were selected north and south of the Chewacla Creek –Parkerson Mill Creek confluence to compare variation in water quality (Figure 1). One of the sample sites was also selected in close proximity to Auburn's wastewater treatment plant outfall into Parkerson Mill Creek. Samples were collected on 03/06/2021 and 04/09/2021.

A YSI Multiprobe™ was used to collect *in situ* water quality data, such as pH, temperature, conductivity, and dissolved oxygen (DO). At each site 500 milliliters of water were collected and sent to the Pesticide Residue Laboratory and screened for atrazine, acetochlor, bifenthrin, diazinon, ethalfuralin, fipronil, and alathion. These compounds were selected due to their prevalence in nearby areas conducted in a similar study (Glinski et al., 2018) and for their potential dangers to the environment and public health when above Environmental Protection Agency (EPA) standards. One to two milliliters were taken from each sample bottle for *E. coli* enumeration using Coliscan Easygel™.

The results of our study are summarized in Table 1. No pesticides were detected throughout the course of this study by either our contaminants laboratory or the Pesticide Residue Laboratory. Water at all sample sites was well oxygenated, with dissolved oxygen concentrations ranging from 10.2 to 13.21 mg/L. However, the *E. coli* concentration in the water at site 1 was well above the maximum limit of 235 colony forming units/100 mL. This result could be due to areas of construction or agricultural runoff that we observed are upstream of site 1. Sample sites 3,6,4 and 5 have lower *E. coli* concentrations that meet the water quality criteria. All of these sites are located after the wastewater treatment outfall, which suggests the stream water is diluted by the treated effluent from the plant. The effects of the effluent are also reflected in other data collected. For example, we observed an increase in temperature and conductivity immediately after the outfall (site 3), then a slow decrease in those parameters further downstream (sites 6, 4 and 5). Together, these data suggest that the wastewater treatment plan does impact water quality, but it is not a source of *E. coli* in this stream segment. Our results suggest that future studies should focus on upstream sources of *E. coli* to pinpoint areas of poor water quality along Parkerson Mill Creek.

Statement of Research Advisor

Kerstin's project took a couple of unforeseen twists and turns because of travel restrictions associated with the COVID-19 pandemic. She persevered and was able to readjust her project to focus on Parkerson Mill Creek, here in Auburn. Throughout her fellowship term, she learned skills in geographic information systems, water quality measurements, contamination dynamics. She also practiced her presentation skills by sharing her work in our lab group meetings. Overall, her study helps us understand the impact of the wastewater treatment effluent on water quality in Parkerson Mill Creek, and it has helped us narrow the focus of future research to upstream sources of *E. coli* contamination.
–Ann Ojeda, Geosciences

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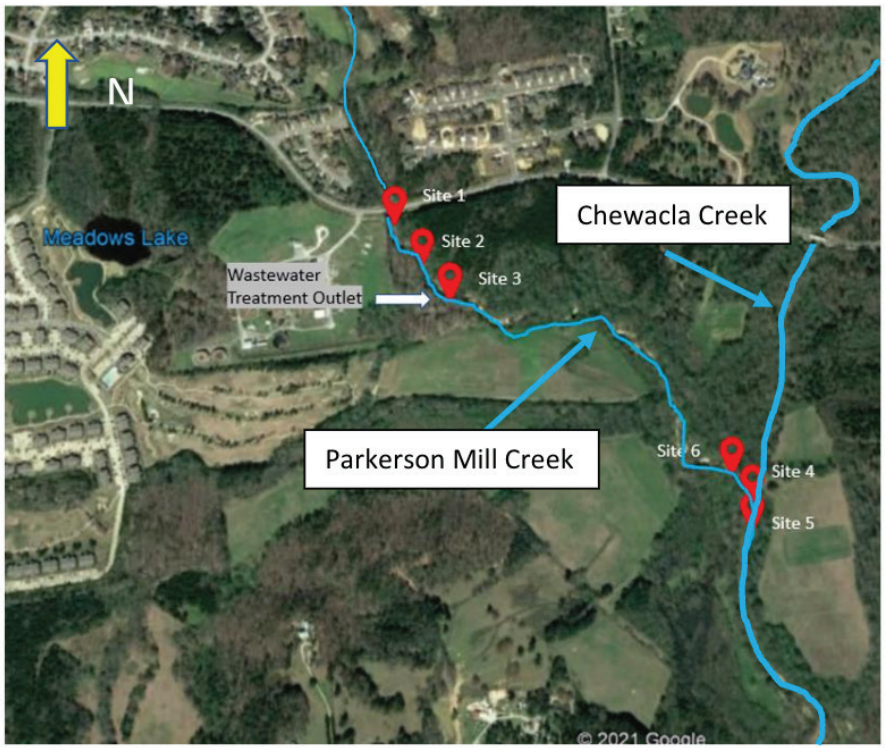

Figure 1: Sample sites for Parkerson Mill Creek. Streams are represented in blue; Sample sites are shown in red. The background layer was taken from Google Earth™.

Table 1. Sample results from the Parkerson Mill Creek Study. The sample sites are arranged in order from upstream to downstream.

Sample Site		pH	Temperature (°C)	DO (mg/L)	Conductivity (µs/cm)	*E. coli* Concentration (cfu/100ml)
Upstream of the outfall	1	5.97	12.17	13.21	130	400
	2	6.45	12.23	11.33	130	-
At the outfall	3	6.41	15.09	11.73	213	100
Downstream of the outfall	6	6.99	15.21	11.07	202	150
	4	6.88	13.56	10.2	94	200
	5	7.07	13.6	11.03	96	250

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