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Table of Contents

FORWARD

Letter from the Editor

Dear Reader,

This issue showcases the remarkable work of yet another talented cohort of current and recently graduated FSU students. Vol. 11 No. 2 features five articles and one research-based creative work spanning a wide array of topics. The rich disciplinary diversity represented in this issue reflects the flourishing research community at FSU, which includes undergraduate student researchers from a wealth of different departments and majors. Biology, chemistry, clinical and health psychology, literature, and creative historical analysis are all represented. This variety continues The Owl's tradition of showcasing student work from a multitude of disciplines in each issue.

I congratulate the featured student authors on their commendable work.

In this Letter, I would also like to dedicate some space to celebrating a number of milestones The Owl has achieved during the 2020-2021 year. As I highlighted in the fall 2020 issue, this is the first year in seven years in which The Owl has published two issues. Both of these issues are published with ISSNs issued by the Library of Congress. Additionally, The Owl was recently accepted into the Directory of Open Access Journals (DOAJ), a collection of scientific and scholarly journals available for free and meeting high quality standards through the use of a peer review system. Thanks to our inclusion in the DOAJ, all Owl articles are now widely available and citable online through a vast number of databases which include DOAJ journals, including popular databases such as Google Scholar. This achievement further solidifies the legitimacy of The Owl as a professional journal and enhances the credibility of its published authors as researchers and scholars. I feel incredibly blessed to have served as The Owl's Editor-in-Chief during such a memorable year.

I would like to sincerely thank Laura Miller for helping me through the DOAJ application process and for her outstanding support on The Owl's website.

Most of all, I would also like to thank this year's team of Associate Editors Caitlin Blanchard, Isha Chekuri, Catherine Cosgrove, Ally Davis, Tyla Dolezel, Elena Gurau, Matthew Masa, Vinnie Vassalotti and Caitlin Violette, and Project Coordinators Naomi Coté, Shrivathsan Margam, Carly Mayzum, and Hannah Smith, for their exemplary work.

I have thoroughly enjoyed my term as Editor-in-Chief and I am proud to display the excellent student research found within this issue.

In Vires, Artes, Mores,

Trystan Loustau

Trystan Loustau

Editor-in-Chief, The Owl

Assistant Director, SCURC

The Center for Undergraduate Research and Academic Engagement, which serves in an advisory capacity to the Student Council for Undergraduate Research and Creativity, has retracted the following article from SCURC's The OWL, an undergraduate peer-reviewed journal:

Courtney Camarillo, **The Impact of Sleep Fragmentation on Alcohol Induced Behavior**

Since publication, the research mentor has expressed that the publication is a misrepresentation of the work as work by a single author.

The OWL Editorial Board has agreed to implement a new phase of the editing process, including adding a faculty verification form to ensure that all parties involved in the undergraduate research project agree to its publication.

ARTICLES

A NOVEL LOOK AT THE FEMALE GOTHIC

Ana Dolorit

Ana Dolorit is a second-year undergrad majoring in Literature, Media, and Culture with minors in Psychology and Political Philosophy. Ana has participated in two undergraduate research symposiums to date, exhibiting her research in religious freedom and the interactions between police body-worn cameras and citizen race. Next year, she will be developing an Honor's in the Major thesis on the political pertinence of Marshall Mather's lyricism. Ana is committed to exploring political inquiries, but she has also published personal articles and poems through FSU's Her Campus chapter and Woman Student Union's annual magazine, Her Voice. Besides her research and academics engagements, Ana spares no effort to look past superficial labels and search for authenticity in the ruffles of life.

Abstract

The Female Gothic, as coined by Ellen Moer in her celebrated novel *Literary Women*, presents women's domestic roles through the supernatural to express the horrors of their docility. Narratives pertaining to this literary canon are frequently considered reflective of a woman's journey toward liberation. By analyzing current film and television narratives alongside a classic short story, this paper reveals reveals a neglected aspect of the Female Gothic mode. The conversation centered on the characteristics of the Female Gothic, while fitting in its observations, disregards the medium that realizes such familiar themes as female entrapment and a suppressive male antagonist. Through fastidious analyses of Charlotte Perkins Gilman's "The Yellow Wallpaper," along with Netflix's miniseries *The Haunting of Bly Manor* (2020) and Universal Picture's *The Invisible Man* (2020), this essay demonstrates how the act of looking effectuates women's doubts over domestic confinements.

Keywords: Female Gothic, act of looking

Marriage, motherhood, and mansions all share something in common; whether figuratively or physically, they entrap women in the sphere of domestic life. Accordingly, it is no wonder they comprise critical parts of the Female Gothic, a literary mode originally coined by Ellen Moers. In Moer's 1976 novel *Literary Women*, she defines Female Gothic elements, specifically how they manifest internal fears about domiciliary life. Ellen Ledoux expounds Moer's definition in her research as a portrayal of "how eighteenth- and nineteenth-century women novelists employ certain coded expressions to describe anxieties over domestic entrapment and female sexuality" (2017, p. 1). In essence, the Female Gothic is a form of gothic orchestrated by women to reveal their often untapped desires to be free of societal pressures and limitations.

Like other literature genres, the Female Gothic has distinguishable requisites, such as a troubled heroine, an oppressive male antagonist, a mysterious mansion, and, according to author Greg Johnson (1989), "familiar Gothic themes of confinement and rebellion, forbidden desire, and 'irrational' fear,'" (p. 3). These characteristics are evocative of several narratives from authors like Jane Austen, Emily Brönte, and Charlotte Perkins Gilman. In Gilman's short story "The Yellow Wallpaper," she incorporates all the essential components of Female Gothic. Indeed, Gilman's unfortunate narrator resides in a "colonial mansion, a hereditary estate," where her oppressive husband treats her postpartum depression, or what he firmly believes to be "a slight hysterical tendency" (2008, p. 3). Gilman's story certainly encapsulates such themes as imprisonment, resistance, refused desire, and, more indispensably, irrational fear. Gilman's narrator elicits her untenable panic through her perception that someone (and at times, some thing) is watching her. This fear translates seamlessly to the character of Dani Clayton (Victoria Pedretti) in the Netflix series *The Haunting of Bly Manor* and Cecilia Kass' (Elisabeth Moss) experience in the 2020 film adaptation of *The Invisible Man*. The show, in conformity with the Female Gothic, embraces aspects of the "The Yellow Wallpaper," such as "'imprisonment' in an old mansion, claustrophobia and a propensity for violence" (Bāniceru, 2018, p. 10). Dani's claustophobia is allusive to Gilman's narrator's fierce disdain for the room her husband kept her in. Cecilia's account can likewise be compared to and analyzed with features of the Female Gothic. Similar to Gilman's narrator, Cecilia is apprehensive of her husband due to his abusive tendencies; her story reflects the Female Gothic by portraying an oppressive marriage and a longing to rid herself from it.

Each story presents the womens' inner fears, notably relating to the domestic realm, as supernatural figures that place them under observance. Whether a wallpaper, a recurring vision, or a husband with invisibility, the looking presence of each entity symbolizes domestic confinement. More emblematically, the stories incorporate protagonists with seemingly fallacious anxieties over

the surveillance imposed on them. This suspicion, for all characters, is a direct result of their adverse relationships with different forms of female entrapment. Arguably, the feeling of being watched lends itself as another staple of Female Gothic, as it undeniably realizes women's intrinsic yearnings to dismantle domesticated structures. Tied to the more popular elements like a suppressive male antagonist and self-discovery, the act of looking is the medium through which supernatural beings reflect women's realistic anxieties.

In the "The Yellow Wallpaper," three distinct entities watch the narrator, embodying her misgivings about marriage's traditional gender roles, domestic expectations, and the limitations that the former two place on women. The narrator's husband, John, John's sister Jennie, and the wallpaper, respectively, represent these fears. Gilman's personification of these horrors allow domestic conventions to veritably observe the narrator, in turn catalyzing her psychosis. Each entity symbolizes its particular piece of the domesticized whole in order to draw connections between the act of watching and the Female Gothic mode.

John's character exemplifies the aspects of matrimony that force an inferior status on women. He deprives the narrator of her bodily-autonomy, self-authority, and infantilizes her—all in the name of marriage. The image of marriage Gilman presents is one of highly (and dangerously) gendered positions, including an "all-controlling husband" (Bāniceru, 2018, p. 10). For example, the narrator repetitively questions her authority in matters of personal health, rationalizing "What is one to do" (Gilman, 2008, p. 5)? It is additonally implied and explicitly mentioned that John aims to restrict the narrator's actions and thoughts. For instance, the entire narrative is structured through the narrator's secret diary entries as she hides her thoughts from John. Her husband also verbally attempts to control her judegement: "There is nothing so dangerous, so fascinating, to a temperament like yours. It is a false and foolish fancy. Can you not trust me as a physician when I tell you so?" (Gilman, 2008, p. 25). Being the narrator's physician and her husband are interchangeable to John, practically synonyms, because they both permit him ascendancy. Lastly, John infantilizes her throughout the narrative to establish the division of power in their marriage. By calling her "little girl" and "little goose," he verbally deprives the narrator of equal status (Gilman, 2008, p. 23, p. 11).

Consequently, the narrator's fear of being seen by John is an analogy for her apprehensions concerning the traditional dynamics of marriage, in which men are irrevocably granted more power. The Female Gothic "centers its lens on a young woman's rite of passage into womanhood and her ambivalent relationship to contemporary domestic ideology, especially in joint institutions of marriage and motherhood" (Davison, 2004, p. 48). Consider Carol Margaret Davison's

(2004) claim in her critical essay "Haunted House/Haunted Heroine: Female Gothic Closets in 'The Yellow Wallpaper'":

> Her husband's failure to respond to her needs and take her seriously, thus denying her experience legitimacy, results in a concerted *repression of her natural and authorial instincts* [emphasis added] and a severe distrust that blossoms into a *paranoid conviction* [emphasis added] that she is the victim of a well orchestrated conspiracy involving her husband and his sister… (p. 60)

Davison acknowledges that John's authoritarian tendencies, inarguably a result of his title as a husband, perpetrate the narrator's irrational fear. She also appropriately interprets the suppressive male antagonist and irrational fear as indicators of a larger mode—the Female Gothic. What she and other scholars have failed to identify, however, is *how* the narrator's fear of being watched connects to other Female Gothic notions like female entrapment. John's looking is the omitted variable in the equation. Indeed, it is his scrutinizing presence that actualizes the narrator's inner fears of marriage and therefore promotes the Female Gothic.

Davison does not specify the nature of the conspiracy and instead ignores the basis of the narrator's "paranoid conviction" (2004, p. 60). However, it is evident that the narrator's distrust of and conspiracy against John are rooted in her wariness of his constant supervision. Gilman showcases a narrator who's hyper-conscious of her husband's seeing presence: "There comes John, and I must put this away,—he hates to have me write a word" (2008, p. 9). Veritably, the narrative structure is influenced by the narrator's concern over John's watching. After admitting that she is "getting a little afraid of John," the entry continues: "I have watched John when he did not know I was looking, and come into the room suddenly on the most innocent excuses, and I've caught him several times LOOKING AT THE PAPER!" (Gilman, 2008, p. 28). The narrator's capitalization underscores the significance of this act; she is afraid of him as a result of his looking. Moreover, the paper is widely interpreted to be a personification of herself, so John's observance of the paper is an additional layer of his looking at her.

Looking as a means of revealing women's inner fears is not restricted to John and his representation of marriage roles; Jennie's looking likewise exposes the narrator's anxiety over domestic expectations. Jennie embodies the "enthusiastic housekeeper" perfectly fulfilled with household chores and domestic conventions (Gilman, 2008, p. 15). Jennie's degree of domesticity is undoubtedly established by the narrator: "Of course I didn't do a thing. Jennie sees to everything now" (Gilman, 2008, p. 16). The narrator gladly relinqushes her household duties

because she resents the traditional model of womanhood. For that reason, the narrator's suspicion over Jennie's looking is more adequately described as a fear of "the pillars of domesticity" (Bāniceru, 2018, p. 10). The narrator is as acutely aware of Jennie's seeing presence as she is of John's. She repeats, "There comes John's sister... I must not let her find me writing" (Gilman, 2008, p. 15). By concealing her true inclination, free self-expression, from Jennie, she is hiding from the overwhelming and demaning expectations of womanhood. As the narrator initiates her psychosis, she admits that "Jennie has an inexplicable *look* [emphasis added]" (Gilman, 2008, p. 27,). Once again, looking is portrayed as an act that is fear-inducing and supernatural, accentuating it as an element of the Female Gothic.

If John and Jennie's looking represent marriage and domesticity, sequentially, then the wallpaper's "unblinking eyes" symbolize the barriers these impose on women. Explicitly described as "bars," the outside patterns entrap a woman that is "trying to climb through" (Gilman, 2008, p. 32). The narrator displaces her fears onto the wallpaper, in turn resonating with this woman. For example, the fact that the woman "creep[s] about behind the pattern" is a projection of the narrator's adverse attitude toward domesticity and her inferiority as a wife (Gilman, 2008, p. 22). The crawling is thus a palpable reference to John's infantilization of her and the creeping woman's entrampment by the outside pattern reflects the narrator's anxieties over the constraints of marriage and domestic chores. The wallpaper, then, is a symbolically-charged, imagined observer that the narrator constructs in her psychosis.

Gilman's vehicle of choice, the wallpaper's looking, achieves the supernatural to express the central elements of the Female Gothic. The wallpaper, according to the narrator, has "two bulbous eyes [that] stare at you upside down...the eyes go all up and down the line, one a little higher than the other" (Gilman, 2008, p. 13). Immediately devising a looking presence in the object representing her internal struggles, the narrator introduces the wallpaper with eyes. Certainly, the fact that the eyes are upside down reflects the narrator's own deterioration—a reminder that her own life is in disarray. In the same manner that her concerns about matrimony and docility seem to watch over her, female entrapment lurks in the wallpaper as an entity capable of "expression" (Gilman, 2008, p. 14). The act of looking becomes a pinnacle of Gilman's Female Gothic mode, allowing her narrator's fears to watch her.

The ending of "The Yellow Wallpaper" subverts the narrator's forebodings by denying them a looking presence: Jennie, the human portrait of domesticity, is forbidden from entering the room; John, a symbol for the inherent patriarchy in marriage, faints before the narrator repeatedly walks over him in a physical act

of new-found dominance. The narrator tears down the wallpaper as she escapes the "social, domestic, and psychological confinements of a nineteenth-century woman writer" (Johnson, 1989, p. 3). With nothing and no one left to observe her, the narrator "got out at last" (Gilman, 2008, p. 41).

The act of looking, as established in “The Yellow Wallpaper,” continues in modern media. In *The Haunting Of Bly Manor* and *The Invisible Man*, there is perceptible usage of looking to evoke terror in the female protagonists. Dani Clayton and Cecilia Kass dread their ex-lovers' seeing presence, which restrain their autonomy and agency for unique reasons.

The miniseries *Bly Manor* underscores a woman's plight over her sexuality, which, as maintained by Moers, is a salient point of the Female Gothic. A significant portion of Dani's irrational fear stems directly from her perception that Eddie, her deceased fiancé, is watching her. Dani bears immense guilt over his death, blaming herself and, more profoundly, her queerness. During their break up, she admits her sexuality in subtle language: "I just thought I was being selfish, that I could just stick it out and eventually I would feel how I was supposed to" (Flanagan, 2020). Eddie reacts fervently, stepping out of the car onto the last moments of his life. As his glasses illuminate with the headlights of an oncoming truck, Eddie’s life ends suddenly. Dani screams as she watches her fiancé die.

Dani’s trauma becomes supernatural as Eddie returns to her life in the form of a hallucination whose gaze pierces through looking-objects like mirrors and glass windows. The vision of Eddie that Dani conjurs is complete with bright shining glasses, undoubtedly signaling that she feels watched by him. Eddie follows Dani wherever she goes—depicted by her meticulous covering and avoidance of mirrors or reflective surfaces. Terrified to look into mirrors, Dani avoids the reality of her past. On the surface, it’s Eddie; and in a deeper sense, it is her lack of self-identity and resentment toward heteronormative marriage roles. Dani’s psychotic hallucinations—reminiscent of Gilman's narrator—are precipitated by the burden she carries over not submitting to an idealized marriage. Eddie is the only character to appear in mirrors because he serves an exclusive purpose in the narrative: His role as Dani's intrusive vision reflects the "conflicts within [herself]... regarding her own sexuality and identity" (Davison, 1989, p. 53). The mirrors and his glasses therefore become symbolic objects that register the act of looking as a medium of invoking fear, substantiating it as part of the Female Gothic.

Of the reoccurring moments in which Eddie watches Dani, there is one that proficiently epitomizes his looking as an element of the Female Gothic. Dani and her love interest, Jamie (Amelia Eve), are sharing a passionate kiss when Eddie

and his gleaming glasses appear behind Jamie. This scene leaves no doubt that Eddie's character is a materialized version of Dani's ambivalence toward her sexuality and her failure to fit into a typical marriage framework. She frightfully notices Eddie observing her as she advances toward self-discovery, suggesting that her anxieties are looking back at her. Therefore, Eddie's *looking* acts as the intermediary between Dani and her internalized angst. Without his penetrating gaze, the theme so familiar to the Female Gothic would not evince itself.

In another instance of contemporary media engaging with the Female Gothic, the 2020 film *The Invisible Man* conspicuously employs the act of looking to reveal Cecilia's dismay over her oppressive husband Adrian (Oliver Jackson-Cohen). Cecilia's story begins with an escape from Adrian's modernized mansion. She flees because, as the audience quickly discerns, Adrian is aggressive and controlling. As she silently maneuvers throughout the house, she passes a screen displaying several angles of security footage, immediately stressing the seeing presence her husband has on her. Cecilia disables the cameras before she flees, signaling a need to be surveillance-free before she can proceed to act out of her own free will. She also pauses in front of what initially appears to be nothing but is truly Adrian's invisibility suit. Her hesitant glancing reflects and foreshadows the looking trope; she unknowingly observes the symbolic-object that Adrian will later utilize to haunt her. Later, while in hiding at her friend's house, Cecilia learns of Adrian's alleged suicide. Yet, Cecilia's intuition is too strong; she is sure that Adrian is still somehow watching her (Whannell, 2020).

As if perfectly cut from the Female Gothic whole, *The Invisible Man* incorporates various forms of domestic grievances and a supernatural entity to embody them. Not only is Cecilia attempting to evade an oppressive marriage, but Adrian also threatens to continue ravaging her life unless she submits to motherhood. Cecilia detests Adrian because of his overpowering position in their relationship and his threat to force maternity on her. Accordingly, his aggressive watching—even prior to the invisibility—alludes to the established trope of women's fears physically looking back at them.

Like Gilman's narrator, Dani and Cecilia ultimately break loose from the forces threatening to suppress them in physical acts of dominance. John's fainting enables the narrator to tear down the paper, a symbol of female entrapment, without being watched by him. Dani's act of rebellion has analogous intentions—she throws Eddie's glasses in a fire to psychologically cut ties with his looking and appreciate her authentic identity. Lastly, Cecilia wears the invisibility suit to stage Adrian's murder as a suicide. After she kills him, she stands out of view of his cameras while looking down at him. Her intentional avoidance of the camera insinuates that she is simultaneously free of his watching and of

the threats that his surveillance superimposed on her. All three women fulfill their needs—those of liberty, independence, and self-acceptance—after their overlapping fears no longer observe them.

In "The Yellow Wallpaper," *The Haunting of Bly Manor*, and *The Invisible Man*, the female protagonists suffer from untenable panic provoked by the manifestation of their fears. While such terror is familiar to the Female Gothic, the medium by which it is incited has been over*looked*. Literary critics acknowledge that the female characters in the Female Gothic mode are apprehensive of domestic confinements, but they neglect the *manner* in which those anxieties are realized, namely the looking presence of symbolically-charged entities. John, Jennie, and the wallpaper represent several domestic impediments that, through watching Gilman's narrator, induce the mental-spiral leading to her defeat of female passivity. Eddie's luminous eyes follow Dani across the world, constantly reminding her of the internalized guilt and shame she holds regarding her sexuality and identity. Through a physical gesture against Eddie's gaze, Dani divorces the heteronormative structure of marriage that once prevented her from living candidly. Adrian maliciously places Cecilia under his surveillance throughout the entirety of their relationship, designing an environment where she would always be the oppressed, subservient wife. He further attempts to manipulate Cecilia into birthing his child by promising to end his torturous watching. Adrian's looking, therefore, becomes a symbol for the domestic ideologies of marriage and motherhood. When Cecilia stands atop his dying body, out of view from Adrian's infamous cameras, she severs his grip over her body and mind. The three narratives, then, promote the act of looking as a trademark element of the Female Gothic, one that unmasks female protagonists' domestic forebodings.

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SAFETY BEHAVIORS IN GENERALIZED ANXIETY DISORDER: EFFECTS ON SYMPTOM SEVERITY AND TREATMENT OUTCOME

Daniel Emanuel

Daniel Emanuel is a senior from Spring Hill Florida, currently getting his degree in both Biology and Psychology. After graduation, he plans to take gap year to get more research experience before applying to a PhD program in Biology.

Abstract

Safety behaviors are behaviors performed with the intention of reducing and managing threat. Paradoxically, their use leads to increases in anxiety that maintain symptoms across a variety of anxiety disorders. However, the role of safety behaviors in Generalized Anxiety Disorder (GAD) specifically is not well understood. Preliminary research has shown GAD patients engage more frequently in these behaviors, but it is unclear whether safety behaviors are associated with GAD symptoms above the effects of worry and the extent to which they impact treatment outcomes. The current study examined the role of safety behaviors in GAD; we hypothesized a positive correlation between symptom severity and safety behavior usage above the effects of worry, significantly higher levels of safety behavior usage in GAD patients, and a moderating effect of safety behaviors on treatment outcome, with greater usage leading to poorer treatment outcomes. The study was a secondary analysis of a computerized worry reduction treatment study. Participants completed the Penn State Worry Questionnaire, Worry Behaviors Inventory, and DSM-5 GAD symptom severity measure at baseline and follow-up. Safety behavior usage was positively correlated with GAD symptom severity controlling for worry (r=.335, p=.020), but did not differ in those with and without a GAD diagnosis. Contrary to predictions, heightened safety behaviors at baseline were associated with better treatment outcome. The study lends support to the consideration of behavioral symptoms in GAD. Future studies should further clarify the interaction between cognitive and behavioral avoidant strategies in this condition.

Keywords: safety behaviors, worry, GAD, behavioral avoidance, cognitive avoidance, computerized worry treatment.

SAFETY BEHAVIORS IN GENERALIZED ANXIETY DISORDER

Generalized Anxiety Disorder (GAD) is characterized by excessive worry about various activities and situations, such as health, work, or home life (American Psychiatric Association, 2013). A great deal of research has shown that anxiety disorders such as GAD are maintained by avoidance of anxious situations (Mahoney et al., 2016; McManus et al., 2008; Robichaud, 2013; Wells et al., 2016). A common avoidance strategy exhibited across the anxiety disorders is the use of safety behaviors, which are behaviors performed to minimize or manage threat in an anxiety-provoking situation (Beesdo-Baum, et al., 2012). Examples include excessive reassurance seeking, which is the process by which an individual seeks constant reaffirmation from those around them to reduce their anxiety, and excessive planning for a worst-case scenario (Beesdo□Baum et al., 2012; Gillett & Mazza, 2018).

Safety behaviors are perpetuated through negative reinforcement, as their use results in a reduction in anxiety (Salkovskis, 1991; Salkovskis et al., 1999). For example, if a patient with GAD fears that a loved one will be in a car crash coming home from work, they may excessively ask a friend for reassurance that a crash did not occur. In the short-term, this reassurance-seeking will reduce anxiety. However, in the long-term, these anxiolytic effects reinforce both the perception that a situation is threatening and the use of safety behaviors whenever the situation arises. This is problematic because safety behavior use can also prevent disconfirmation of threat, since individuals attribute positive outcomes to the use of the safety behavior, rather than to the inherent safety of the situation (Salkovskis et al., 1999). The use of safety behaviors thus prevents safety learning regarding the situation itself (Blakey & Abramowitz, 2016).

To date, GAD research has primarily focused on cognitive mechanisms, such as worry, that maintain the disorder by helping an individual manage threat through avoidance (Borkovec, et al., 2004). However, safety behaviors, such as reassurance-seeking and checking, are frequently present in individuals with GAD and are likely to have similar clinical implications to the use of safety behaviors in other anxiety disorders. As a result, Mahoney and colleagues (2016, 2018) developed the Worry Behaviors Inventory (WBI), to assess safety behavior usage in GAD. The WBI includes a range of safety behaviors, such as reassurance seeking, excessive planning, and repeated checking. The measure was shown to be a valid tool in assessing safety behavior usage in GAD, possessing convergent validity with the GAD-7 and Penn State Worry Questionnaire (Mahoney et al., 2016) . Furthermore, the WBI was shown to be elevated in individuals with a GAD diagnosis compared to controls (Mahoney et al., 2016). However, neither this study nor past investigations examined if the associations between safety behaviors and broader GAD symptoms existed independently from worry. As such, it is still unclear whether worry and safety behaviors are

redundant constructs, especially given that both are avoidant means of reducing anxiety (Borkovec et al., 2004). With the growing push for behavioral components to be incorporated in clinical guidelines for assessing GAD (Lebeau et al., 2012), it is important to clarify the relationship between GAD symptoms, safety behaviors, and worry.

Across anxiety disorders, the use of safety behaviors during treatment can worsen treatment outcomes (Beesdo□Baum et al., 2012; Helbig□Lang & Petermann, 2010; Salkovskis, 1991; Salkovskis et al., 1999; Sloan & Telch, 2002), but few studies have examined the impact of safety behaviors on GAD treatment outcome specifically. Effective treatment often requires fear confrontation to promote habituation and provide corrective information for the perceived threat (Foa & Kozak, 1986; Schmidt et al., 2012). As safety behaviors are inherently avoidant, their usage hinders fear confrontation by lowering arousal and preventing threat disconfirmation and habituation (Salkovskis, 1991; Salkovskis et al., 1999; Schmidt et al., 2012; Wells et al., 2016). The coupling of safety behaviors to threat and anxiety can also cause safety behaviors to serve as cues to be anxious (Gangemi et al., 2012). If an individual is unsure of how to respond to a situation and notices they are using their safety behaviors, they may interpret this to mean the situation is something to be anxious about (Van den Hout et al., 2014).

Most research on the impact of safety behaviors on treatment has focused on anxiety disorders other than GAD (Salkovskis et al., 1999; Wells et al., 2016). Beesdo-Baum and colleagues (2012) examined safety behavior usage in the context of GAD treatment, finding that GAD patients exhibited greater safety behavior usage than healthy controls and higher safety behavior usage at post-treatment was associated with higher worry ratings six to twelve months after treatment, accounting for post-treatment worry ratings. However, the study utilized exposure-based and applied relaxation treatments, whereas GAD treatment typically includes an emphasis on cognitive mechanisms (Zinbarg et al., 2006). As such, it will be important to examine whether safety behaviors, not typically targeted in cognitive treatments, impact treatment outcomes.

The current study sought to examine the importance of safety behaviors in the context of a treatment study of individuals with elevated worry, many of whom met criteria for GAD. While past studies have demonstrated a positive association between safety behaviors and GAD symptoms, it is unclear if this effect is redundant with worry. Worry is a cognitively avoidant strategy (Borkovec, et al., 2004), which may differ from the behavioral avoidance exhibited with safety behaviors. The study also analyzed whether usage of safety behaviors impacted treatment outcomes in a novel Worry Disengagement Training (WDT) intervention for pathological worriers. This computerized treatment

involves having individuals alternate between writing about worry and positive non-worry topics to facilitate attentional disengagement from worry (McDermott & Cougle, in press). While safety behavior usage negatively affects treatment outcome in the context of exposure therapy (Beesdo□Baum et al., 2012; Salkovskis et al., 1999; Sloan & Telch, 2002), it is unclear how these behaviors will affect WDT, a more cognitively focused treatment.

To address the first area of concern, the distinction between worry and safety behaviors and their effect on GAD, we hypothesized that safety behavior usage would be positively correlated with GAD symptoms above the effects of worry. We also hypothesized that individuals with GAD would present with higher levels of safety behaviors than worriers without GAD (Mahoney et al., 2016; Mahoney, Hobbs, Newby, et al., 2018). When discussing the effects of safety behaviors on treatment outcome, we hypothesized that greater safety behavior use at baseline would be associated with worse treatment outcome because safety behaviors are likely to keep individuals focused on sources of threat and distract them from considering positive alternatives to worry.

Methods

Participants

The current study made use of existing data collected from an experimental study assessing the potency of computerized treatments for worry (McDermott & Cougle., in press). Fifty participants were recruited (92% female), with an average age of 19.02 (SD=1.62). Participants were recruited via the FSU subject pool. The sample was restricted to those high in worry (PSWQ score above 60), with 66% (*n*=33) meeting criteria for GAD.

Measures

Penn State Worry Questionnaire (PSWQ) (Meyer et al., 1990). This 16-item questionnaire measures an individual's level of worry. Items on this scale included statements such as "I do not tend to worry about things." Participants responded to these items on a scale from 1 ("not at all typical of me") to 5 ("very typical of me"). This measure was used to obtain pre- and post-treatment levels of worry in participants to determine the effects that safety behaviors have on post-treatment reductions in worry. Internal consistency was adequate in the current sample (α=.75).

Worry Behaviors Inventory (WBI) (Mahoney et al., 2016). This 10-item measure assesses the use of common safety behaviors, especially reassurance seeking, individuals who show signs of GAD. The measure asks participants to rate the frequency of which certain statements (i.e. "I seek reassurance from sources of information (e.g. personal records, internet, reviews, books)") apply to them on a scale from 1 ("No, not at all") to 7 ("Very much"). The purpose of this measure is to find the frequency of safety behavior usage to assess the

role safety behaviors have on GAD symptoms and treatment outcomes. This measure displayed good internal consistency (α=.80).

Severity Measure for Generalized Anxiety Disorder–Adult (GAD5) (Lebeau et al., 2012). This 10-item measure examines the severity of GAD symptoms over the past seven days. Participants provide the frequency of their symptoms (i.e. "felt moments of sudden terror, fear or fright.") on a scale from 0 ("Never") to 4 ("All of the time"). This measure allows us to observe symptom severity at baseline and determine if this is associated with safety behavior usage. The measure had less than adequate internal consistency (α=.68) .

Procedures

Participants completed an initial screening at the beginning of the first lab visit in which it was determined whether they met the diagnostic criteria for GAD. After this, the participant filled out a series of baseline questionnaires. Following the completion of these tasks, those in the treatment condition completed a treatment session in the lab, then returned to the lab to complete an additional two treatment sessions over the course of the week. They then completed three additional treatment sessions at home, after which they came back in for a follow-up visit. Those in the waitlist condition returned for the same follow-up assessment.

Treatment

Worry Disengagement Training (WDT) (McDermott & Cougle, in press). Participants engaged in six sessions of treatment, each lasting approximately 30 minutes. Treatment included four writing periods for worry and four writing periods for non-worry alternatives for disengagement; participants alternated between worry writing and non-worry writing for the duration of the session. Worry writing periods asked participants to discuss a current, future-oriented worry, describing their thoughts and fears about the worry topic. After completing a worry period, participants were prompted to disengage and focus on positive alternatives to worry such as meaningful activities, future goals, and helping others. By alternating between worry writing and positive non-worry writing, the treatment intended to increase attentional disengagement abilities that could be applied whenever individuals begin to worry.

Data Analysis Plan

A bivariate correlation was used to examine the association between safety behavior usage and GAD symptom severity. A follow-up partial regression looked at this association while controlling for worry. An independent samples t-test was used to examine if there were differences in mean safety behavior usage based on GAD-status. To determine the interaction between treatment condition and behavior usage in predicting treatment outcome, hierarchical regressions were conducted. Step one included centered condition, centered

WBI, and pre-PSWQ scores. Step two added the interaction term for WBI and condition. For both steps, the outcome variable was post-PSWQ score. Additional regressions looked at the interaction effect when WBI scores were high and low using one standard deviation above and below the mean.

Results

In line with our first hypothesis, bivariate correlations showed that, at baseline, safety behavior usage was positively correlated with GAD symptoms (r=.374, p=.008) but not worry (r=.179, p=.219). The pre-planned partial correlation to examine the association between safety behaviors and GAD symptoms controlling for worry was performed and showed that the association was still significant when controlling for the effects of worry (partial r=.335, p=.020). Our second hypothesis was not supported, as the independent samples t-test showed that there was no difference in safety behavior usage in participants with (M=23.56 , SD=7.13) and without GAD (M=24.76, SD=6.14; t(47)=.589, p=.559). Our third hypothesis was partially confirmed, as safety behavior usage moderated the association between treatment condition and post-treatment PSWQ scores, such that this association was significant only for individuals high in baseline safety behaviors (Table 1). However, contrary to our hypothesis, this association was negative. Post-treatment reductions in worry were present only for those high in baseline safety behavior usage (β=-.640, p<.001), whereas there was no association between condition and outcome for those low in safety behavior usage (β=-.115, p=.479). Individuals with higher baseline safety behaviors experienced greater benefits from treatment and lower safety behavior usage had no effect on treatment outcome.

Discussion

Safety Behaviors and GAD Symptoms

The current study assessed the association between safety behaviors and GAD symptom severity, and the impact of baseline safety behaviors on treatment outcome for pathological worry. We hypothesized that greater safety behavior usage would be correlated with increased GAD symptom severity, controlling for the effects of worry. We found a positive association between safety behaviors and GAD symptoms, consistent with past studies detailing the link between GAD symptoms and safety behavior usage (Beesdo□Baum et al., 2012; Cougle et al., 2012; Mahoney et al., 2016). Further, this relationship remained significant when controlling for worry, indicating that safety behaviors are not redundant with worry in their impact on disorder symptoms. These results emphasize the importance of considering these behaviors in the clinical presentation of those with GAD and point to the need for further examinations of the causal associations between safety behaviors, worry, and broader GAD symptoms. As recent studies have demonstrated bidirectional mediation of cognitive and behavioral

avoidance in predicting symptom severity (Mahoney, Hobbs, Williams, et al., 2018), future research should incorporate the present findings to examine how safety behaviors and worry function independently and in tandem to affect GAD symptoms.

Safety Behavior Usage Differences in GAD

Our second hypothesis predicted that individuals with GAD would exhibit higher safety behavior usage than those without GAD; this hypothesis was not supported. We found no difference in safety behavior usage in those who did or did not meet diagnostic criteria for GAD. It is possible safety behaviors are linked to greater symptom severity but cannot be used to differentiate those with and without GAD. This relationship, however, is not in line with previous findings, which have shown that safety behaviors are more common in GAD patients (Mahoney et al., 2016; Mahoney, Hobbs, Newby, et al., 2018). The nature of our sample should be considered when evaluating this discrepancy; the present study was restricted to high worriers regardless of GAD status. It is possible that current safety behavior measures have less ability to differentiate individuals with and without GAD at higher levels of worry.

Safety Behaviors and Treatment Outcome

Our third hypothesis was that safety behaviors at baseline would worsen treatment outcomes, and this hypothesis was partially supported. While baseline safety behaviors did interact with treatment condition in predicting post-treatment worry ratings, we found that this was only in participants with high safety behavior usage. The treatment was only effective in reducing worry for individuals with heightened baseline safety behaviors. This result was the opposite of what we hypothesized, as we predicted high baseline safety behavior usage would worsen treatment outcomes. While several studies have shown that safety behavior usage can negatively affect treatment outcomes across anxiety disorders, these studies focused on treatment involving worry exposure (Beesdo□Baum et al., 2012; Salkovskis, 1991; Salkovskis et al., 1999; Wells et al., 2016). As the current treatment focused on attentional worry disengagement, safety behaviors may affect treatment via a different mechanism. Anxious individuals who use safety behaviors tend to over or under-engage with their anxiety (Mahoney et al., 2016). Safety behaviors involve either the inability to disengage from worry, for example through checking, planning, or seeking reassurance, or avoidance of engagement with worries, for example through avoiding situations, thoughts, or people that cause worry. As the aim of WDT was to train appropriate levels of engagement with worry, it is possible that participants with heightened safety behavior usage at baseline may have especially benefitted from WDT due to these preexisting deficits in disengagement ability that were directly targeted with this treatment.

Limitations

Several limitations exist that impact the findings of this study. As mentioned previously, the sample was restricted to only those high in worry. In addition, the sample was predominately female undergraduates. Both factors limit the generalizability of this study to the general public and to treatment-seeking populations. Another limitation is the lack of tracking safety behavior usage during treatment. As this was a secondary data analysis, tracking safety behavior usage at each treatment session was not included in the original protocol. Due to this limitation, it remains unclear if changes in safety behavior usage during treatment impacted outcomes, or whether our interaction findings could be attributable solely to baseline differences. Future studies should monitor safety behaviors throughout treatment to determine if safety behaviors employed during treatment impact outcomes. Finally, the current study employed a cross-sectional design, limiting conclusions about the directionality of the relationships we found, particularly that between safety behaviors and symptom severity. Future studies should incorporate a longitudinal design to clarify the relationship between behavioral avoidance and GAD symptoms above the effects of worry. Additionally, such a study could examine temporal effects between safety behaviors and worry.

Conclusion

The current study found safety behaviors were positive associated with GAD symptom severity controlling for the effects of worry. These findings add further support to the inclusion of behavioral symptoms in the clinical evaluation and treatment of GAD. Furthermore, our findings suggest that individuals who frequently use safety behaviors may actually experience greater benefits from treatment targeting disengagement from worry. This supports the notion that safety behaviors should be assessed prior to treatment. Understanding baseline levels of safety behavior usage can aid clinicians in better assessing treatment outcomes.

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NONLINEAR CURRENT-VOLTAGE CHARACTERISTICS DUE TO ION MIGRATION IN LOW-DIMENSIONAL ORGANIC METAL HALIDE HYBRIDS

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Abstract

Perovskite-related metal halide hybrids are currently a hot topic in materials research because of their affordability, efficiency, and abundance. Rapid advances are being made in terms of improving the performance of perovskite-based photovoltaics, but the materials remain unstable in the presence of light, moisture, and heat. A more comprehensive understanding of the physical processes of these materials is necessary for us to make improvements to the stability and efficiency of organic metal halide hybrids. Specifically, much research in this field focuses on higher-dimensional (2D, 3D) structures. Lower-dimensional materials (1D and 0D) may provide more stability by virtue of their molecular structures but require further investigation. One issue that is particularly relevant to stability is ion migration in these materials, in which mobile ions move as a result of an applied electrical bias and induce an electric field that opposes said bias. This research examines data taken from several lower-dimensional samples while they are exposed to a light source in order to gain a deeper understanding of the electrical transport properties of N,N'-dimethylethylenediaminium tin iodide ($C_4N_2H_{14}SnI_4$). In particular, we will examine the effect that ion migration may have on the current-voltage characteristics of $C_4N_2H_{14}SnI_4$.

Keywords: perovskites, solar, condensed matter, photovoltaics, physics

NONLINEAR CURRENT-VOLTAGE CHARACTERISTICS

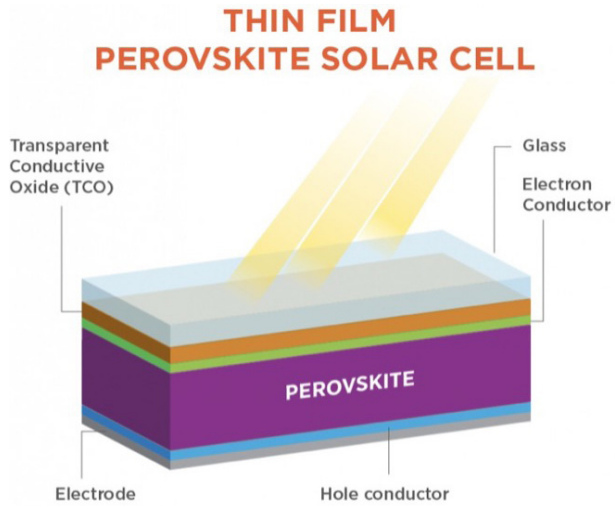
Low-dimensional organic perovskite-related metal halide hybrids are currently a popular research subject in materials science because of their many interesting optoelectronic properties, which suggest promising applications in devices such as solar cells, LEDs, and photodetectors (Liu et al., 2019). These materials have generated interest because they are cheap, abundant, and effective - three qualities that have led some scientists to refer to perovskites as the 'holy grail' of solar cell materials.

In the field of solar energy, it is possible to substitute perovskite metal-halide hybrids for silicon, a semiconductor currently used in over 90% of solar cells on the market ("Perovskite Solar Cells"). Because of perovskite's band gap tunability, it would also be possible to increase the efficiency of current solar cells by using silicon and perovskites in tandem, as perovskites can complement the absorption of whatever substance they are in tandem with ("A History of Perovskite Solar Cells", 2018). Solar cells are formed by a semiconductor layer, known as the absorber layer, that sits between an electron conducting layer (n-type semiconductor) and a hole conducting layer (p-type semiconductor). When the sun's rays strike the solar cell, incoming photons excite electrons in the absorber layer and create free electron-hole pairs known as excitons. These electrons and holes travel along a transport pathway composed of the electron and hole conducting layers and the absorbing layer, and said current is gathered by an electrode.

Silicon solar cells are limited by high cost as well as physical fragility, which makes them difficult to transport. Additionally, perovskite solar cells have achieved conversion efficiencies of up to 25.2% in 2019 (up from 3.8% in 2009) (Vekony, 2020). The current efficiency record for a silicon solar cell is currently 26.7%. While this is higher than 25.2%, it has taken decades to reach this level of efficiency, and research suggests that we are approaching the efficiency limit of silicon("Perovskite Solar Cells"). This implies that with time and research, perovskite based solar cells have the potential to become significantly more efficient and widely available than those made with silicon.

That being said, perovskite solar cells are not yet market-ready because of the substance's susceptibility to moisture, light, and heat. Because they deteriorate so quickly, research must be done to make them more resilient before they become a viable substitute for silicon. Several attempts to improve perovskite solar cell stability have included cell encapsulation, the use of buffer layers, and the optimization of perovskite compositions(Liu et al., 2019). In general, these attempts have been concentrated on two-dimensional (2D) and three-dimensional (3D) perovskites. Our research focuses on the behavior of low-dimensional halide perovskites, in which the metal-halide chains are

Figure 1: Components of a perovskite solar cell. Source: U.S. Department of Energy



insulated by a protective organic cation layer, suggesting that they may be more resilient against environmental factors than their higher-dimensional counterparts (Ma et al., 2019).

One phenomenon that must be understood in order to make advances in perovskite-hybrid technology is the appearance of current-voltage (I-V) hysteresis. When I-V measurements are performed on perovskite samples, hysteresis makes it difficult to accurately analyze or reproduce results (Liu et al., 2019). Hysteresis is also often exaggerated in the presence of a light source (Liu et al., 2019). Several hypotheses for this phenomenon have been offered, including the ferroelectric effect, unbalanced charge carrier transport or ion and ion vacancy migration. This research concentrates on the latter, and the effect that it may have on charge transport in metal halide hybrids.

The purpose of this research is to gain a deeper understanding of the effect that light has on field-assisted ion and ion vacancy migration within metal halide hybrids. This includes identifying which ions may be responsible for the induced electric field, how their motion relates to the bias current, and how many ions may be accumulating at each side of the crystal to induce said electric field.

This thesis is organized into a background, which will give information on metal-halide hybrids as well as field-assisted ion migration. Next, we will describe the experimental methods used to gather our data and present said data. After that, we will present analysis performed on the data gathered over the course of our research. Finally, the findings are summarized into a conclusion and the future of this research is discussed.

Background

Metal-Halide Hybrids

Perovskite is a classification that refers to both the mineral calcium titanate and a class of materials that share the same structure as calcium titanate. While perovskite was discovered in 1839 by mineralogist Gustav Rose, it was mainly used for pigmentation until the discovery of barium titanate in 1945. The substance is named for Lev von Perovski, a Russian nobleman and mineralogist ("A History of Perovskite", 2018).

The classic perovskite structure can be written as ABX_3, where A and B are cations of varying size and X is an anion. ABX_3 has a body centered cubic (BCC) structure, visible in figure 2.

Figure 2: Perovskite unit cell with BCC structure.

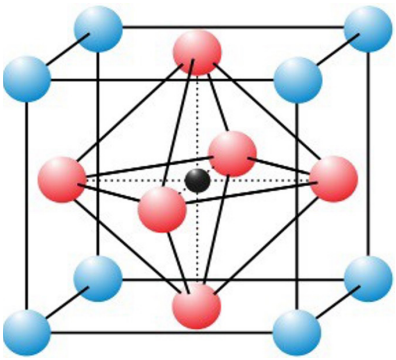


Fig. 2 If we consider the ABX_3 perovskite structure, the blue spheres are the A ions (cations), the red spheres are the B ions (also cations), and the small black sphere at the center is X (an anion). Source: Wikimedia Commons

Metal-halide hybrids fall within the perovskite class but specifically contain a metal and a halogen. Several features, including a high absorption coefficient, ease of tunability and direct band gap make these materials extremely promising for photovoltaic applications.

The most common metal-halide hybrids used in photovoltaic cell research are methylammonium lead iodide ($CH_3NH_3PbI_3$) based (Eames et al., 2015). While some of our research was initially performed with lead iodide, we found that because of the toxicity of lead it was easier to fabricate samples from tin iodide hybrids. Tin has a lone pair of valence electrons just like lead and is in the same periodic group, so it is an acceptable substitute that is already being used in some perovskite-related research (Kamminga et al., 2019). The crystals used in

this experiment are N,N'-dimethylethylenediaminium tin iodide ($C_4N_2H_{14}SnI_4$).

Low-dimensional metal-halide hybrids are of particular interest because of their chemical stability. Typically, the categorization "low-dimensional" can be employed to describe two different classes of perovskites: those with molecular-level low-dimensionality and those with morphological low-dimensionality. Morphologically low-dimensional metal-halides are compounds with physical low-dimensionality. This includes 0D quantum dots, 1D nanowires, and 2D nanoplatelets. Our research is focused on molecular-level low-dimensional metal-halide hybrids. In these measurements, we examined 1D $C_4N_2H_{14}SnI_4$ halide chains. These are formed by long chains of individual metal-halide molecules surrounded by a layer of organic cations. As discussed in the introduction, one of the main concerns surrounding perovskites is stability in the presence of external factors like moisture and heat. The protective layer of organic cations surrounding the unstable metal-halide species tells us that lower-dimensional metal-halides may be more stable than their higher-dimensional counterparts (Ma et al., 2019).

Field-assisted ion migration

Ion migration has frequently been proposed as one phenomenon that may be at fault for the hysteresis commonly found in current-voltage (I-V) data taken from perovskites (Wang et al., 2017). Ionic conduction has been well-documented in perovskite hybrids, both theoretically (Azpiroz et al., 2015) and confirmed experimentally using techniques such as temperature dependent photocurrent mapping (Wang et al., 2017). Additionally, a non-zero voltage shift observed at zero current within our own samples supports this possibility.

Before any bias is applied, mobile ions are distributed evenly across the sample. Once a bias is applied, ions and ion vacancies begin to travel along the applied electric field (E_{bias}) until they accumulate. The buildup of these ions and vacancies causes a separate induced electric field (Eion) that counteracts E_{bias}. Eion increases proportionally to E_{bias} until at some point the hole-current will no longer allow Eion to increase. Once this saturation point has been reached, the electric field that the sample is experiencing is simply the difference between E_{bias} and Eion. After the bias is removed, the relaxation period in which Eion returns to zero has been reported to be on the order of 10^2 seconds (Eames et al., 2015). In this case, it seems that the migrating ions may be I^- ions and their vacancies.

Additionally, it has been shown that photo illumination may have some minor enhancement of ion migration (Xia et al., 2019). More research must be done in this area as no definitive relationship between light and ion migration has been quantified or cemented.

Methods

Synthesis and Fabrication

The crystals used in these measurements were synthesized by Dr. Qingquan He, a postdoctoral fellow in the Ma group of the Department of Biochemistry and Chemistry at FSU. In order to protect the samples from light and moisture, the synthesis took place on a Schlenk line reaction system with N2 protection.

First, a mixture of 10 mL *HI* (57 wt. % in H_2O) and 1 mL H_3PO_2 (1 mL) was heated to 120◦ C and 0.5 mmol of Tin(II) iodide powder was dissolved in. This occurred under nitrogen flow and constant magnetic stirring for approximately 5 minutes. 0.5 mmol of N,N'-dimethylethylenediamine were then added, creating a clear solution. Once this clear solution was reached, magnetic stirring ceased and the solution was left undisturbed at room temperature overnight. During this rest period, the $C_4N_2H_{14}SnI_4$ crystals were able to form. These crystals varied from batch to batch in terms of surface roughness, color, length, and brittleness. An ideal crystal for our measurements needed to be long enough that we could fabricate four contacts on its surface and not so brittle that it would splinter during the fabrication process.

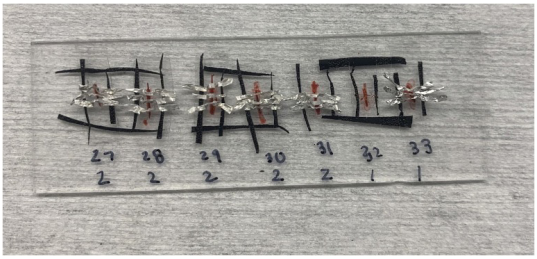
In order to avoid sample degradation from light and moisture, crystals were stored in a glovebox or vacuum system until measurements were taken. Additionally, synthesis was performed relatively close to when samples were prepared and measured.

To conduct electrical measurements on these samples, individual crystals were mounted onto glass slides using a small amount of exposed photoresist. In order to create contacts on the samples, thermal evaporation was performed to deposit 5 nm of Cr and 30 nm Au on the samples. To ensure that this process created four individual electrodes rather than simply depositing an uninterrupted layer of metal onto the sample, two types of shadow masks were used to disrupt the Cr/Au layer in three places. The first shadow mask was fabricated using thin strips of aluminum foil. The foil strips were manually laid above the crystal so that they were not in direct contact with its surface but were held in place by contact tape placed parallel to the crystal. This placement did not allow evaporated Cr/Au particles to reach the sample and created a set of four electrodes on the crystal. While this method allowed us to precisely select where the contacts were placed and control how many contacts were placed on a sample, it was time-consuming as the foil strips had to be extremely thin in order for the gold to evaporate in between strips. Additionally, the process of placing the aluminum foil on the samples presented a danger to some of the more fragile crystals, as it was easy to accidentally damage the surface while applying the foil strips to the contact tape. The second shadow mask was a prefabricated mask made of stainless steel

that could simply be placed over the sample, held in place by contact tape. This method took much less time and created electrodes that looked exactly the same every time but did not allow us much control over the number and placement of the electrodes.

Figure 3: Two different experimental methods used to create Cr/Au electrodes onto our samples.

3a. Aluminum foil strips



3b. Stainless steel shadowmask

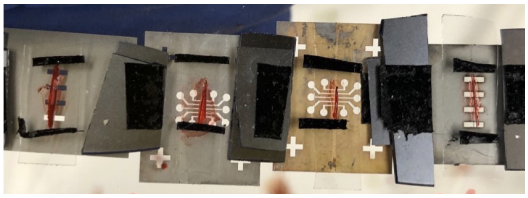


Fig. 3 This is how a sample looked right before it was placed into the evaporator.

After thermal evaporation, the glass slide and attached crystal were attached to an electrical socket with 14 pins, again using exposed photoresist. Silver contacts were then created on the surface of the crystal using silver paint and platinum wire. While it would have been possible to make electrical measurements on the samples using only silver paint and no gold evaporation, silver paint contacts have an inherently high contact resistance. The evaporated Cr allows the silver contacts to adhere to the sample more effectively and the Au mitigates the effect of the resistance of the silver paint on the total measured resistance of the sample. The platinum wire was then soldered with indium to pins on the socket.

Figure 4: This picture is a fabricated sample underneath a microscope.

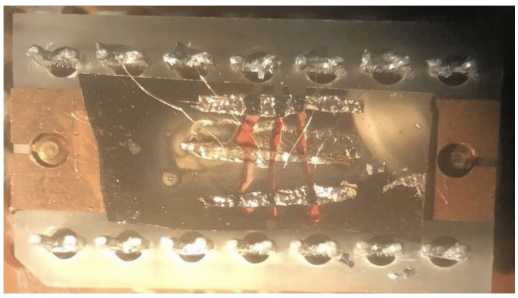


Fig. 4 Lining the top and bottom of the photo are the 14 pins that each contact is connected to by a thin platinum wire. The crystal itself is in the center of the sample. The three red lines are the areas where the aluminum foil mask prevented Cr/Au from evaporating onto the surface.

A total of four contacts were made on each sample. Because each crystal had a length on the order of a few millimeters, it was not productive to try and fit more than four on the sample with space in between each contact. Any less than four would prevent us from being able to neglect contact resistance in our data. With four contacts, we were able to run current across the contacts on each far end of the crystal and measure the change in voltage across the two middle contacts.

The data included in this thesis is from three crystals, all synthesized in the same batch. For this reason they are extremely similar in physical characteristics such as length, color, and surface roughness. The electrodes made on these samples were formed by an aluminum foil shadow mask.

Measurements

The electrical measurements on our samples were performed using a Keithley 2400 source meter and an HP 34401 multimeter. The setup of these two meters and sample can be seen in figure \ref{setup}. Beginning at -30 nA and increasing by increments of 3 nA until 30 nA was reached, a small current was applied from one contact at the far end of the sample to the contact at the opposite end (from here on, these two contacts will be referred to as the current leads). Two main types of measurements were taken on these samples. First, a control run was performed using two terminal (2T) measurements to make sure that the equipment was properly set up and the samples were intact. In this instance, voltage at each of the current leads was measured and the change in voltage between them was plotted against the applied current. Because the silver paint contacts have an inherently high resistance, this is a good way for us to make sure that our setup is working, but an inaccurate measurement as it

measures both the resistance of the sample and the contacts. To get a reading that only measured the resistance of the sample, we performed four-terminal (4T) measurements. Across the two middle contacts, the voltage at each contact (or voltage lead) was measured and the change in voltage between the two leads was calculated. The applied current and voltage drop between the leads was then plotted as an I-V curve.

Figure 5: This is a picture of our experimental setup, taken and labeled by Gillian Boyce.

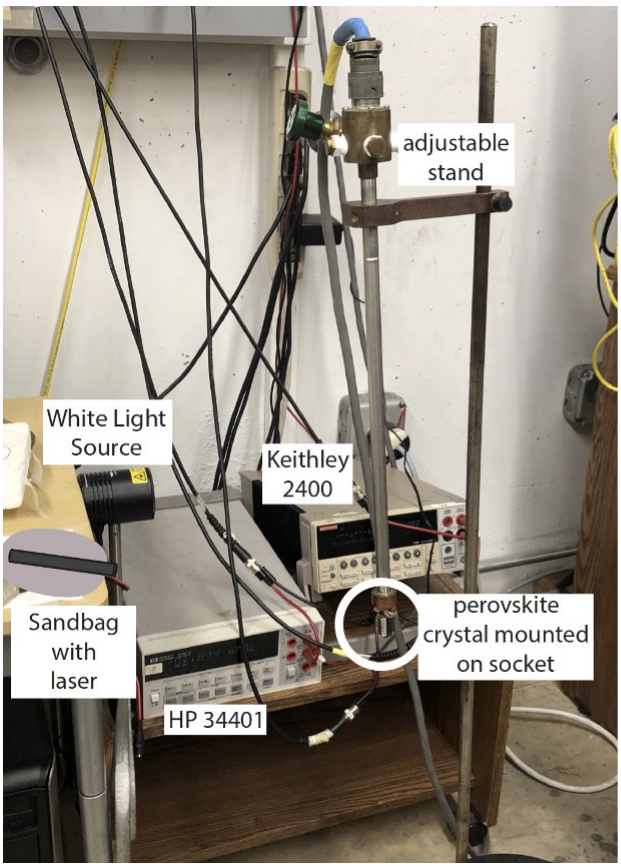


Fig. 5 The socket holding the fabricated sample is connected to the source meter and multimeter by the adjustable stand. On the desk adjacent to the meters is the white light source, and an illustration of how the laser is held in place by a sandbag.

In order to explore how light affected the photovoltaic characteristics of the

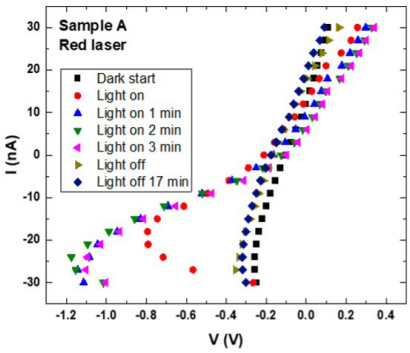
samples, we systematically applied a white light and several different colors of laser to the samples while taking measurements. We used lasers that were red, blue, and green (wavelengths 650, 405, and 532 nm respectively). Because of the small size of the samples, lasers allowed us to concentrate the beam of light directly onto the halide perovskites. The white light had a wider beam, but was still focused over the sample. One factor that can affect how the sample responds to light is exposure time, so a timer was used throughout these measurements to monitor how long the light had been applied or removed. First, a control measurement was made with no applied light source. As soon as the first -30 nA current was applied, we started a timer that kept going through the duration of the measurements. At 1 minute, the light source was turned on and current measurements began at the exact same time. This usually left about 30 seconds relaxation time in between measurements, where the light was not removed or added but no current was being applied to the sample. Measurements were then taken in 1 minute increments for several minutes of light exposure (usually 4 or 5), after which the light was turned off. A measurement was taken at the same time that the light source was removed. After 15 minutes of the sample having no light source placed on it directly, another measurement would be taken to see if any unique behaviors that occurred while the light source was applied were reversible.

Figure 6 shows the I-V measurements for three samples taken from the same batch. Each is experiencing a different monochromatic applied light source. This is the first run for each of these samples, meaning that they were held in vacuum until these measurements were taken and were not previously exposed to a focused light source like the lasers. Each graph has seven curves in total: the first taken with no applied light source, the next four taken with an applied light source, the sixth taken at the exact moment that the light source is removed, and the final taken approximately 15 minutes after the light source was removed and the sample has been left alone.

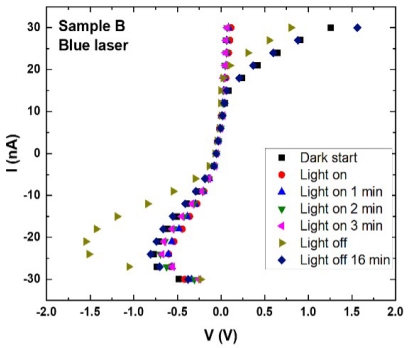
While these three samples have many differences in their data, several qualitative features are similar across the measurements. All of these samples exhibited a clear C-shape occurring at the beginning of the negative applied bias. This curve eventually disappears and is overtaken by a relatively linear I-V shape. That effect seems to increase in the presence of light and decreases eventually in its absence, with some exception. The presence of the C-curve is consistent with our hypothesis that field-assisted ion migration is occurring. Initially, negative ions and their positive vacancies are evenly distributed across the sample. As soon as the negative bias is applied , they begin to migrate, which causes the initial negative slope. At some point Eion cannot increase

Figure 6: IV curves for three crystals from the same batch, each experiencing a different light source.

6a.



6b.



6c.

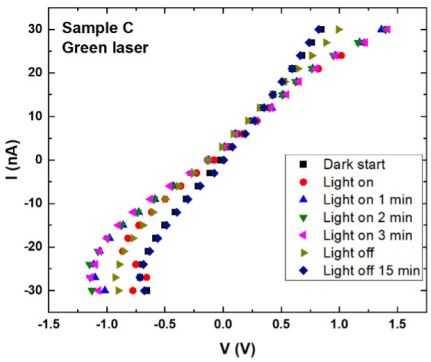


Fig. 6 This is the first run for these samples - in other words, it is the first time that we are testing their response to applied light. Typically, multiple runs were performed on each sample. However, the samples were extremely sensitive to both the current and applied light and deteriorated with each run.

any more, and the slope of the graph becomes positive as the primary source of current becomes charge carrier transport rather than ion migration. A graphical representation of this process is visible in figure 7.

Additionally, the slope (or resistance) of the quasi-linear section of graph that occurs immediately after the C-shaped curve consistently changed with exposure to light. However, the specifics of this change are inconsistent across samples. In sample A and C, the slope dramatically changed, but it increased under the blue laser (sample A) and decreased under the red (sample C). In sample B, we saw the resistance slowly and gradually decrease as light was applied, and then

increase back to its initial point after the light was removed. Further research must be done to find out whether this is the result of the different light sources or simply a factor of the environment/fabrication.

In all three samples, the effects of illumination seem to be reversible. A final measurement was taken on each sample about 15 minutes after the light source was removed. For samples A and B, the I-V curve before light was applied and 15 minutes after light was applied are almost identical. For sample C, the curves are extremely similar, but the final curve is shifted approximately by approximately -0.05 V. The fact that these two curves exhibit similar (if not the same) C-curves supports the theory of ion migration, as previous work has shown that most ion induced fields have a relaxation period on the order of several minutes (Lee et al., 2019).

Figure 7: An drawing of an I-V curve with the characteristic initial c-shape.

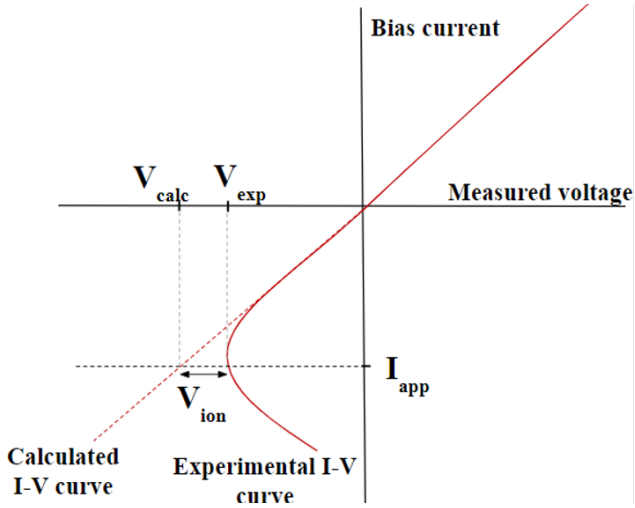


Fig. 7 For some applied current I_{app}, there are two voltage values: one which can be calculated from portion of the curve that is linear (V_{calc}) and the experimental value (V_{exp}). Any voltage difference that is the result of ion migration is the difference between these two values. In other words, $V_{ion} = V_{calc} - V_{exp}$.

Analysis

In order to gain a deeper understanding of the field-assisted ion migration potentially occurring in our samples, we focused on the c-shaped curve that was prevalent at the start of many of our measurements. This curve provided key insights into Eind. The first thing that we wanted to know was how much of the voltage drop that occurred between the voltage leads was the result of ion migration. Because Eion opposes E_{bias}, we know that ion migration would cause an experimental value for V that is smaller than that which would occur

without the presence of ion migration. Each c-curve was followed by a linear section of IV curve, so we used the slope of the subsequent line to predict what the voltage drop might have been without ion migration. We then subtracted the experimental value (V_{exp}) of the voltage drop from the calculated value (V_{calc}) to get this expression for V_{ion}:

$$V_{ion} = V_{calc} - V_{exp}$$

This relationship is shown graphically in figure 7. Additionally, the calculated values for V_{ion} can be found plotted against the applied current bias for each sample in figures 9, 10, and 11.

To analyze the number and motion of the mobile ions, we simulated their movement as though all of the positive mobile ions were concentrated at one end of the sample and all of the negative mobile ions at the other end like two point charges of equal and opposite charge. We used the measured V_{ion} to calculate the total charge of each of these points, or "blobs" of accumulated ions. This setup is visualized in figure 8.

Figure 8: This image shows how the gathering of mobile ions on the sample (above) was simplified into a system of two point charges.

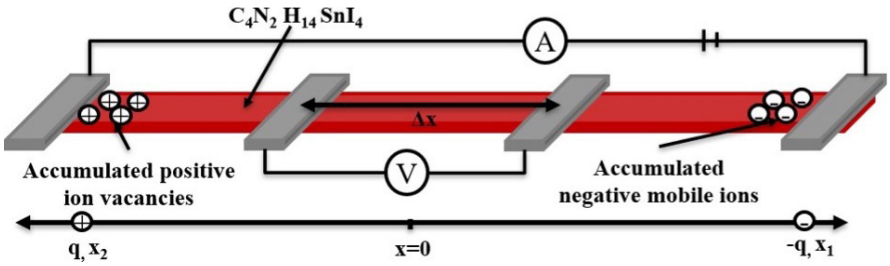


Fig. 8 The charge of each point charge, q and $-q$, are equal to the total charge of each accumulation of mobile ions. The distance of the two current leads (x_1 and x_2) from the center of the sample is the distance of the point charges from '0' on the x-axis. Δx is the distance between the two voltage leads.

In order to find charge q in terms of V_{ion}, an expression was written for difference between the potentials at each voltage lead (V_2 and V_1) from the two point charges.

$$V_{ion} = V_2 - V_1 \qquad (2a)$$

$$V_1 = 1/(4\pi\epsilon_0)\,((-q)/(x_1 - 1/2d) + q/(x_2 + 1/2d)) \qquad (2b)$$

$$V_2 = 1/(4\pi\epsilon_0)\,((-q)/(x_1 + 1/2d) + q/(x_2 - 1/2d)) \qquad (2c)$$

$$V_{ion}=_{q}\Delta x/(4\pi\epsilon_0)\ (1/(x_1^2-1/4\Delta x^2)+1(x_2^2-1/4\Delta x^2)) \qquad (2d)$$

Solving this equation for q gives us

$$q=(4\pi\epsilon_0)/\Delta x V_{ion}(1/(x_1^2-1/4\Delta x^2)+1/(x_2^2-1/4\Delta x^2))^{-1} \qquad (3)$$

It is now possible to calculate the number of mobile ions accumulated at each end of the sample. If our mobile ions are in fact I^- ions, then each ion has an individual charge of

$$I^-=-1*e=-1.602\times10^{-19}\ C \qquad (4)$$

Therefore the total number of ions (n) at each end of the sample is given by

$$n=|q/(-1.602\times10^{-19}\ C)| \qquad (5)$$

Calculations and analysis of the accumulation of these charges can be found in figures 9, 10, and 11.

In general, n was significantly higher at the initial maximum applied biases and decreased with the bias current. This is consistent with other findings (Wang et al., 2019), as the density of mobile ions increases with higher biases. In all three samples, whatever effect light had on the accumulated charge ions seemed to be reversible as the calculations based on data taken before light was applied and after a relaxation period were extremely similar. Additionally, the n vs I curves could be grouped into three main sections for each sample: measurements taken before and long after light was applied, measurements taken while the sample was illuminated, and the measurement taken at the moment that the light source was turned off. What was consistent across all three samples was that each group showed some pattern. Said pattern, however, was not consistent across the samples. First, we can examine sample A. Without illumination, including the measurement taken as soon as the laser was removed, n was small but positive from -30 to -20 nA bias and then became approximately zero for the rest of the measurement. Measurements taken while the sample was illuminated also saw n approach zero, but continuously saw fluctuations nearing $15x10^4$ ions after that, particularly from 10 to 30 nA bias. This is consistent with our hypothesis of ion migration. With a higher bias, the number of mobile ions concentrated at each end of the sample should increase as the induced Eion is proportional to applied bias. Sample C had a similar pattern, where measurements taken without the illumination saw n remain approximately zero after the initial decrease of accumulated ions, while with illumination n moved further away from zero as the positive bias increased.

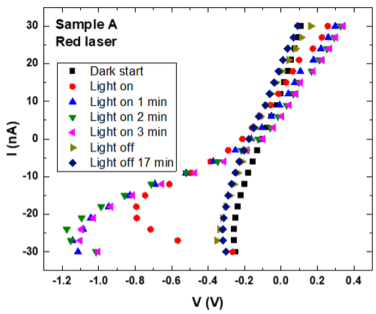
In sample B, n began with a positive accumulation that was nearly zero with -20 to 0 nA bias for all measurements. As the positive bias increased, n became non-zero and then re-approached zero when no illumination had been applied

for a while. While we were shining the laser on the sample, *n* moved farther and farther from zero as the positive bias current increased. For the measurement taken at the removal of light, the accumulation of ions increased to a level much higher than any of the other measurements with the application of a positive bias current. It is unclear why there is so much variation in this sample from the other two. It could be the result of the wavelength of the light source, or some factor of the sample's structure/fabrication. More research and a larger data size are needed to understand the relationship between illumination wavelength and the behavior of mobile ions.

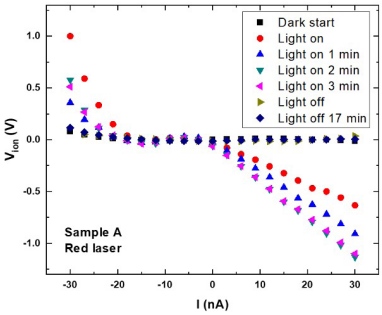
In all three samples, one thing of note is that the accumulation of mobile ions seems to be reversible. The measurements taken before any light was applied and the measurements taken after ≈15 minutes of relaxation time are extremely similar.

Figure 9: These figures show the data taken from sample A as it was exposed to a red laser, as well as the subsequent analysis performed on said data.

9a.



9b.



9c.

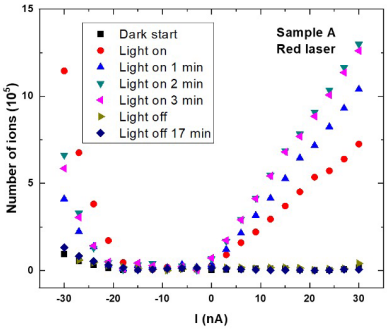
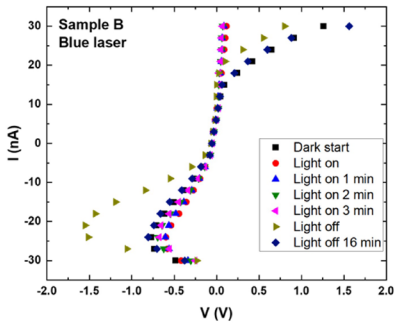


Fig. 9 Figure (a) shows the bias current vs measured voltage. These curves

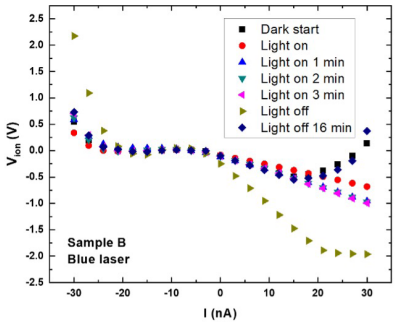
all show the characteristic C-shape at the beginning of their measurement. Measurements taken when light was not being applied develop a linear shape immediately after the C-curve. Measurements taken while the sample was illuminated have a much smaller slope until the bias reached approximately 0 nA, at which point the resistance became similar to those curves without illumination. **Figure (b)** is a plot of V_{ion}, calculated from equation (7), plotted against the bias current. **Figure (c)** shows the number of accumulated ions at each current lead, calculated from equation (5).

Figure 10: These figures show the data taken from sample B as a blue laser was shined on it, as well as the subsequent analysis.

10a.



10b.



10c.

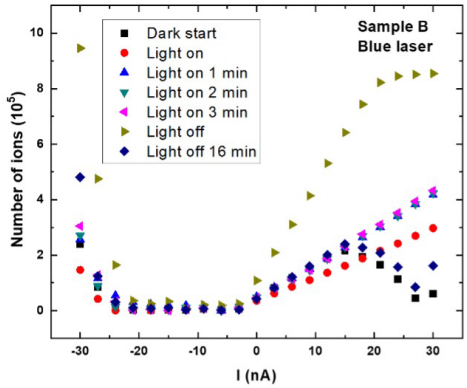
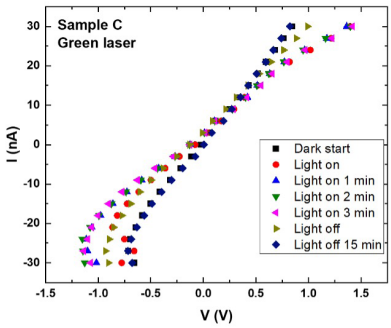


Fig. 10 Figure (a) shows the bias current vs measured voltage. These curves all show the characteristic C-shape at the beginning of their measurement. This C-shape exhibited little change with the application of the laser but became significantly more pronounced as soon as the laser was removed. **Figure (b)** is a plot of V_{ion}, calculated from equation (7), plotted against the bias current. **Figure**

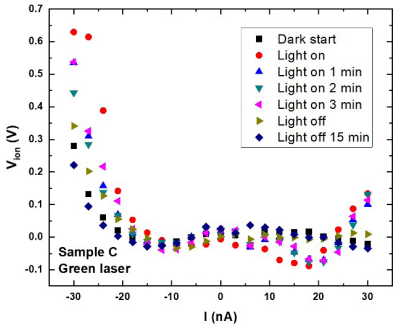
(c) shows the number of accumulated ions at each current lead, calculated from equation (5).

Figure 11: These figures show the data taken from sample C as a green laser was shined on it, as well as the subsequent analysis.

11a.



11b.



11c.

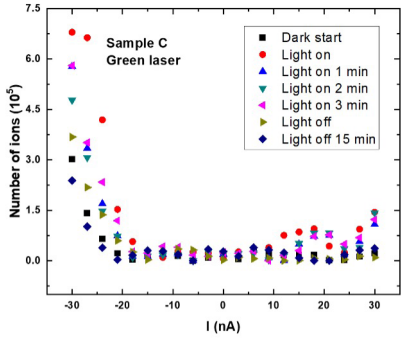


Fig. 11 Figure (a) shows the bias current vs measured voltage. These curves all show the characteristic C-shape at the beginning of their measurement. Aside from the C-shape, these curves are mostly linear. The slope of each linear line seems to decrease with the prolonged application of light, implying a decreasing resistance. **Figure (b)** is a plot of V_{ion}, calculated from equation (7), plotted against the bias cur- rent. **Figure (c)** shows the number of accumulated ions at each current lead, calculated from equation (5).

Conclusions

We performed an experiment to examine the electrical transport properties, especially the effect of photo illumination, on N,N'-dimethylethylenediaminium tin iodide ($C_4N_2H_{14}SnI_4$). This was done by monitoring the I-V curves for multiple samples before, during, and after subjecting them to a monochromatic light

source.

Much of the analysis in this thesis was concentrated on the C-curves present in our I-V measurements, as well as modeling the number of accumulated mobile ions in each sample from the I-V data. Ultimately, the hypothesis that ion migration may be responsible for these C-curves was supported by our mathematical calculations. However, several I-V curves show behavior at high positive bias that mimics the negative C-curve. If it is possible that ionic current is being induced by a high negative bias, it is worth examining in future work whether or not a similar ionic movement is occurring in the opposite direction with the application of a high positive bias.

In the sample labeled A, all of the data that was collected supported the presence of ion migration, both in the negative and positive bias regions. First of all, each I-V curve showed the customary C-shape suggesting the migration of mobile ions and the accompanying electric field. The other two main areas of analysis, including the voltage drop resulting from the accumulation of mobile ions and the modeled number of mobile ions, also supported this hypothesis in both bias regions. Samples B and C mimicked some of the general behaviors of sample A with fluctuation, although sample C exhibited more of these important characteristics than B. As all three samples were taken from the same batch, it may be worthwhile in future to perform a similar experiment with many samples synthesized under the same conditions. Additionally, our modeling was based on the simplification of the two accumulated mobile ion clouds to two point charges. More specific and rigorous modeling may provide further insight.

Although our data was performed in the presence of a concentrated light source and with the hope of identifying some relationship between applied light and I-V behavior, no definitive patterns were identified that could be correlated with the wavelength of incoming excitons. Future research in this area would require a larger data pool, as these samples are not stable enough to withstand multiple runs.

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A CORRELATIONAL STUDY ON PHYSICAL ACTIVITY AND GPA AMONG COLLEGE STUDENTS

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Abstract

Studies have documented positive effects of physical activity on a variety of outcomes, including academic performance. However, other studies report mixed or null results, mostly based on samples of high school students or post-graduates. The current, novel study examined physical activity and grade point average (GPA) in a sample of undergraduate students at the Florida State University. This association was tested using a survey distributed to students online. Respondents (n=200) reported on their GPA and answered questions on engagement in physical activity and other health behaviors (i.e., cigarette smoking, alcohol use, etc.) and variables (i.e. personality and psychological symptoms) potentially associated with both GPA and physical exercise. They also completed a cognitive test. Contrary to what expected, the analyses indicated a non-significant correlation between time spent in vigorous or moderate physical activities and GPA, when controlling for age, sex, race/ethnicity and years in college. GPA was also unrelated to cognitive performance and other health behaviors. Further studies are needed to confirm these results and explore associations between study variables longitudinally, over the course of the four years of college.

Keywords: physical activity, GPA, college, health behaviors, correlations.

PHYSICAL ACTIVITY AND GPA

Current scientific literature has widely demonstrated that regular physical activity benefits health, decreasing risk of diseases (e.g., cardiovascular disease, diabetes, cancer, hypertension, obesity, depression and osteoporosis) and premature death (Warburton et al., 2006). These benefits start at young age and extend across the lifespan. At young age, physical activity appears as important in attaining higher academic achievement and a healthy lifestyle. For example, studies correlated physical activity with both academic and cognitive performance, from high school to undergraduate and specialized upper-level graduate programs (Al-Drees, 2016; Wald et al., 2014; Weston et al., 2020). Yet, the transition into college could be particularly challenging. For students to maintain their academic performance, it may come at the cost of reducing time spent on extracurricular activities, including physical activity. Further, with increased autonomy, students often engage in health-risky behaviors (i.e. poor diet, alcohol drinking and substance use; DiBello et al., 2018). This study could suggest exercise as interventionist techniques for combatting low academic performance.

One common method to assess academic performance among college students is evaluating self-reports of their grade point average (GPA; Kuncel et al., 2005). To date, studies that examined the association between physical activity and GPA reported mixed results. While some studies found a positive association (Wald et al., 2014; Weston et al., 2020), other do not observe a significant correlation between these two variables (Khan et al., 2017; Xu & Sansgiry, 2018). Using data from a national survey of college students, Wald et al. (2014) found grade average was higher in students meeting moderate-vigorous physical activity, and engaging in a healthier lifestyle, following fruit and vegetable intake, and sleep recommendations. Xu and Sansgiry (2018), on the contrary, did not found an association between physical activity and GPA, but observed that students with lower body mass index (BMI) had higher GPAs than students with higher BMI. In another study, Khan et al. (2017) evaluated stress levels and GPAs of medical students in relation to their physical activity. The authors found physical activity to be correlated with reduced stress levels, but the correlation between physical activity and academic performance was not significant (Khan et al., 2017). To note that most of extant literature has been conducted either on adolescents or graduates in physical and medical training, but few studies have focused on traditional undergraduate students.

The aim of the current, novel study was to explore the correlation between physical activity and self-reported GPA in a sample of undergraduate college students at the Florida State University. The study further assessed health-related habits and psychosocial variables that could potentially be related to physical

activity and GPA—i.e. personality and psychological symptoms (i.e. depressive symptoms). Cognitive performance was also assessed as consistently associated with physical activity and academic performance in young populations to increase the validity of the data (Bergol & Steinmayr, 2018; Phan et al., 2018).

Methods

Participants and Procedure

This study consisted of an anonymous Qualtrics survey distributed to college students at the Florida State University. The survey was advertised as an online study on academic performance and health behaviors. Recruitments was carried out through the distribution of flyers at the main campus in Tallahassee and ads on university-related Facebook groups and/or webpages. Ads and flyers included a link/QR code that participants could use to access the survey online. Students were not given credit or remuneration. Data collection was completed in the Spring Semester of 2019.

The survey consisted of four blocks of questions: Block 1 included questions on socio-demographics and self-reported GPA; Block 2 included questions on health-related behaviors, such as physical activity; Block 3 included self-report questionnaires on depression and personality; and Block 4 consisted of a series of computer-based cognitive tasks. Of 246 students who initiated the survey, 200 (81.3%) reported on GPA and answered questions on physical activity. Of these, about 85% (up to 174/200 respondents) participants reported on other health behaviors (i.e., sleep hours per night, alcohol use, etc.); 82% (n=165) reported on depression symptoms and 80% (n=161) on personality. Fewer participants (less than 70%) completed the last block of the cognitive tasks and the whole survey.

On average, participants took 12 minutes to complete the survey. For the focus of this article, we analyzed data on self-reported GPA and physical activity, and explore correlations among health-related and personality variables. The analytic sample (n=200) was between 18 and 25 years of age, mostly female (69.0%) and white (69.5%); 22.6% were freshmen, 22.6% sophomores, 40.2% juniors, and 16.6% seniors (see Table 1 details).

All materials and procedures were approved by the Institutional Review Board of the Florida State University.

Measures

Self-reported Grade Point Average

Because we had no access to official academic records, we asked participants to report their cumulative GPA. Specifically, we asked, "Please indicate your current cumulative Grade Point Average (GPA)?" Response options were on a

scale from 0.00 to 4.00. Self-reports of GPA are commonly used as indicator of academic performance (Sticca et al., 2017) and would be accurate representations of the sampled population, though measure errors occur (Kuncel et al., 2005; Rosen et al., 2017).

Health Behaviors

Physical Activity. Questions used to investigate students' physical activity were adapted from other surveys (Sylvia et al., 2014). Participants were asked whether they engaged in any vigorous or moderate physical activity in the last month (response: yes/no) and the type of physical activity (i.e., football, soccer, swimming, etc.) they typically engaged in. For each type of activity separately (vigorous and moderate), they reported the number of days a week and the hours a day spent exercising. The time spend exercising was calculated multiplying days a week and hours/day spent in each activity, vigorous and moderate. For the analyses, we computed an average scores of time spent exercising across vigorous and moderate activity.

Cigarette Smoking. Participants were asked whether they currently smoked cigarettes (response: yes/no), and if not, whether they ever smoked a cigarette in the past (yes/no). Those who reported to smoke were asked to indicate the number of cigarettes smoked per day.

Alcohol Drinking. Participants were asked whether they currently drank alcohol (response: yes/no), and if not, whether they ever consumed alcohol beverages (yes/no). Those who currently drank also reported on the numbers of days they drank in the past month (possible range = 0-31) and number of drinks had on the days they drank (range = 0-90). The total number of drinks had in the last month was computed multiplying the number of days per number of drinks a day.

Other substance use. Participants reported whether they currently used marijuana (response: yes/no), and if not, whether they ever used marijuana in the past (yes/no).

Body Mass Index (BMI). Participants reported on their weight and height. BMI was calculated by dividing weight (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703.

Hours of sleep per night. Participants were asked how many hours of sleep they had, on average, per night during the last week (possible range = 0-24).

Depression Symptoms

Participants completed the 8-item version of the Patient Health Questionnaire, depressive module (Kroenke et al., 2010). They reported the frequency of

depressive symptoms (e.g., "Feeling down, depressed, or hopeless") over the past 2 weeks, on a scale from 0 (not at all) to 3 (nearly every day). Scores ranged from 0 to 24, with higher scores indicating more depressive symptoms (alpha reliability =.71)

Personality Traits

Neuroticism, extraversion, openness, agreeableness and conscientiousness were measured with the 20-item form of the International Personality Item (Donnellan et al., 2006). Participants were asked to rate each item, e.g. "I sympathize with others' feelings." on a 5-point scale, from *strongly disagree* (1) to *strongly agree* (5). Alpha reliabilities ranged from .62 for neuroticism to .83 for extraversion.

Cognitive Measure: Mental Rotation

We used an adapted short mental rotation task to measure cognitive performance (Shepard & Metzler, 1971; Ganis & Kievit, 2015). Participants were presented a set of paired 3D cube images. For each pair, respondents were asked whether the target image on the left was the same (a rotated version) or different from the image on the right. After two practice trials, respondents were presented with 10 paired images. This cognitive test was used to explore possible correlations between cognitive performance and GPA and other self-reported variables.

Data Analysis

Descriptive statistics and correlation analyses were conducted using SPSS software, version 25. To identify correlations between self-reported GPA, physical activity and other health behaviors, personality, depression, and cognitive performance, we used non-parametric rank-order (Spearman's rho) correlations that controlled for age, sex, race/ethnicity and years in college to establish a clear link between physical activity and academic performance.

Results

Frequencies, means and standard deviations for sample and study variables are reported in Table 1. We reported statistics for those who had valid data on GPA and who reported at least some information on physical activity. The smallest number of responses was for the mental rotation task (n=84/200; 42% of the analytic sample).

GPA values ranged from 2.50 to 4.00 with a mean of 3.48 (SD=0.36). Only 18 students reported a GPA lower than the 3.00. There were no differences in GPA across the four years of college (p<.05). Of note, the GPA score in the current sample was slightly higher than what reported by FSU Office of Institutional

Research (GPA Spring 2019, *M*=3.21; *SD*=0.57). Specifically, the present sample had 0.27 points higher GPA compared to the average undergraduate FSU population in Spring 2019 (Cohen's $d = 0.56$).

Respondents were highly active: About 80% (159/200) reported to have engaged in vigorous physical activities in the last month and 78% (156/174; 26 missing cases) reported to have engaged in moderate physical activities. Only 10/174 students reported to not have engaged in any vigorous or moderate activities. Most frequent vigorous activities were running (57%), weight lifting (45.5%), cycling (22%) and high-intensity aerobic exercises (28%). Most frequent moderate activities were brisk walking (54%) and weight lifting for fitness (47.5%). On average, respondents spent about 3 days a week and 5 hours per week engaging in vigorous or moderate exercises.

Table 2 shows non-parametric correlations between GPA, physical activity and other study variables, controlling for age, sex, race/ethnicity, and years of college. Contrary to expectations, correlation analysis showed no association between self-reported GPA and measures of physical activity, nor other health-related behaviors (*p*=-.10) Physical exercise was associated with lower depressive symptoms (*p*=-.36*) and neuroticism(*p*=-.30*), and higher extraversion (*p*=.28*). Students that were more extroverted and outdoing also reported higher alcohol drinking(*p*=.32*), use of marijuana (*p*=.36*) but less depressive symptoms (*p*=-.48*), and BMI (*p*=-.24*),. There was no correlation between GPA and mental rotation performance (*p*=.085) (see Table 2).

Table 1

Descriptive Statistics

Variables	*Frequency (%) or Mean (SD)*	*Response Rate N (%)*
Self-reported GPA	3.48 (0.36)	200 (100%)
Age (years)	20.00 (1.22)	200 (100%)
Female	138 (69.0%)	200 (100%)
White	139 (69.5%)	200 (100%)
College year		199 (99.5%)
First (Freshman) year	45 (22.5%)	
Second (Sophomore) year	41 (20.5%)	
Third (Junior) year	80 (40.0%)	
Forth (Senior) year	33 (16.5%)	
Vigorous Activities (yes)	159 (79.5%)	200 (100%)
Times spent in Vigorous Activities		200 (100%)
Days a week	2.85 (2.03)	
Hours a day	1.17 (1.23)	
Total hours/week	4.49 (6.71)	
Moderate Activity (yes)	156 (78.0%)	174 (87.0%)
Times spent in Vigorous Activities		166 (83.0%)
Days a week	3.11 (1.95)	
Hours a day	1.25 (1.62)	
Total hours/week	4.47 (6.91)	
Total time (hours/week) spent in exercising	4.46 (6.53)	200 (100%)
Average hours of sleep per night in the last month	6.93 (1.07)	174 (87.0%)
Ever drank alcohol (yes)	164 (82.0%)	171 (85.5%)
Average alcohol consumption		168 (84.0%)
Days when drank in the last month	5.41 (5.11)	
Drinks/day drank in the last month	3.79 (3.46)	
Total no. of drinks had in the last month	23.63 (34.33)	
Ever smoked cigarettes (yes)	44 (22.0%)	171 (85.5%)
Currently smoking (yes)	3 (1.5%)	
Ever used marijuana (yes)	115 (57.5%)	171 (85.5%)
Currently using marijuana (yes)	57 (28.5%)	
BMI	23.58 (4.00)	163 (81.5%)
BMI ≥ 30	9 (4.5%)	
Depressive symptoms (score = 0-24)	6.59 (4.63)	165 (82.5%)
Personality (score = 1-5)		161 (80.5%)
Neuroticism	2.89 (0.78)	
Extraversion	3.30 (0.99)	
Openness	3.67 (0.78)	
Agreeableness	4.04 (0.74)	
Conscientiousness	3.62 (0.84)	
Mental Rotation (score = 0-10)	8.64 (1.78)	84 (42.0%)

Table 2

Non-parametric partial correlations

Variables	1	2	3	4	5	6	7	8	9	10	11	12	Mental Rotation
GPA	-.10	.22	-.16	-.11	-.04	-.08	-.05	.06	-.08	-.14	-.01	.03	.085
1. Physical Exercise (tot. hours/week)	1	-.01	-.01	.08	.18	.09	-.36*	-.30*	.28*	.15	.21	.14	-.09
2. Hours of sleep per night		1	-.22	-.19	-.26*	-.12	-.16	-.22	-.20	-.19	.03	.08	.12
3. Drinks drank in the last month			1	.16	.34*	-.06	.05	-.01	.36*	.18	-.05	-.09	.11
4. Ever smoked				1	.25*	-.12	.13	.29*	-.02	-.16	-.27*	-.03	-.09
5. Ever used marijuana					1	-.10	-.15	.04	.32*	-.08	-.05	-.03	-.07
6. BMI						1	.07	-.03	-.24*	-.02	-.24*	-.14	-.04
7. Depressive symptoms							1	.44*	-.48*	-.20	-.19	-.36*	.02
8. Neuroticism								1	-.32*	-.32*	-.01	-.17	-.13
9. Extraversion									1	.33*	.41*	.15	-.10
10. Openness										1	.147	.18	-.08
11. Agreeableness											1	.29*	-.02
12. Conscientiousness												1	-.06

Note. N size varies base on missing values. The smallest number of responses was for the mental rotation task (n=84/200; 42% of the analytic sample). The analyses controlled for age, sex, race/ethnicity and years in college.

* p<.05

Discussion

With the current sample, no statistically significant correlation between physical activity and GPA was observed. This stands in contrast with some of the studies that found a positive association between these variables (Wald et al., 2014), but align with those finding a non-significant correlation (Gonzalez et al., 2014; Xu & Sansgiry, 2018; Khan et al., 2017).

One possible explanation for this null result is that students entering college may have reduced time for and resources spend on extracurricular activity such exercise (as suggested by Gonzalez et al., 2014). That is, students would rather spend time studying and focusing on their study program that engaging in physical activity. GPA was also not associated with other health-related behaviors, contrasting previous results of alcohol drinking, smoking and sleep deprivation associated with poor academic performance (Ansari et al., 2013; Smith, 2019; Taylor et al., 2013). GPA was as well unrelated to performance on the mental rotation test.

One important limitation to point out is that the current sample reported high GPA values. The GPA of the sample was higher compared to the average GPA of the Florida State undergraduate population in Spring 2019 (+.27 points). Given this, it is possible that limited variability in GPA scores would not allow to detect significant association with other study variables. Further, GPA is only one index of academic performance and success. This study did not assess other important aspects, such as actual grades, but also attainment of learning objectives, satisfaction, and acquisition of specific competence. Self-reported

GPA could have been artificially inflated by the respondents, further affecting the correlation. In addition, the sampled population gender demographics did not accurately represent the Florida State University population (57% Female actual vs. 69% Female sampled).

The results did support the known associations between personality, health-behaviors and depressive symptoms. For example, the trait of extraversion (i.e. tendency to be sociable and outgoing) was associated with physical activity, as well as with lower BMI and depression, but also more substance use. Neuroticism and depressive symptoms in contrast were associated with lower physical activity. These associations are in line with those observed in prior studies of personality and health behaviors among college students and general population (Aherthon et al., 2014; Raynor & Levine, 2009).

This study adds to the literature on physical activity and GPA assessing a convenience cross-sectional sample. Further studies are needed to confirm the null association of physical activity with GPA. It is also important to explore associations between study variables longitudinally, over the course of the four years of college.

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CREATIVE WORKS

YA NO SE DEJA: THE EVOLUTION OF PUERTO RICAN SOCIOPOLITICAL SOLIDARITY

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Research Statement

Ya no se deja represents the culmination of Puerto Rico's 500 year colonial history. I utilize historiographical texts and ethnographic works to chronicle the development of insular solidarity. This narrative project focuses on proletarian lives spanning from the early days of Spanish Empire up to the COVID-19 pandemic. In spite of a government deemed "genocidal" in its apathy (Bonilla, 2020 (3), 2), a new generation of Puerto Rican proletariat rose up in the summer of 2019 and declared "*ya no se deja*" (no more). This meant the rejection of the government's elitist rhetoric exposed in the *Rickyleaks* scandal, of the increasing privatization of education on the island, the continued relegation of the island to a colonial state, and a unilateral declaration that, in the words of poet Raquel Salas Rivera, "[Puerto Ricans] owe no one shame [nor] smallness".

I created this research-based narrative as a part of my honors thesis, which focuses on the effects of the COVID-19 pandemic on Puerto Rico's tourism industry. The creative research done here helped me to understand the infrastructural, social, and economic damage done unto Puerto Rico. In the last forty years, increasing neoliberal policy and privatization has led to an already extant apathy increase in toxicity. In the aftermath of Hurricane María, many Puerto Rican communities in the interior of the island were left stranded by the government. Today, the COVID-19 pandemic has taken its own effects, with the continued pro-business government mindset focused on the provision of opportunity zones to foreign investors. Through this project, I demonstrate how the populous has historically reacted to that mindset, with a particular focus on the protests seen in the summer of 2019. I also speculate on how Puerto Ricans could rise up once more. Continued governmental incompetence could very well reactualize an indigenous, autonomous, and revolutionary spirit akin to that of their *jíbaro* ancestors.

Introduction: A War About Stories

"This too is a war about stories", writes Solnit (*in* Fernandez Arrigoitia, 2017, 405). In-deed, a war on stories has been occurring in which the oppressed have been neglected since Puerto Rico de San Juan Bautista was founded 500 years ago. As I write this from the diaspora, I think of the stories of those on the island which are often replaced by the daydreams of an island with gold-en beaches, clear skies, and evergreen trees that bring us calm. In our minds – that is, those of Puerto Ricans who are no longer in Puerto Rico – the island remains a treasure trove of drunken reminiscences which make us wonder: when will we go back?

The reality of the situation is markedly different. The tourism ads featuring Ricky Martin dancing over rich emerald landscapes and bright turquoise waters have lied. The stories they tell are those which propagate the idea of *la Isla del encanto*, as it is often popularly referred to. They es-pouse those same golden beaches which the diaspora tells their American neighbors they must vis-it. But visiting is not understanding. To pass through the main city of San Juan and take photos at its crimson gates just north of *la Fortaleza* is not to acknowledge an outrageous public debt. Nei-ther is it paying respects to the four thousand people were left to die in the aftermath of Hurricane María, nor is it giving voice to the myriad pleas from the island to shut its borders during the COVID-19 pandemic, which were turned down by the federal government (Puerto Rican Tourism Company, 2020).

These are stories which must be shared. They are those of a people who experience daily life under a colonial regime. They have made attempts to speak out for themselves sporadically throughout history. In 1868, the island's first revolution against the Spanish Crown came to frui-tion in the form of *el Grito de Lares* (Picó, 2017, 186). Instigated by failed governmental respons-es to a hurricane and financial crisis in the same year, a collective front of slaves, day laborers, farmers and intellectuals assembled. Together, they attempted to seize several towns and establish the Republic of Puerto Rico, only to be defeated by the extensive reach of the Crown and its deep-seated paranoia of creole aspirations (Mintz, 2010, 139). In the American age of empire, peaceful protestors marching in Ponce on March 21, 1937 were shot down by police after their permit to protest had been revoked (*Washington Post*, 1999, A03). This type of repression of solidarity is present throughout island's history, placing the fear of being directly targeted by the colonial state into the Puerto Rican proletariat. Such difficulties are best understood in the words of Mari Mari Narvaéz, a journalist and political advocate, who noted that "[in] some instances, advocating for human rights becomes a privilege" (*in* Bonilla and

Lebrón, 2019, 7). Because of the fear of this repression, only those who the state will not specifically target have the privilege of speaking out.

The summer of 2019 thus presents a quagmire for those studying the island's sociopolitical history. The protests which successfully ousted Governor Ricardo Rosselló were instigated by the leak of a private group chat imbued with vile epithets and slurs against both political opponents and the general populous. However, Puerto Ricans had been long simmering with resentment for the political status quo. Recently, the implementation of neoliberal economic tenets by presidential ad-ministrations from Regan to Obama have proven exceedingly effective when it comes to rendering Puerto Ricans disenfranchised. As a politico-economic system, neoliberalism has single-handedly managed to devastate the island's infrastructure and economy. The public has been forced to as-sume an outrageous $120 billion debt (Perez Semanaz, 2020). This prompted the federally appoint-ed Financial Oversight and Management Board to cut government spending in healthcare, educa-tion, and social security (among many other areas) to pay off the debtors. Particularly affected has been the generation of the new millennium, baptized by Puerto Rican reggaeton artist Bad Bunny as the *generación* "*yo no me dejo*,". Because of the failures of neoliberal policies, the *generación* ended up fulfilling a now prophetic anecdote from Helen I. Safa's ethnography *The Urban Poor of Puerto Rico*:

> If, after meeting the requirements of the system, the young are still denied an oppor-tunity, or if the system keeps raising requirements in order to continue excluding the poor from their just share of material prosperity, then conditions may become ripe for a growing political and class consciousness among the poor that demands an end to this continued inequality in Puerto Rican society. (1974, 96)

What follows in writing is a chronicle of their story. It is that which has been long fomenting, cooked in a cauldron left simmering for five centuries. It is a dish served with various accoutre-ments such as genocide, slavery, natural disaster, fiscal mismanagement, corruption, and more gen-eral *welebichería* (a non-exhaustive list). This is the story of how a million Puerto Ricans manifest-ed in a class act of solidarity in the summer 2019 protests. In shouts above the tremoring tambou-rines, they denounced the perpetual state of "progress" under which they have lived, demanding now for themselves that there will be no more promises of development (Bonilla, 2020 (1), 156). They are now acting for themselves against those who would have thought they could never do it.

Chronicle: *Ya no se deja*

The *jíbaros* originated from the mountains of Puerto Rico. They were figures

which lived under the scalding sun of the Caribbean, working subsistence farms founded on the rising ever-green slopes crowing into the clouds (Mintz, 2010, 143). Far to the north of the island, the city built and administered by the Spanish from 1512 often left these rural agrarians to fend for them-selves. Too focused on funneling the myriad tonnes of plundered Aztec gold back to Iberia (Mintz, 2010, 137), the indifference displayed by the port of San Juan itself towards the rest of the island cultivated a culture of autonomy among the *jíbaros*. This allowed them to live isolated, independent, and away from attention (Scarano *in* Mintz, 2010, 143).

It was not until the turn of the nineteenth century when the Spanish Crown began to see its Caribbean possessions as ideal for the capital exploitation. Partly fueled by the loss of their main-land colonies to revolution, Spanish officials saw fit to change the economy of their remaining ter-ritories. The former "colonial backwater" of Puerto Rico was thus transformed into a sugar econo-my modeled after the French and English sugar colonies (Mintz, 2010, 145). With this change in economy came the inevitable augmentation of the island's slave population, rising by 400% be-tween 1765 to 1821 (Picó, 2017, 154). However, the profit promised by sugar cultivation never came to full fruition for the Hispanic Caribbean. By the middle of the 19th century, Puerto Rico maxed out in production as the French and the English had entertained such an economic domina-tion among themselves (Mintz, 2010, 141).

This new sugar cultivation, so inherently bound to the tradition of chattel slavery, naturally created an upset within the Puerto Rican populous. By the end of the American Civil War in 1865, Puerto Rico's latent mobilization of a sugar economy caused the island to be one of three remaining slave states in the Atlantic world (Picó, 2017, 182). The persistence of slavery in Puerto Rico gave way to several abolitionist initiatives. One was a joint Cuban-Puerto Rican *junta* sent to Spain in a failed attempt to parlay for more autonomy, another was the more explosive *Grito de Lares* revolu-tion in September of 1868 (Picó, 2017, 184). This uprising would see the collective action of slaves, day laborers, farmers, and intellectuals arrest Spanish officials and proclaiming a free re-public in several towns, including, successfully, in Lares. Though the uprising failed as a result of disorganization and the extensive reach of the Spanish Crown, the revolution "[represented] the first major concentrated effort by Puerto Ricans to alter their common situation" (Picó, 2017, 186). It was a foundational event for Puerto Rican solidarity.

Institutionalized attempts to thwart this solidarity would continue from the Spanish era of empire to the American era. The annexation of Puerto Rico into the increasing list US overseas "protectorates" presented new opportunities

to wealthy Americans (Mintz, 2010, 150). New sugar corporations known as *colonias* differed from the Spanish *haciendas* in their widespread con-sumption of land and the destruction of natural forests. The land would then be reorganized to plant commodified crops cultivated for the sole purpose of corporate capital gain (Picó, 2017, 243). Though the *colonias* incentivized workers by promising economic security from threats of natural disaster, the environmental vulnerability of the island was given up for non-sustainable enterprises which deeply affected living security.

The introduction of the American politico-economic system to the island was accompanied by a paranoia of political solidarity for plantation workers in the south. One of Mintz's subjects, Don Taso, recalls the fear of being discovered participating in Socialist Party politics (1974, 150). "They used to have this system so that when the voters would come from their *colonias* to vote, they were confronted with the *mayordomos* sitting there," recalls Taso. This would in turn force the workers into place a where they would have to vote against their own interests so that they could keep their jobs.

When the pro-business Popular Democratic Party came into power in the 1948, American industries began flooding the island's northern metropolis to take advantage of new lucrative tax exemptions (Picó 2017, 271). These exemptions proved so effective that by 1970, manufacturing overcame agriculture as the leading labor force on the island (Picó, 2017, 272). To grow the num-ber of urban proletariat available for work in these industrial jobs, the government began increasing expenditures on education, housing, and welfare (Safa, 1974, 1-5). Subsequently, a large influx of migrants forced many onto fringe communities set up on marginal public land. There, chronic de-pendency upon the greater metropolis for public works and transportation worked to make these migrants politically docile (Safa, 1974, 12). Regardless, many of these communities experienced an internal solidarity that is often seen by underfunded and impoverished peoples. "Poor as we are, but we always had something for someone in need," noted Safa's subject Raquel (1974, 61). These systems of aid are best understood as non-activist, local forms of solidarity that permit the mutual mobilizations of individuals based on their social network (Stack, 1974, 43).

The growing influence of capitalist industrialization on the island can also be seen in the increasing privatization of life by the urban proletariat. To achieve the promise of capital gain, the poor tended to "quietly go about their business of making a living" (Banerjee, 1982, 176). Many working-class Puerto Ricans experienced a median household income sub-par to that of mainland United States that was coupled with an increasing social inequality (Rivera-Batiz &

Santiago, 1996, 67; Quintero Rivera, 1976, 167). Rather than unionizing in political solidarity, an individual notion of thrift and initiative was promoted as the best way to ascend the economic ladder (Safa, 1974, 33). Education played a significant role in the economic enfranchisement of future generations. Parents stressed to their children that a high school degree would bring them a significantly broader array of opportunities (Safa 1974, 56). However, the growth of educational institutions remained a façade for the working class. The promotion of these schools as individual means of socioeconom-ic ascension made education "the opium of the working people" (Quintero Rivera, 1976,166). Many Puerto Ricans were not fully aware of the repercussions of an occupational sector growing at a slower rate than the educational sector (Safa, 1974, 58). As such, there remains little space to succeed in spite of a wide variety of tools to do so. These developments began to lay the ground-work for what Safa argues would become the ripening conditions for "a growing political and class consciousness among the poor" (1974, 96). Despite meeting the systematic requirements for suc-cess, younger generations found themselves walking a thin tightrope between the middle class and outright poverty.

The façade soon faded with the expansion of neoliberal economics on the island. When the Clinton administration eliminated tax incentives in 1993, the manufacturers which had previously dominated the insular economy left in search of cheaper manufacturing deals (Bonilla, 2020 (2), 6). Looking to balance Puerto Rico's budget, local banks piggybacking off the Federal Reserve began to draw increasingly irresponsible loans from vulture funds and Wall Street banks (Morales, 2015). Over the course of the next two decades, the debt augmented to a spectacular $72 billion sum that was declared unplayable in 2015 (Morales *in* Bonilla and Lebrón, 2019, 1). However, US territories were prohibited from filing for bankruptcy by a 1984 legislative ruling. This prompted the US Congress to pass PROMESA in 2016, a law which which allowed President Obama to appoint a Financial Oversight and Management Board (known colloquially and henceforth as the *junta*). The junta was then granted permission to take federal control over the island's debt pay-ment, and by consequence, its budget and economy.

The junta's initial directive was to minimize government spending so that more capital could be allocated to settling the debt. This meant the widespread privatization of many previously public platforms, foremost among them education. Many K-12 schools were shut down and reo-pened with private American sponsors, as was the case with the former Escuela Julia de Burgos, now titled Fountain Christian Bilingual School (Brusi and Godreau *in* Bonilla and Lebrón, 2019, 3). Specifically targeted by the junta was the prominent

higher-level University of Puerto Rico. The University was both one of the strongest contributors towards upward mobility on the island. More importantly, it was most prominent platforms speaking out against the threat of the Junta, and by extent, of American empire (Brusi and Godreau *in* Bonilla and Lebrón, 2019, 6-7). As such, defunding the institution was no problem for the federally-operated junta.

Here we see the foundations for what Safa argued would be the catalyst for the growing class consciousness lacking in Puerto Rican society (1974, 96). The privatization of schools left many students and members of the younger generation out on the block, jobless, and now too without the previously sanctified promise of social mobility through education.

The establishment of this new austerity state for Puerto Rico was the product of its devel-opment under United States imperialism. This is to say, when a population lacks a politically-endowed self-determination, they are unable to produce and sustain an economy which benefits themselves over others. They subsequently become economically disabled and disproportionately dependent on a "helping hand" in times of crisis. But what happens when that "helping hand" doesn't come? When, after 24 hours of wall-battering winds and rain, insular infrastructure be-comes devastated? When phone lines are down and the blackout is universal, who is there to turn to?

Such was the case in the aftermath of Hurricane María. With the residue of a toxic sociopo-litical system scattered across the island, the head of the island's emergency management admitted that the government "had virtually ceased to function" (Bonilla, 2020 (2), 5). Puerto Ricans were left stranded. State aid eventually came in the form of insulting sausage-and-Skittle meal boxes and tossed paper towels (Klein *in* Bonilla and Lebrón, 2019, 12), but recovery of Puerto Rico was left predominantly in the hands of private contractors given millions of federal dollars. Companies like Whitefish Energies, in charge of repairing the electrical grid, were more inclined to capitalize on the crisis than support the communities which they had been charged to restore (Fernández Campbell and Irfan 2017). This was made even more explicit when 98% of the island's territory was de-clared an "opportunity zone" for foreign investors (Bonilla, 2020 (1), 155). The colony was once again open for business.

As such, the Puerto Rican people were left with a case of "[missing] the thing by waiting for it" (Kafka *in* Krasznahorkai, 1985). In the perpetual wait for state aid that would never suffi-ciently come, Puerto Ricans were forced to resolve many of the problems left by María on their own accord. Several autonomous initiatives were taken by towns to cope with the loss. One such initiative was the Adjuntas community organization of Casa Pueblo which implemented renewable

energy measures able to withstand the attack of the hurricane (Massol-Deyá *in* Bonilla and Lebrón, 2019, 7). In using a communally-based form of power, the private contractors as well as the state government subsequently became disenfranchised when the people began to cultivate their own electrical (and thus political) power. Another method by which Puerto Ricans coped with the hurri-cane was the establishment of socialized foodways. Initiatives such as the *comedores sociales* (social diners) rejected the aforementioned meager and inadequate meals by flexibly exchanging quali-ty food for money, donations, or volunteer labor (Roberto *in* Bonilla and Lebrón, 2019, 3). This ensured communities that none of their members would starve.

It seems then than much of the *autogestión* developed by the Puerto Rican people was a direct rejection of the increasing privatization of affairs by the government. Communities managed to protest generations of official neglect by focusing on "taking care of themselves" as opposed to waiting for government aid (Bonilla *with* Klein *in* Bonilla and Lebrón, 2019, 11). In many ways, the devastation of María forced a return to the sustainable and autonomous methods of care dis-played by the Puerto Rican *jíbaro*. One could then argue that the *espiritu jíbaro* (*jíbaro* spirit) was romantically reincarnated once more in the communal care-taking seen after María. One thing is certain – that it was neither the government, nor Donald Trump, nor the private companies, nor the American people who saved the island from capitulation. Rather, it was the Puerto Rican people who refused to miss their recovery by waiting for it to happen.

Rejecting political dependency proved in Puerto Ricans's favor. In the immediate aftermath of the hurricane, communities became so focused on recovery that they could not focus on explicit political action and protest (Bonilla with Klein *in* Bonilla and Lebrón, 2019, 11). That was no long-er the case come two years later. In July of 2019, the *Rickyleaks* scandal broke news, in which governor Ricardo Rosselló and his board of secretaries had their group chat leaked to the public. Around 800 pages of misogynistic, homophobic, fatphobic, and elitist were shared across news outlets across the island. Particularly explicit among the group chat was a message which declared the need of a body from one of María's victims to "feed the vultures" (Tormos-Aponte, 2019), which subsequently invoked the memory of the 4,000 dead in the aftermath. The gubernatorial ne-glect could no longer be hidden.

The only response for Puerto Ricans was to take the anger simmering for five hundred years and overwhelm the capital city of San Juan. On the busiest day, over a million protestors called specifically for the resignation of governor Rosselló, and more generally for top-down sys-tematic change (Bonilla, 2020

(3), 1). This protest saw its participants physically manifest in that communal bond characterizing the class consciousness that Safa claimed had been lacking in the general populous (1974, 96). On display at the protests were myriad colors. Banners ranging from Pride flags to the black-and-white revolutionary flag were seen waving over the heads of partici-pants. Clamoring drums beat along to the sound of shouts denouncing the government's "genocid-al tendency" (Bonilla, 2020 (3), 2).

The protests were not just proletarian in nature, as sincere displays of solidarity were made by prominent Puerto Rican artists. Ricky Marin, Bad Bunny, Residente, and iLé were present and participant, and the latter three released a song inspired by the protests aptly titled "*Afilando los cu-chillos*" ("Sharpening the Knives") (Vélez Santiago, 2019). In it, they refer to the generation of ac-tivists leading the movement as the generación "yo no me dejo" (*generation* "*I won't be fooled*"). Because the generación had seen the consequences of colonialism amplified in their lifetime, they became a generation which "[prioritized] civic action" (*El Nuevo Dia*, 2019 [translated manually]) over any other form of pass-time.

Ultimately, the protests succeeded in achieving their specific goal of getting governor Ros-selló to resign (Robles and Mazzei 2019). Yet the activism which characterized the *revolución del verano '19* has by no means ended. In January of 2020, Rosselló's successor Governor Wanda Vázquez was the target of another wave of protests. The primary grievances were the failed gov-ernment response to still-consistent earthquakes in the south of the island and the discovery of a caché of unused supplies from the post-María era (*The Guardian*, 2020). Though these protests were smaller in number and shorter in nature, it is doubtful that Puerto Ricans are feeling a fatigue from advocacy. The very fact that in this turn they sought to arm themselves with a symbol as revolutionary as the guillotine proves that they are not afraid to stand up to a government which they have deemed an "Assassin State" (Bonilla, 2020 (3), 2).

Protests have continued into the COVID-19 pandemic as well. On April 15th, 2020, pri-vate citizens and members of Puerto Rico's emergency medical teams were out in the streets of San Juan. They caravanned before the governor's mansion in San Juan to protest the inefficient gov-ernmental strategies regarding public health (*Latino USA,* 2020). Among the grievances cited was the purchase of a $38 million dollar testing kit package. The seller company had no previous expe-rience in the assembly of medical equipment but had ties to Vázquez' New Progressive Party. Be-cause the government mishandled one of the first initiatives meant to combat the COVID-19 pan-demic, the people responded by fighting back. Just as seen in the summer of 2019, Puerto Ricans will continue

pushing back against political incompetence should they be incited to do so. For now, as seen, the *welebichería* only continues.

Conclusion & Reflections: We Owe No One Shame

In many ways, the effort to chronologize the development of solidarity on the island into a less-than 5,000-word paper written for an undergraduate journal may seem farce. Ten words per every year of Puerto Rico's existence under colonial rule seems nearly insufficient to properly tell the story of the popular response to colonial abuse. There is not enough space to properly portray the nuance which it has exhibited.

Thus, we come back to the opening quote by Solnit: "This too is a war about stories" (*in* Fernandez Arrigoitia, 2017, 405). Though not writing specifically about Puerto Rico, her words can be applied to the very process of just *telling* a story. The storyteller must run through a series of justifications for what is going to be said and who is going to be involved. They often question themselves if there is greater significance in someone that remains voiceless or something that re-mains unsaid.

These are ideas which consistently plague storytellers, and, in the specific case of this pa-per, the ethnographer. It goes without saying that when an ethnographer is conducting an intro-spective study on their own culture, they will find it impossible to separate themselves from it. As I write this now, I think back to the news articles flooding my feed which chronicled the develop-ment of Puerto Rico's summer 2019 protests. I think about the myriad voices which were all shouting for Governor Rosselló's resignation. I think about the myriad tones, tongues, and teeth which produced these shouts. In regards to myself, I think about how I was filled less with scien-tific curiosity and more of a desire to be a part of the change I want to see.

Certainly then, any work which I produce on Puerto Rico will inherently try to tie itself to the narratives of the people of the island. My perspective becomes inherently islander because I hear those myriad voices. Though they are by no means monolithic, I understand them all. Even as a son of the diaspora, I have felt their grievances. I have understood their pride, their embarrass-ment, their mourning, their love all as my own. And thus, I can at least hope that what I have writ-ten properly reflects what Puerto Ricans have seen and felt throughout the existence of the Puerto Rican nation.

Yet the story does not stop here. So long as the "commonwealth" status quo remains, so long as insular politics remain divided as to the island's political status in relation to the US, so long as the island derives its economy from a deeply seated colonial relationship, the story will continue. The war for those

stories will continue. And so long as it does, I am not only reminded of but inspired by the following words written by Raquel Salas Rivera:

> No le debemos a nadie la vergüenza
>
> No le debemos a nadie la pequeñez
>
> We owe no one shame
>
> We owe no one smallness

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