

JR Journal of IP Research in Progress

at Howard Community College

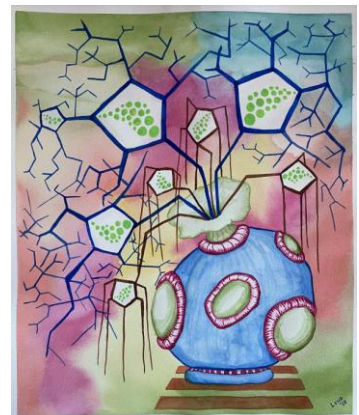




**JR Journal of
IP Research in Progress**
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**10901 Little Patuxent Parkway
Columbia, MD 21044**

On the Cover: Lind Stevens has enjoyed making art since childhood, but it was not until retirement loomed, that she firmly committed herself to developing and exploring her potential as an artist. Fascinated by line, shape, and form, pattern has emerged as a strong exploration within her art. Since enrolling at HCC, several of her pieces have been included in the Student Invitational Exhibitions.



A Note from the Editorial Team

This volume of Howard Community College's Journal of Research in Progress (JRIP) marks the sixth year that a group of dedicated student researchers and artists, mentors, faculty, staff, and all their support systems has worked together to bring a volume of peer-reviewed articles and artwork to fruition. Launched in 2017, the idea of JRIP was first conceived by a Faculty Professional Learning Community (FPLC) that initially gathered to discuss undergraduate student research. Since then, 49 papers representing the work of almost 100 student researchers and their advisors have been published in JRIP alongside the artwork of 23 students. Even with an uncertain return to campus in amid a global pandemic, the emergence of COVID variants and resulting spikes in infection, and changes in campus and journal administration and personnel, the numbers of papers and represented researchers and artists in JRIP continued to grow. What was first imagined by STEM folks as a publication of STEM undergraduate research has since expanded to also include exceptional student work in the health professions, social sciences, arts, and humanities whose publication is overseen by an editorial team with representatives from an equally varied collection of academic disciplines and departments on campus. It is with great anticipation that we look forward to what the next five years will bring.

In gratitude and service,

The JRIP Editorial Team

Students interested in submitting articles for next year's volume of JRIP should contact the editorial team at JRIP@howardcc.edu.

An electronic copy of this journal is available at
<https://pressbooks.howardcc.edu/jrip6>



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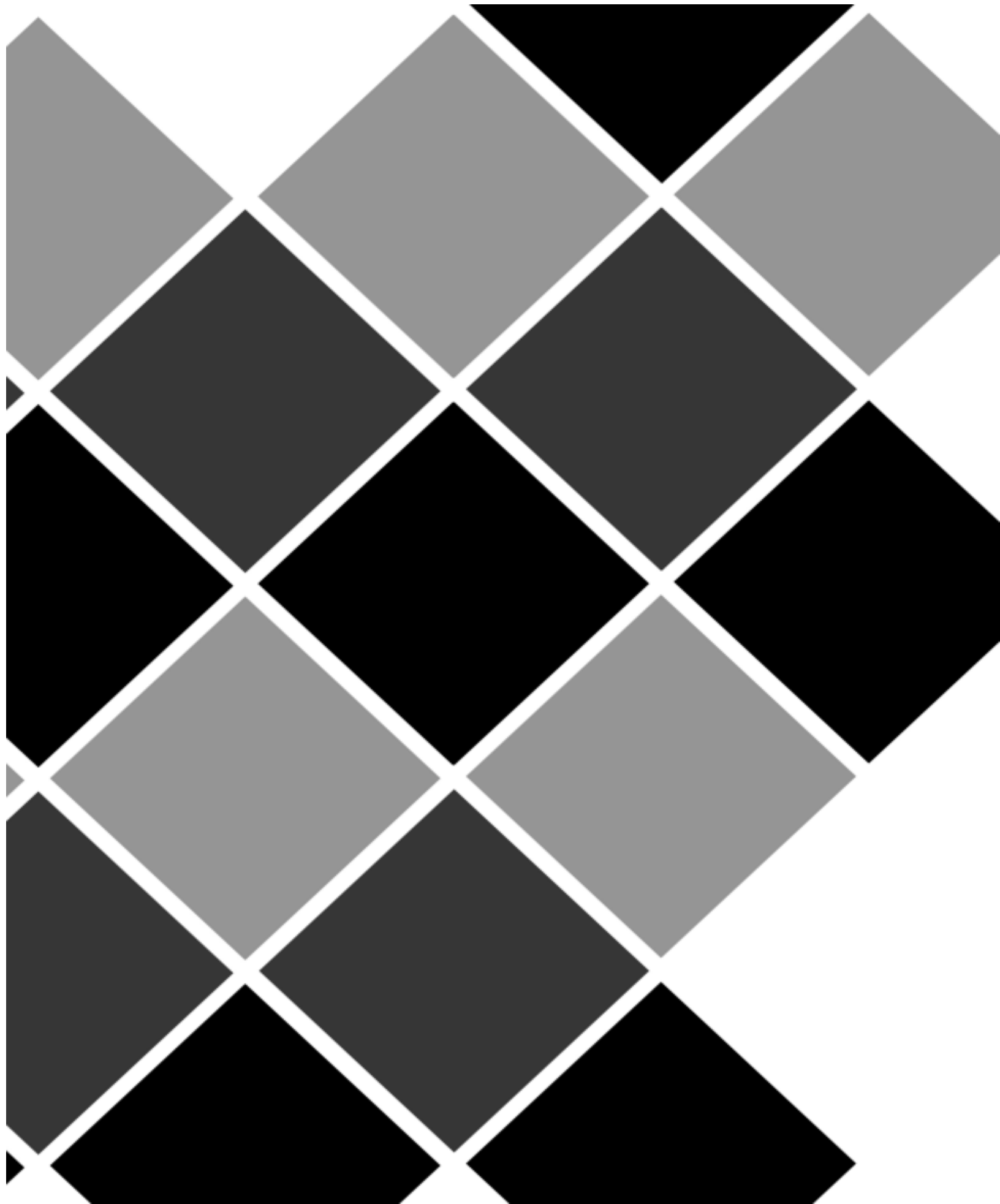
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“Using *Saccharomyces cerevisiae* live cells as a model to study RAS mRNA and interactions with small molecules using fluorescent microscopy”

Lind Stevens

Watercolor and gouache on paper

I was drawn to this topic because it had to do with biology, which I find fascinating, mRNA cells, simple yeast cells, fluorescent microscopy, and the hope of finding a cure for cancer. Through the use of design, with emphasis on color, repetition, and shape, I hoped to capture some of these concepts in an artwork that would give homage to them. The molecular structure of RNA was suggested by the five-sided shapes and attached lines. The vase was inspired by the shape of a single yeast cell. The thick, dark lines under the vase depict the journey of discovery offered by research. The dangling, straight brown lines, provide a sense of something gone awry. And last, the green dots echo the use of green fluorescence used in this study, with the leaf shape suggesting the hope of health.

Mentored by: Fahimeh Vahdat

Is *Saccharomyces cerevisiae* a Viable Model for Studying Cancer Mutations in KRAS?

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Abstract

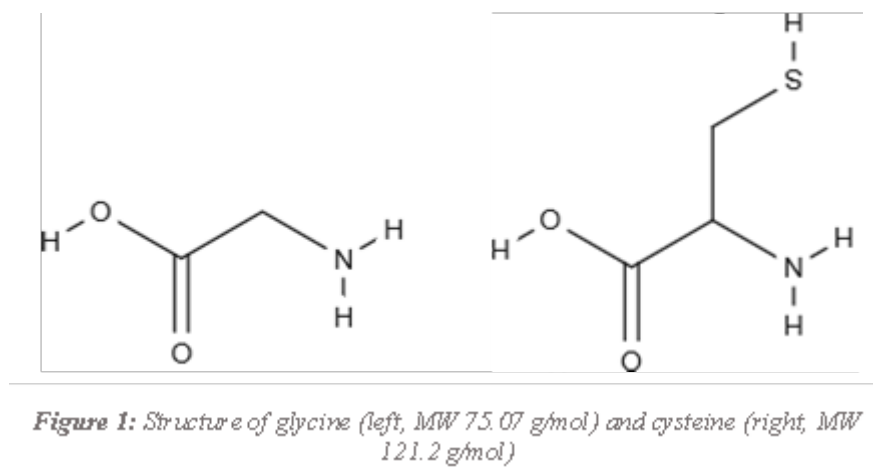
Saccharomyces cerevisiae has been used as a model organism for many diseases as approximately 1/3 of the *Saccharomyces cerevisiae* genome has human homologs and the related proteins also have about a 32% amino acid similarity to humans[4]. The question if *Saccharomyces cerevisiae* can be a model for cancer is discussed here. Mutations in KRAS are implicated in many human cancers and was one of the first isolated human oncogenes. *Saccharomyces cerevisiae* has a homolog to KRAS, named RAS1, and the sequence is highly conserved. Bioinformatics methods were used to predict primary, secondary, and tertiary structures of the mutant protein to see if the RAS1 mutant would be a viable model to mimic the mutations of KRAS. Here it is shown that the predicted structures of the mutant are comparable to the structure of RAS1 and indicate that RAS1 would be a viable model to mimic KRAS justifying the use of *Saccharomyces cerevisiae* as a model for cancer cells.

Introduction

Cancer research has existed for centuries, and, in the past 100 years, there have been many advances, but there still is a lot about cancers that are poorly understood. One such advancement was the discovery of proto-oncogenes. A proto-oncogene is a gene involved in normal cell growth. Mutations in proto-oncogenes can induce uncontrollable growth leading to cancer. The KRAS gene was one of the first isolated human oncogenes, and its mutations are present in 25% of all tumors including in 32% of lung cancers, 40% of colorectal cancers, and 90% of pancreatic cancers[6]. The KRAS protein is imbedded in the cell membrane and wild type KRAS proteins cycle between on and off by binding

to guanosine triphosphate (GTP) and converting it to guanosine diphosphate (GDP). KRAS activity is an early step in the cascade leading to other signaling proteins to initiate certain gene expressions to initiate the cell cycle progression, cell proliferation, RNA and protein transport, and actin organization[7]. Certain mutations lead the KRAS protein to always be active (constantly bound to GTP). The overactive KRAS protein leads uncontrolled gene cell cycle progression and cell proliferation which can lead to cancer. KRAS has been considered “untargetable” because of its small size, smooth surface, and the constantly bound GTP[8].

The most common mutation in KRAS is in codon 12 which codes for glycine (G12). The majority of the mutations in the amino acid are glycine to cysteine (G12C; 39% in lung cancers), glycine to valine (G12V), or glycine to aspartic acid (G12D) and a small percentage of other mutations[9]. Glycine-12 is located next to the active site where KRAS binds GTP but is not part of the active site[9]. Since it is the most common mutation and the significant differences in the side chains, we chose to look at the G12C mutation. Glycine is a nonpolar amino acid, while cysteine is a polar, neutral amino acid with a thiol group (sulfur-hydrogen) as its side chain and a much larger molecular weight (MW) (Figure 1).



Although for many years, KRAS has mostly been considered “untargetable” because its unusual shape made it difficult to design drugs to bind to it. Over the past several years, drugs that bind to and inhibit the KRAS with the G12C mutation have been developed. Several of these are in clinical trials, and one of these, Sotorasib, was approved in December 2022. Sotorasib is highly effective in treating patients with advanced non-small-cell lung cancer (NSCLC) who have a specific KRAS mutation known as KRAS G12C[10]. The study found that Sotorasib binds covalently to KRAS G12C. Sotorasib works by binding to a specific pocket on the KRAS protein and preventing it from becoming active by inducing a conformational change in KRAS. Unfortunately, these drugs only work with KRAS with the G12C mutation; it does not

work on KRAS with other mutations. In addition, although this drug works well initially, over time the cancer cells become resistant to the drug.

Proteins are characterized by primary structure (amino acid chain), secondary structure (folding based on hydrogen bonding of the backbone) and can form β -strands, α -helices, and loops, and a tertiary structure (three-dimensional folding based on the interactions between the side chains). By analyzing the KRAS protein and comparing it to the *Saccharomyces cerevisiae* homolog, RAS1, it would be possible to determine if RAS1 would be a viable model for studying KRAS. Importantly, once RAS1 is mutated, it could lead to different secondary and tertiary structures as an amino acid on the primary structure changes.

Saccharomyces cerevisiae (baker's yeast) has been used as a model organism for many diseases as approximately 1/3 of the *Saccharomyces cerevisiae* genome has human analogs and the related proteins also have about a 32% amino acid similarity to humans[4]. Studies include aging, cell cycle control, DNA damage response, metabolism, and signal transduction[4, 11]. *Saccharomyces cerevisiae* has a KRAS homolog called RAS1. The sequences of RAS1 and KRAS are highly conserved, especially in the active site. It is important to realize that G12 in KRAS will not necessarily be G12 in RAS1. In this paper, bioinformatics approaches were used to predict the conformation of RAS1 carrying a G to C mutation would be the same or similar to KRAS. The alignment of the genes and amino acids, predictions of secondary and tertiary structures were then compared to KRAS to determine if RAS1 would be a viable model to proceed with wet lab testing.

Methods

Multisequence alignment. Using Clustal Omega[5], a sequence alignment was done to determine the similarities between human KRAS protein (NP_001356715.1) and *Saccharomyces Cerevisiae* RAS1 protein (NP_014744.1). The protein sequences were obtained courtesy of the National Library of Medicine.

Comparison of Secondary Structures. Since the crystal structure of RAS1 is known, the secondary structure is also available. By changing the sequence of G12C in RAS1, we were able to predict the secondary structure using PsiPred prediction database[12] and compared it to the known secondary structure of RAS1.

Comparison of Tertiary Structures. Since the secondary structures of RAS1 and the mutated sequence (G12C) were slightly different, we used AlphaFold Protein Structure

Database to predict the tertiary structure of our mutant protein and compared it to the known tertiary structure of RAS1[13].

Results

The alignment of the human KRAS protein and *Saccharomyces Cerevisiae* RAS1 protein shows that glycine-12 in human KRAS aligns with glycine-19 in RAS1 (Figure 2). RAS1 is much larger than KRAS, but the proteins are highly conserved (similar) at the N-terminal end (beginning) of the proteins. While RAS1 has more than 100 additional amino acids than KRAS, 80% of the amino acids are similar including about 60% of the amino acids being identical[14]. Glycine-19 appears to be a good target for mutation but knowing how the protein folds in its secondary and tertiary structures will be necessary to understand if RAS1 would be a good model for KRAS. Comparison of the secondary structures using the known structure for wild-type (WT) RAS1 and the selected mutant RAS1 G19C shows that there are no differences in the secondary structure of the active sites of the proteins (Figure 3) indicating that the mutant would likely still function. This mutant could explain why mutant KRAS is always “on.” There are slight differences in

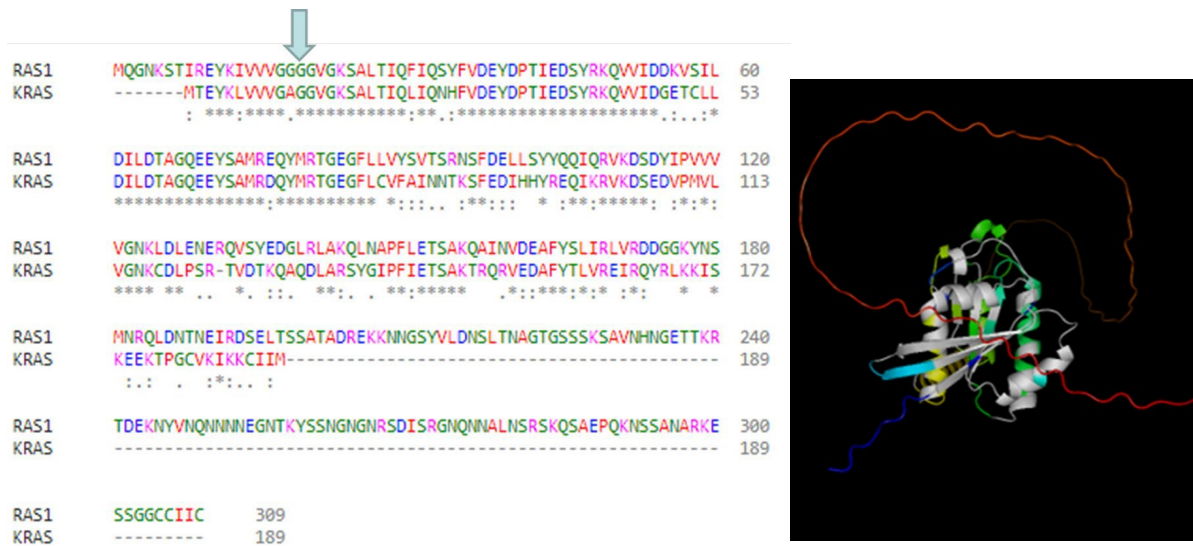


Figure 2: (left) Alignment between *S cerevisiae* RAS1 and human KRAS proteins indicate that G12 of KRAS aligns with G19 of RAS1 (indicated by arrow). Identical amino acids are identified with (*), amino acids with strongly similar properties (same functional group) are identified as the same color and with (:), and amino acids with weakly similar properties (polar, nonpolar) are identified with a (.) [5]. (right) Three-dimensional protein structure for *Saccharomyces cerevisiae* RAS1. The amino acids in white are identical to the human KRAS protein. Image is from PyMOL software [2].

the amino acids involved in β -strands and α -helices as well as varied sizes in the structures.

The three-dimensional folding of the WT RAS1 compared to RAS1 G19C mutant shows that the active sites on both proteins are similar to each other in shape and provides more evidence that the protein would be still able to function. However, there are differences in the folding of the protein (Figure 4). The differences in folding could possibly be the reason GTP is permanently bound to the mutant KRAS protein and would be supported if GTP is permanently bound to the RAS1 G19C protein. The entire protein

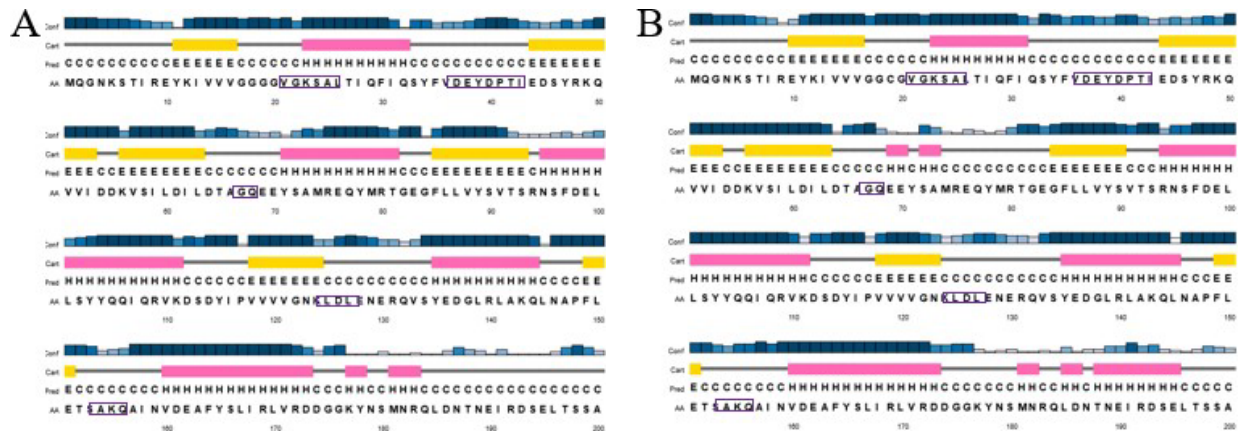


Figure 3: (A) Secondary structure of the wild type RAS1 protein. Purple boxes indicate active site of the folded, active protein. Yellow indicates β -strands, and pink indicates α -helices. (B) Predicted secondary structure of RAS1 (G19C) mutant protein. Purple boxes indicate active site of the folded, active protein. Yellow indicates β -strands, and pink indicates α -helices[1].

outside of the active site is known as the allosteric site. Changes in the allosteric site could possibly mean a tighter bind to the GTP preventing the protein from properly functioning leading to the uncontrolled activation.

Discussion and Conclusion

The comparison that was shown in (Figure 2) indicates the human KRAS G12 overlaps with *Saccharomyces cerevisiae* RAS1 at G19. The predicted models of the RAS1 G19C mutant show that there are similarities in WT RAS1 and RAS1 G19C mutant. The differences in the secondary structures (Figure 3) and tertiary structures (Figure 4) do not affect the active site but could indicate how a mutation in RAS1 could leave the protein turned “on” and always bound to GTP. Since RAS1 G19C mutation is not at the active site but is the amino acid immediately preceding the active site, we believe that the preliminary data supports the hypothesis that *Saccharomyces cerevisiae* would be a viable model for studying cancer mutations in KRAS.

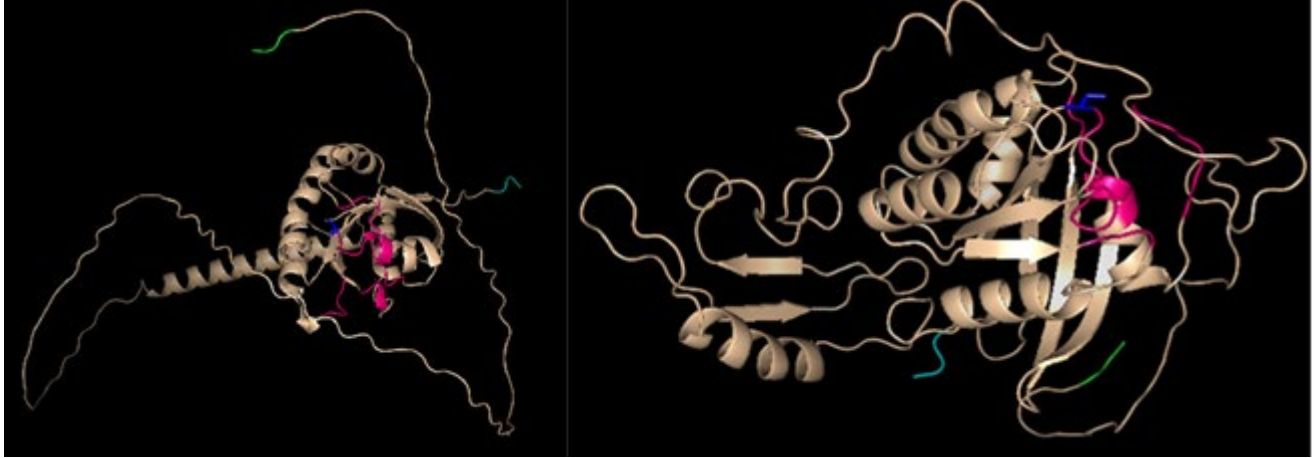


Figure 4: (left) Crystal structure of wild type RAS 1 Protein. (right) Predicted tertiary structure of RAS1 G19C mutant. Color Codes: Cyan indicates the N-terminal end of the protein. Green indicates the C-terminal end of the protein. Dark blue indicates the mutated cytosine. Hot pink indicates protein active site. Images are from PyMol[2].

Now that it appears that RAS1 will be a good model for human KRAS, the next steps will be to insert the RAS1 gene into expression vectors (plasmids) and perform site-directed mutagenesis in G19. Future studies will have the plasmids inserted into *Saccharomyces Cerevisiae* and visualized under the fluorescent microscope. The mRNA for the RAS1 protein using single molecule fluorescent in situ hybridization (smFISH) will be visualized using the MS2 bacteriophage protein binding sites containing the RAS1 gene in one plasmid tagged with green fluorescent protein (GFP) bound to the MS2 bacteriophage protein from the second plasmid. The binding of the GFP-MS2 to the target mRNA with the MS2-binding sites will allow visualization of individual RNA molecules[3, 15] (Figure 5). The long-term goal would be to use site directed mutagenesis to mutate the cDNA (copy DNA from mRNA). The hypothesis is that this would lead to uncontrollable proliferation. Once successful, smFISH will be used in live cells with the mutated RAS1 again visualizing individual mRNA molecules. Finally,

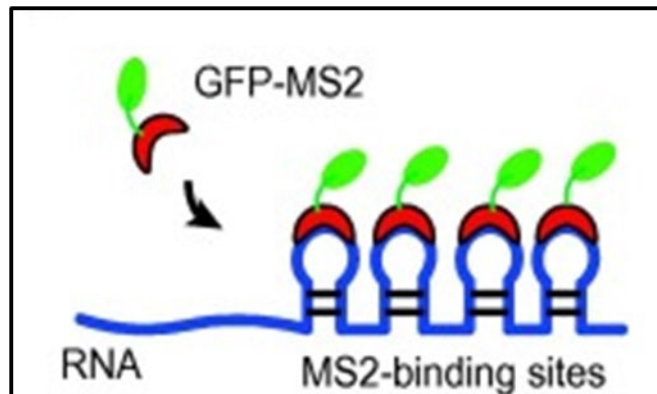


Figure 5: Model indicating how the MS2-binding sites in the mRNA will bind with the GFP-MS2[3].

small molecules will be used to target the mRNA with the goal of preventing translation. By targeting the mRNA, many problems associated with targeting the KRAS protein may be eliminated.

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Criteria and Communication: How the Two Affect Treatment and Diagnosis in Body-Focused Repetitive Disorders

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Mentored by: Matthew Van Hoose, Ph.D. and Kristel Ehrhardt, MA

Abstract

Body-Focused Repetitive Disorders (BFRDs) are a family of conditions that are identified by uncontrollable, repetitive self-grooming behavior. BFRDs are identified in the DSM-5 under Obsessive-Compulsive and Related Conditions. Treatments are not well studied for these conditions and research tends to rely on treatments for other disorders BFRDs are falsely compared to. In this process, important components of criteria, cause, and analysis are missed in studies. A lack of communication is also prevalent in this research topic. Thus, conflicting information emerges, as well as studies that reiterate previous research when new information is needed. This analysis explores how these criteria and communication issues affect how BFRDs are studied. Interviews done with professionals in the field will be used alongside current literature on the subject to investigate the effect these problems have on the treatment and diagnosis of BFRDs.

Introduction

Self-grooming is a behavior in which one modifies or maintains their appearance without help from others. For example, combing one's hair, clipping fingernails, and popping pimples are all ways one can partake in self-grooming. For many, these actions are controlled and done consciously. However, there are some cases in which these behaviors become uncontrollable and even obsessive. This is known as Body-Focused Repetitive Disorder (BFRD). In some literature, this is called Body-Focused Repetitive Behavior (BFRB). It is important to note that a BFRD is a condition listed in The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) with its own symptoms and criteria while a BFRB is the behavior that can, but not always, develop into a BFRD. The two are often used interchangeably in literature, which can lead to confusion or misinterpretation.

Not much is known about these types of conditions. Even the most well-known disorder in this cluster, Trichotillomania (Trich)¹, does not have much representation in research or the media. Thus, the information on how to diagnose and treat Trichotillomania, and its similar BFRDs, is insufficient. Currently, this body of disorders sits under the umbrella of Obsessive Compulsive and Related disorders in the DSM-5 due to the repetitive and obsessive nature of the condition. However, because of the lack of research, it is unclear if this is the correct placement

¹The repetitive, uncontrolled pulling at one's hair on one or various targeted spots of the body.

for Body-Focused Repetitive Disorders due to other symptoms correlated with the disorders.

I propose that because research is not responding directly to the needs of practitioners, there is a gap in the literature on BFRDs that is directly affecting treatment and diagnosis. In this analysis, I will take various studies in which conflicting information emerges as well as interviews with professionals who specialize in these disorders to justify my claim. In these interviews, I have asked the professionals their understanding of BFRDs, their understanding of the current literature, how those two might be similar or different, and the effect that difference or similarity has on diagnosis and treatment.

Methods and Data

Professionals were screened through the following process:

- Did they have experience working with/treating the condition?
- Where they educated in a medical or medical-adjacent field?
- Was their knowledge on the condition enough to confidently make assessments in accordance to interview questions?

Some professionals were found through an organization that specializes in BFRDs. Due to a lack of resources, there were not many professionals that passed screening. Thus, some of the professionals were referred to this study through channels of communication from other professionals.

All six professionals are therapists with varying levels of education and experience. They are all to remain anonymous and will be referred to as numbers 1 to 6. All six of the interviewees were women that both treated and had a BFRD. This correlation was not sought after but instead is an outcome by a phenomenon discussed later in this paper.

Interviewee 1 also has experience working with anxiety and depression. Interviewee 1 is a Licensed Clinical Social Worker and has over 10 years of experience. Interviewee 2 also has experience working with anxiety, depression, obsessive compulsive disorder (OCD), and bipolar disorders. Interviewee 2 is a M. Ed Licensed Professional Counselor and has over 20 years of experience. Interviewee 3 also has experience working with anxiety, depression, Post-Traumatic Stress Disorder (PTSD), attention deficit hyperactivity disorder (ADHD), and OCD. Interviewee 3 is a Licensed Professional Counselor, a Licensed Mental Health Counselor, and has over 20 years of experience. Interviewee 4 also has experience working with anxiety, depression, ADHD, OCD, bipolar disorders, and trauma-related disorders. Interviewee 4 is a Certified Physical Assistant and has over 5 years of experience. Interviewee 5 also has experience working with anxiety and depression. Interviewee 5 is a Licensed Clinical Social Worker with over 20 years of experience and has authored a book about BFRD treatment. Interviewee 6 also has experience working with anxiety, depression, and substance abuse disorders. Interviewee 6 has an MS, is a Licensed Mental Health Counselor, and has over 10 years of professional experience.

The questions were formulated to cause the least amount of influence possible to the interviewees. The questions asked covered the following topics:

- Their understanding of BFRDs and how that compares to their understanding of other conditions.
- Their thoughts on current standard treatments, including Habit Reversal Therapy (HRT) and Cognitive Behavioral Therapy (CBT).
- What they used in treatment for their clients.
- Their knowledge of current literature, including professional, educational, and general media.
- Their communication with other professionals that may encounter BFRDs.

These questions then allowed the professionals to conclude how they believed current literature is affecting treatment and diagnosis.

All interviewees signed consent forms prior to being interviewed. All interviews were recorded for data collection but were not published.

BFRDs are their own condition

BFRDs are currently categorized as an Obsessive Compulsive or Related disorder, but not all professionals in this field agree with this categorization. “I definitely agree with the idea of putting body focus repetitive behaviors in their own category... I think they have more in common with each other than they do with any other disorder, and as far as all of the other ones you listed- anxiety, depression, OCD, tic disorder- often are found comorbid with body focus repetitive behaviors” [5].

Comorbidity and symptom overlap are common in mental health. Anxiety and schizophrenia both list hallucinations as a symptom, yet both are considered different conditions. Autism and ADHD have considerable overlap with regulation and sensory sensitivity, but both are still considered different neurodevelopmental disorders. Comorbidity or symptom overlap does not make two or more conditions merge into one. Instead, it indicates that it is common for the two or more conditions to develop in the same person. For example, OCD and eating disorders can be comorbid because the symptoms of OCD can develop into an obsession with food which eventually produces an eating disorder. However, these disorders are still categorized separately and treated as their own conditions in accordance with the DSM-5.

The current literature on BFRDs reject this notion and instead try to link BFRDs with another condition. Zavrou’s [17] study investigating BFRDs in Cypriot teenage dancers tried to link anxiety and stress to the development of BFRDs but was unable to. Zavrou notes that, “Several studies have been conducted to date on the incidence of BFRBs and their correlation with emotional and behavioral symptoms. ‘These studies have found skin picking present in as many as 78% of college students’ [14], ‘although damaging skin picking is believed to have an incidence of 4% among college students’ [13]” [17, pp.332]. In this quote, Zavrou cites a study done by Keuthen and perceives this study to have successfully shown a correlation between a stressful situation (college) and the development of a BFRD. However, Keuthen’s study was to find the occurrence of BFRDs in a non-clinical setting. Assessments were taken on stress and anxiety, but that was not the focus. In the results of Keuthen’s study, it is explained that the

subjects who met the criteria for BFRDs tended to have more issues with body appearance than anxiety. Keuthen also notes that the 78% included those who partook in any self-grooming behaviors, while the 4% were the participants who met the criteria for BFRDs.

While proving a hypothesis incorrect can still collect data, this study added little relevant information to the literature of BFRDs as it only restated previous knowledge. Studies have already concluded that anxiety is not the sole reason for the occurrence of BFRDs. To once again try to link the two takes up limited resources on this topic and does not help practitioners obtain the information needed to better diagnose and treat BFRDs.

In another example, Redden's study on the significance of familial medical history did not provide much new information. Previous studies had already found a correlation between having a relative with a BFRD or Substance Abuse disorder and having a BFRD. The only new information found was: "In terms of clinical measures, nothing was significantly based on the Bonferroni correction; however, those with a first-degree relative with a SUD [Substance Abuse Disorder] reported more time each day pulling or picking and greater depression symptomatology. There were also no statistically significant clinical differences between adults with and without a family member with a BFRB" [16, pp.189]. This information of little to no clinical difference could be considered less relevant compared to research on a new medication or treatment for BFRDs. When resources are limited, a handful of studies that add little relevant information takes away the time of researchers, the limited funding institutions or independent researchers receive, and the availability of subjects willing to take part in studies that medical professionals want or need.

Besides OCD and Anxiety, another disorder BFRDs are being compared to is Tic Disorders (TD). This comparison is relatively new as recent research has concluded that some of the behaviors in BFRDs can be involuntary. One example of this would be O'Connor's study done in 2017. "BFRBs are also similar to tic and Tourette disorder and could be part of the tic disorder spectrum: both actions are semivoluntary, show similar trigger profiles, bring relief from sensations, and involve sensory stimulation; and in both disorders there is sensori-motor activation and organizational perfectionism' [10] 'and similar metacognitive trigger profiles' [12]" [11, pp. 274]. Results of this study determined using the assessment for TDs better diagnosed BFRDs compared to the OCD and Related Disorders assessment.

In the same year, a study done by Sauvé [9] tried to find the neurological similarities between TDs and BFRDs. Results showed some similarities as well as made comparisons to previous studies: "...which suggests that BFRB and OCD patients may be distinct disorders with similar behavioral symptoms, while showing dissimilar P300 pattern" [9, pp. 6]. The P300 pattern is a measured brain wave associated with decision making. This means that the behavior is the same but the brain activity in deciding on that behavior is different.

Some of the interviewees agreed that BFRDs and TDs have similarities. "I do see it related to tic disorders, as well. I can see that, especially when people say there's not an effective trigger. 'I can be sitting on the beach reading the book feeling fine', but they're engaged in the behaviors." [2]. However, the consensus was to still place BFRDs under their own category. O'Connor's study supports that tools for TDs work better for BFRDs compared to OCD, but

Sauvé's [9] study verifies that the brain activity is dissimilar enough to categorize BFRDs on its own.

Comorbidity, not a symptom

BFRDs have been treated as a symptom of another condition rather than a comorbidity. In the example given earlier, an eating disorder would not be categorized as a symptom of OCD, but rather a possible comorbidity. However, there are instances where obsessive food habits are not enough to warrant a separate diagnosis. Then, it is said the OCD has a subtype or focus. This type of categorization could be possible for BFRDs, as those with certain diagnoses may self-groom in certain situations, but the lack of research makes this differentiation challenging.

To focus on comorbidity, interviewee 4 had a specialty in ADHD and was able to make connections of BFRDs and ADHD in her interview. "I think that ADHD is a gigantic comorbidity that we haven't really looked into and know as much about... I find that not everybody with ADHD has a body focus[ed] repetitive behavior, but nearly all, I want to say all, but nearly all people with a body focus[ed] repetitive behavior have ADHD [or] some symptoms of ADHD" [4]. When fixating on the idea of anxiety or stress as a sole trigger for BFRDs, it can be easy to overlook other possible causes. A study done in 2018 found that, "Consistent with hypotheses, individuals with clinical BFRBs showed greater sensory sensitivity and sensory avoidance than individuals with subclinical BFRBs and healthy controls, even when controlling for comorbid diagnoses" [7, pp. 49]. In this study, clinical BFRBs are described as meeting the DSM-5 criteria for a BFRD. A subclinical BFRB is someone who has partaken in the behavior, but not to the extent for a diagnosis. Knowing that abnormal sensory processing can be common in BFRDs, it is then not surprising that ADHD could be highly comorbid with the disorder as both conditions would then have similarities in difficulties processing stimuli.

Interviewee 4 agreed that BFRDs should still be considered its own condition, and that more research would be needed to correctly identify and understand the link between the two conditions. Other interviewees mentioned ADHD and BFRDs in passing but did not find the same level of connection, possibly due to differences in specialties and volume of patients seeking specific care. This demonstrates the ability for BFRDs to exist without ADHD, further solidifying its need to be categorized separately.

Anxiety also lists skin-picking or other types of self-grooming as a symptom. Many studies try to link BFRDs to Anxiety or an Anxiety-adjacent condition, but it is not clear when self-grooming is an acute response to anxiety or is a result of a BFRD. Thus, it is important to find this distinction before continuing to force a link that may not be there. Anxiety can trigger a BFRD, but recent studies show that any strong emotion can enact a similar response. Interviewee 1 reiterates this fact in her interview, "We're pulling our hair, or picking our skin, we're biting our nails, we're biting our cheeks and we cannot stop for anything, right, no matter how hard we try, we cannot stop without medical intervention... It's typically associated with some sort of emotion, whether that's stress and anxiety or celebration, or relief or, you know, whatever it is. These are typically associated with some sort of emotion" [1].

The link between interest and having a BFRD

All six professionals explained that they had a BFRD and having this condition made them interested in studying it. Growing up, many of them did not have access to information on BFRDs throughout school or general life. Interviewee 4 described a bad experience she had at the dermatologist when she was younger. She was misdiagnosed with Alopecia because the dermatologist did not know about Trichotillomania and other BFRDs. This misunderstanding gave interviewee 4 the passion to learn and treat BFRDs [4]. This connection between having a BFRD and being interested in studying it does not end with the participants. The interviewees spoke of various social media forums made for medical practitioners who both have BFRDs and treat it. Some of the interviewees also spoke of several conferences in which many of the participants presenting or attending had BFRDs.

Interviewee 6 mentioned one notable outlier of this phenomenon. She spoke of Dr. Sam, a woman who obtained a PhD in the BFRD field. Dr. Sam has run a data symposium where her PhD students presented their theses. These theses all concerned BFRDs, but some of them included LGBT people, while others focused on introversion and extroversion [6].

This occurrence affects the literature. Most of the professionals stated that there was little to no exposure of BFRDs in their graduate programs. Interviewee 6 spoke of her experience with universities as a resource for knowledge. She had reached out to multiple universities and offered to speak about BFRDs. Despite asking for nothing in return, none of the universities replied [6]. As someone who went through the graduate program without exposure, she wanted to educate the next generation of specialists to prepare them for counseling clients with BFRDs. Unfortunately, the cycle of no experience to general specialists will continue and instead, new therapists will only find out about these conditions by their own means, which tends to be having it or knowing someone with it.

The absence of education on BFRDs affects more than the mental health sector. “Dermatologists shame so many of their patients that they will stop going and have infections rather than be shamed for picking. They’re medical professionals, they shouldn’t be shaming their patients” [2]. It is well known that negative emotions, fear, shame, and hate, can all stem from deficient education. While it is not in best practice to shame a patient regardless, it does not help being misinformed on this condition.

In terms of public literature, there is not much. Interviewee 6 talked about an old TV show called *Chicago Hope*². On one of the episodes, there was a patient with Trichophagia. This is when someone with Trichotillomania ingests the hair they pull. If enough hair is ingested, it forms a trichobezoar, or hairball, that must be removed surgically. Said patient acted in outlandish ways, pretending that he lived in the Wizard of Oz and one of the nurses had to dress up like Dorothy to get him to agree to surgery [6]. The director, David E. Kelley, did not know anyone with a BFRD at the time and made a damaging depiction of this condition that many with BFRDs were outraged about. Interviewee 6 noted that later in David E. Kelley’s career, someone close to him was diagnosed with Trichotillomania. Afterward, he created a different character with a sound representation of a BFRD.

²A Hospital Drama that ran on TV in the 1990s.

A few of the interviewees were able to mention a book or two that included BFRDs. Interviewee 5 was in the process of authoring a book during the interviewing timeframe that has since been published. The book was important to her because she had felt current treatment processes were not working for her. At one specific BFRD workshop in 2009, she remembers feeling lots of strong emotions, but was expected to simplify her emotions enough to fit them into neat boxes. This process did not work for her and gave her the idea for her book [5].

There is no issue in those with BFRDs creating solutions they need. The problem comes from those without BFRDs refusing to listen, provide resources, or help. Not everyone with a BFRD can become a therapist, hairstylist, dermatologist, or educator. Those without BFRDs, especially professionals, need to step in and help as they have for other conditions. It is not expected for someone with cancer to develop and apply treatments they researched, so it is unfair to require that with BFRDs patients.

Opening communication

Interviewee 1 explained the role medical necessity takes when resources are distributed. Health insurance uses data to label treatment procedures with different levels of medical necessity. For example, a double mastectomy for someone with breast cancer is more medically necessary than the same surgery for someone with slight back pain. Then, resources provided by the government or other institutions will be distributed according to the labels. Treatment for depression has been deemed a high level of medical necessity because people have committed suicide. BFRDs have not be deemed any level of medical necessity because the data that exists focuses on other aspects, such as anxiety or stress, rather than the BFRD itself [1]. Existing BFRD non-profits do not receive adequate funds or attention due to the missing information on the significance of BFRDs. Better communication between legislators and BFRD specialists would help in this area.

When asked about the level of communication between researchers and BFRD specialists, interviewee 4 responded: “I get most of my referrals from bfrb.org because I'm listed on their website as their, you know, one of their approved clinicians so my name at least is on their website. I [have] never been contacted about research, new research, to do research. Recently I was contacted by two women at MIT, doing some research on chronic nail biting, but it was limited to that” [4].

Interviewee 6 commented on the responses of the research currently being done, “It's interesting too because I mean, some of the stuff that researchers are doing is very interesting from a research point of view, and just in general what makes it start, this or that, but I've met a lot of people [that are] like, ‘I don't care about the theory’, you know, ‘I want techniques, give me solid techniques that just helped me stop this’ ”[6]. Using this quote in conjunction with the one from interviewee 4, the little communication between researchers and specialists is causing resources to be used on studies that are not crucial now.

Instances of noncommunication or misunderstanding between researchers exist as well. Wood’s meta-analysis on treatment for BFRDs in adolescents ruled out 37 of the original 60 studies in review due to “...not clearly containing adolescents or children within the sample

(n=2), lack of a control condition (n=21), lack of psychosocial therapy (n=2), and lack of reliable assessment methodology (n=12)” [8, pp. 299]. Over half of the studies in review did not meet the given criteria. Whether the reliability of the studies or the meta-analysis is put into question, there is a missing component in BFRD research. For example, two years after Wood’s analysis, Rahman published a study on the effectiveness of Habit Reversal Therapy (HRT) on adolescents with Trichotillomania. This study was chosen because the age range in the study was 7-17 and the diagnosis criteria used was from the DSM-IV, not the DSM-5 [15]. If Rahman’s study had been published first, it would not have met the criteria for Wood’s analysis due to outdated assessment methodology. This does not mean Wood or Rahman is more correct over the other; it simply points to a lack of reliable communication that causes mismatched or irrelevant information.

Conclusion

Mental health is not an easy topic. It is not uncommon for new information to be presented that disproves old information. Sometimes studies will contradict each other and there are a lot of niche conditions or topics the general person will never hear about. However, Body-Focused Repetitive Disorders are a serious topic that should be getting attention. Currently, BFRDs are treated as a symptom or subset of other conditions, which is causing the research to miss crucial components. Thus, the diagnosis criteria and treatment tools are lacking. At the moment, there are no formal, qualified treatments for BFRDs and diagnosis tools are not reliable.

For this to change, there needs to be more prominent communication regarding BFRDs. Not every study will be reliable, but the mistakes pointed out in this paper create a snowballing effect that will continue if not intervened. Communication will allow specialists and researchers to find a middle ground of what needs to be done and what can be used. Communication will also allow BFRDs to be recognized by the public. It is not exactly known what percentage of the population is afflicted with a BFRD, but as it becomes more well-known, researchers may be able to get a clearer number. Thus, institutions may grant more resources to those studying this umbrella of conditions which would allow for clearer diagnoses and better treatment options.

Future research

Because the literature on BFRDs is so scarce, there are many directions future research could go. All six of the interviewees mentioned research they hoped to see. Interviewee 6 specifically mentioned age and how difficult it could be reversing the obsessive grooming habits attached to BFRDs. Interviewee 4 wanted more research on ADHD and BFRDs. Interviewee 1 wanted to see if there was a relation between personality types and BFRDs. These are all studies possible for the future, with this analysis helping to further the ongoing dialogue. I would like to see studies done on the self-regulating component of BFRDs and if the presence of Gender Dysphoria can aggravate BFRD symptoms.

Acknowledgements

I would like to thank my partner who supported me on this journey of independent research, as well as all my friends who stood by my side when I doubted myself. I would like to thank my parents for supporting me financially, which has given me the opportunity to take on this endeavor.

Thank you to all the professors and honors faculty that have pushed me to do my best, step out of my comfort zone, and provided me with such an opportunity. Without their support, from the Mathematics Department and Honors advisors especially, I would not have accomplished an undertaking of this magnitude.

Finally, a special thanks to those who took part in my interviews. Without these amazing people, this paper would not exist.

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Giving Voice to Community College Students

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Abstract

This qualitative research study conducted individual interviews with students to contextualize the results of contemporary literature relating to the experience of community college students. The results from an open-ended questionnaire survey accomplished at one community college are compared with the literature. The project's main purpose is to provide the student's voice in the matter of challenges they encounter at the community college. The study focuses on four major areas of the student experience as found relevant by literature review on this topic. These are: one, why students choose to attend a two-year community college rather than a four-year college; two, the experience of attending community college; three, to explore the possible relationship between the stigma of community colleges and socio-economic status; and four, the role that community colleges serve as a stepping-stone for students to reach their ultimate educational goal. The author hypothesizes that the individual narratives of community college students are important in order to offset generalizing and minimizing the student experience to numbers and labels, and to amplify these topics found in current literature.

Introduction

Assumptions of what college students want, feel, and think about their schools are continuously formed by institutions, but their voices and stories are often overlooked. Four-year university students carrying the spotlight gain support, while the needs of two-year community college students are often absent and lacking, with their experiences reduced to numbers and statistics. These students may be confined to categories and labels. There is also a significant gap between what the institution thinks community college students need, and what community college students actually need. While juggling home and life challenges, students also face a negative stigma surrounding their choice of attending a two-year community college. The purpose of this research study is to open the door on how community college students view their experience at community college, and to determine if gaps exist between the individuals' responses to their needs and the college's capacity to meet those needs. The results provide community college students a voice and contextualize their experiences.

The goal of my research was to gain depth of the community college experience from individuals who are currently enrolled. Capturing a range of different voices of community college students may amplify the importance of findings rather than achieve generalizability and ultimate truth from the students' perspective. Another goal of this study was to emphasize the variety of needs and aspirations of community college students.

Background

In his article, "Enhancing Community College Operations to Promote Student Success," K. McGhee notes that community colleges play a crucial role in providing students with a low-cost, post-secondary education [1]. McGhee concludes that the type of students that benefit the most from attending community colleges are students with disabilities, students who want to complete a degree, students with a specialized major, and lastly, students who are balancing work and school. In addition, this article discusses common barriers that community college students face, as well as the ways community colleges can relieve or eliminate these barriers for their students. For example, community colleges can enhance the support of academic advising to increase student retention and graduation rates.

Socioeconomic status (SES) is explored in response to M. P. Bowden and J. Doughney's research [2]. Also using a survey format, they found two important trends. First, is the positive correlation between student socio-economic status and the level of their aspirations. A large proportion of students with higher SES aspire to attend four-year institutions, while students from a low SES background aim to work or attend a vocational training institution. Second, the authors found cultural and linguistic diversity amongst university students.

L. A. Palinkas and colleagues' work on sampling, data collection, and analysis are used for reference [3]. They believe that mixed method designs are preferable in implementation research because they provide a better understanding of research issues than either quantitative or qualitative approaches alone do. Quantitative methods are intended to achieve breadth of understanding and place primary emphasis on generalizability, ensuring the knowledge gained represents the whole population. While qualitative methods are intended to achieve a depth of understanding and places primary emphasis on saturation, gaining a comprehensive understanding. Each methodology has different expectations and standards for determining the size of the sample group required to achieve its purpose.

Random sampling is used to ensure generalizability of findings by minimizing the potential for bias, whereas the framework of non-purposeful sampling involves identifying and selecting individuals that are knowledgeable about the research of interest. Purposeful sampling takes into consideration the subjects' availability and willingness to participate (without incentives), and their ability to communicate experiences and opinions in an articulate, expressive, and reflective manner.

Leaning on the work of the literature reviews mentioned throughout this paper, my research intends to include additional insight from the students' perspective and voice their stories that are often overlooked.

Methodology

The population is among students attending a single community college located in a suburban county in Maryland, USA. As of the fiscal year 2022, the community college included 13,000 credit students and 10,000 noncredit continuing education students [4]. The average student body of the community college is 24 years old and with backgrounds from 95 different countries.

After reviewing the literature, an interview questionnaire was devised to explore the topics of focus. The general college population were invited to participate in this interview study in-person or via email. To be included, subjects were required to be over the age of 18 years old, be involved in credit courses working towards a degree or certificate and sign informed consent. Subjects received the informed consent form in-person as a hard copy, and were invited to ask any questions about the conduct of the study.

Data was collected from the structured interviews using the questionnaire. The same person administered the interviews. Questionnaire data was gathered through formal and informal interviews with approximately 20 individuals. Aside from questions regarding demographic information, such as race, ethnicity, gender, and age, most consisted of open-ended questions regarding the student's experience. Open-ended questions included asking individuals why they decided to attend this specific community college, their first impressions of the community college, how they viewed their experience so far, their interactions with students and faculty, and what they think could be improved. This format allowed students to lead the discussion, which was conducive for identifying trends regarding the students' experience at community college.

The results were analyzed by categorizing into one of the four categories investigated by the questionnaire, and then these were compared to previous literature on each category. Categories were: one, why students choose to attend a two-year community college rather than a four-year college; two, the experience of attending community college; three, to explore the possible relationship between the stigma of community colleges and socio-economic status; and four, the role that community colleges serve as a stepping-stone for students to reach their ultimate educational goal.

Results and the Literature

Students selected for this study ranged from 18 to 34 years old. The racial and ethnic demographics of students included Black Americans, Asian Americans, Hispanic/Latinos, White, and Multiracial students. Two-thirds of the students interviewed identified as females, while one third identified as males. All participants commuted to the college; one had children; and two were enrolled in degree programs at a 4-year university but needed courses supplied at the community college not available otherwise.

Who Are These Community College Students?

The qualitative survey methodology allows for distinguishing the collective student body at community colleges from the experiences and stories of individual students. For example, I interviewed a student, in his second semester at the community college, who was the first member of his family to attend college. He qualified for the Maryland Dream Act, which allows Maryland high school graduates who are undocumented immigrants exempt from paying the out-of-state tuition rate at a public institution of higher education in the States [5]. This student shared his story, saying, “My parents told me college is a privilege. Neither of them had the opportunity to attend one. In high school, I didn’t even consider going to college. It just wasn’t an option.” Fortunately for this student, at the last minute he was encouraged by his high school art teacher to apply to this community college.

Other students I interviewed were going back to school after coming back from the work field. For example, after serving six years in the military, one student explained to me the financial benefits of going back to school. Another student, after being a first-line healthcare worker during COVID-19, decided she wanted to pursue a new career. One single mother student, who dropped out of college six years ago due to pregnancy, decided to give college another shot. Juggling a sassy toddler and three courses at the college, she explained to me why she wanted to come back, saying, “My main goal is to put my child in a good private school, so he can get a good education. Getting a degree would help me be able to afford that for him.” Her current goal is to earn an associate degree. However, this is not her final stop. Afterwards, she aims to go to a four-year university in another state or in the United Kingdom to finish her bachelor’s degree. The most apparent trend I have seen from the people I have interviewed is that community college students are diverse and come from a variety of different backgrounds. There is a vast range of goals and visions they have for themselves.

Why Do Students Choose to Attend Community College?

Factors impacting participants' attendance at the community college were cost, close proximity, the school’s program, available scholarship possibilities, the need to supplement courses at other colleges, and provide a period to consider final goals.

College attributes and affordability were primary reasons why students decided to attend the community college I researched. When I asked one student why he chose to attend a community college over a four-year university, he responded, “I equate going to university like buying Nike shoes, we look at the brand but not the actual statistics.” This was not the only student that I interviewed who chose to go to community college for its attributes rather than be swayed by branding. Other interviewees agreed with this analogy. From a glance, four-year colleges look like the optimal choice because of the perceived prestigious status that comes along with it. However, as this student pointed out, many do not look further than merely the name brand.

Several students also use community college as a steppingstone for their future career goals. Others enjoyed not having to fully commit to a four-year college and, instead, use

community college as an opportunity to find what truly resonates with them, rather than, as another student phrased, “throwing away \$40,000 a semester only to find out I don’t want to be a doctor after all.”

The Community Behind Community College (*Experience*)

The particular community college is a commuter school and the student’s longest commute time was twenty minutes. The majority of students drove to the main campus, while one student rode her bike and another walked to school. The presence of residential students allows for more bonding time among them, thus providing more of a sense of community milieu. The Vice President of the Student Government Association (SGA) responded to this problem among commuter colleges saying, “It’s an oxymoron, we’re called a community college, but yet, we lack that sense of community.” One respondent observed, “I didn’t even know we had an SGA here.”

Furthering an interview with the SGA President, I asked her, “What’s one problem community colleges face with their students?” She responded, “Besides common stress, is boredom. Students at community college are bored; they go to their class, work, and then home. There’s no experience, no fun, and no engagement with each other.” She then explains that one of her goals as SGA President is to tackle this problem by having SGA gain more of a presence on campus through various events like Homecoming. She also states, “Personally, for me, I love to have these events and people on campus. With parties, eating, music, and just connecting with each other for a change. And I think it’s important to not exclude anyone, especially minority students, faculty, and staff.”

While the SGA President values a community on campus, some respondents cited a lack of time or that these events are not inclusive to those in night class and working students. More than half of those interviewed had a full-time job while juggling their full-time courseload and home-life responsibilities. Several students said they would love to be more involved in student life, but that it is just not feasible within their busy schedules. The single mother who I interviewed said, “I feel like, based on all the emails I get, the school literally has something going on every day that tries to involve everyone. But when am I ever going to be able to? I would love to participate more in school activities, like clubs and programs, but I’d need to find a babysitter to watch my son.” She suggested that having an on-campus affordable daycare center would help with this and benefit not only faculty and staff but the students who have children as well.

Although for some students, the community college lacks a sense of community, acknowledgements of this by the SGA president and her ideas to improve this was a positive.

What Do Community Colleges Offer Their Students?

Students were pleasantly surprised when they did discover that this particular community college offered an array of support systems, both academic and social, that were free for them to utilize. Many students mentioned not only does the college offer academic support such as tutoring, but also social support such as student lead discussion groups and career and personal

counseling. One student I interviewed states how the community college supported her college journey:

“The faculty and staff, from admissions to the financial office are kind, emphasizing, and understanding. They work with you and talk with you, and not at you, which is super important. They always try to give their students opportunities like internships; especially the faculty, who understand the issues and problems we face. Many of us have a stressful life outside school and they understand that. I’m able to just pop by in a professor’s office and talk to them about general life events, and they listen and see us. Which is something really special about this community college.”

A study conducted by K. M. Kilbride and colleagues looked at the needs of immigrant students at a community college in Toronto, Canada [6]. They researched the perceived needs of these students, whether they sought help for their needs, and how the college supported their needs. The researchers found that language assistance was a crucial need for immigrant students. Although language assistance was identified to be the biggest need for immigrant students, the college assisted with less than half (42.1%), of those 68 students who stated they needed language assistance. Yet, when the college did provide this service, these students succeeded in their college education experience.

The community college that was studied has recognized this need and addresses it in their program named Ambiciones. The program is designed to pair first-generation Hispanic/Latino students with Spanish speaking faculty mentors. One student explained to me how Ambiciones was a huge support system for him. He was able to talk to someone who spoke his language and could understand what he was going through. The mentor he was assigned to also assisted him in filling out necessary documents for academic and personal life. The student also utilized the community college’s free personal counseling services after realizing he needed to seek more emotional support.

Respondents also suggested other areas which might improve their college experience. One student said, “I think the college has a good infrastructure, but making it more robust and better quality is where the issue lies. Also, the curriculum can sometimes show a sense of bias and needs to work on being more inclusive, showing all sides of history, not just the victors.” Another student suggested improvements to address the issues about inclusivity:

“We might not be as inclusive as everyone thinks we are. Everything here is so surface level. When the school is having a discussion group about a certain issue or topic, it isn’t specific enough. It seems like no one truly wants to be direct or specific about the issues community college students face. Let’s really talk about depression, anxiety, sexual assault, and racial discrimination. The reality is that these issues are uncomfortable, but we can’t half-ass these things. Which I think the school sometimes, although unintentionally, does.”

Stigma Culture Around Community College

When referring to buying Nike shoes mentioned earlier, community colleges are perceived as the off-brand sneakers. It is the more affordable option, but the durability and quality of the sneaker is questionable. There is a negative stigma around students who attend community college. Some students spoke on the topic and agreed that the stigma of the quality of community colleges, and the students who attend them should be torn down. They shared their experiences of shame from attending community college or knowing of others who have faced it from their friends and family.

Previous research has shed light on the stigma around community college and how these stigmas impact community college students. Research conducted by M. K. Meisel and colleagues found that experiences of education-related stigma and discrimination that students who have not attended a four-year program face, are associated with higher levels of depression and anxiety symptom severities [7]. S. T. Shaw and colleagues focused their research specifically on the experience that students face for attending community colleges and how they might overcome these feelings [8]. Research conducted on those attending Career and Technical Education (CTE) programs found that the stigma for these students is the perception that these programs are meant for the less able and that the programs themselves contribute to the demoralization of higher education [9]. The study also found that community colleges may implicitly contribute to the stigmatization of CTE.

R. L. Brower and colleagues' study sheds light on intersectional stigmas [10]. Traveling to twenty-one state community colleges in Florida and conducting focus groups, they found that not only do many students face stigma from attending their form of college, but also from other identities of their life. Other factors of intersectional stigmas that community college students experience include homelessness, addiction, and a history of incarceration. The researchers also examined how colleges can help these students change their self-perceptions to combat these stigmas and successfully complete their degrees.

One student voiced her own perspective on this issue. She discussed with me the negative stigma community college students can face and how it personally affected her. This student entered community college with a negative mindset, jokingly stating she was one of "them," who disregarded the notion of a good community college. This student was deferred for a semester at another nearby four-year college. Her purpose for attending this community college was not for affordability or uncertain future career path, therefore, she felt like she did not fit into the 'typical' mold of a community college student. Being an outlier had great effects on her mental health and overall experience at the community college. She elaborates:

"One thing with this whole stigma thing is that I wish more people were not so negative about community colleges. If I came in with an open mind, I could have been more involved rather than being sad and lonely. We need to break down the stereotypes of who a community college student is. I didn't fit into the normal categories for attending, and I felt like I couldn't connect to those students because of their circumstances. They come for affordability or maybe they needed more support, but I just came because I got

deferred for the spring semester of the university I wanted to go to. This was just a holding place for me until the spring, so I could at least get a couple of credits in.

You can't group everyone from the community college for just two reasons why they attend. It just disconnects everyone who isn't in that group. I felt disconnected and excluded, which is why I started looking at everyone with the same lens that stigmatizes community college students. That's where the disconnection happens, because society places that stigma and negativity on community college students, so I started disconnecting myself here as well."

Current literature on the negative stigma around community colleges does not carry the complexity of the students themselves. The majority of students hold multiple identities and may have other intersectional stigmas. Tackling and dismantling this negative aura is crucial, particularly as the United States attempts to change its economy toward training more individuals to staff jobs not requiring a 4-year university degree. There must be an emphasis on the importance of voicing these students' experiences and developing discussion groups to understand the factors that perpetuate them.

Socio-Economic Status & Stigma

Students who attend community college are often seen as coming from low-income households, leading to stereotypes imposed on the students, such as being unintelligent or lazy. This ties into and feeds the negative stigma that these students often experience.

Although the SES of these community college students is not explicitly said, many respondents used the open-ended questions to discuss the financial burdens they faced. They believed that attending a low-cost college will help to achieve their ultimate goals, such as obtaining a master's or doctorate's degree, in a more affordable manner.

Further research examines how the achievement gap and cultural capital tie into SES backgrounds. In their research A. Smeding and colleagues use the framework that universities serve a dual function: *educational*, to improve students' skill and knowledge, but also as a *selection* function, to compare people and guide them in different ranks in society [11]. Current assessment practices focus on selection more than the educational function of universities, which are characteristics that align more with the norms and values of the dominant high-status cultural groups. This will favor high socio-economic status students over low-SES students in terms of their performances. The researchers hypothesized that when assessment of students is perceived as mastery-oriented, promoting student learning over selecting students, that the achievement gap between the high and low-SES students at universities can be reduced. Using the educational function as the key assessment rather than the selection function of schools, their empirical data supported the hypothesis.

One purpose of a community college is to close this achievement gap. They are able to offer students a more affordable option to achieve their ultimate academic goals. While also providing quality and additional support as well. This notion was highlighted throughout the interviews with students.

In her article, “Bridging Socio-Cultural Incongruity: Conceptualizing the Success of Students from Low Socio-Economic Status Backgrounds in Australian Higher Education,” M. Devlin mentions the importance of cultural capital as well [12]. Stating that university students from a higher SES and more conventional backgrounds build a solid understanding of the assumptions, values, and expectations of the university over their lifetime. They found that first-year students from low-SES backgrounds were more likely to say they had difficulty following course material and adjusting to their professor’s teaching styles in the university environment over higher-SES students. In addition, there is a culture of academia that is dominant and not in favor of students of low SES. Learning through trial-and-error, which many low-SES students face, is not an ideal method of learning.

Cultural capital is still an important aspect to look further into. Having more cultural capital can help students later in life, which is another purpose community colleges serve. The community college I researched offered career counseling, giving students an additional boost when it came to their resumes or preparing for interviews. This is an example of how the college tries to help its students’ overcome obstacles that would put them at a disadvantage. In this study, both financially insecure and secure students took advantage of the additional resources that the community college offered, suggesting that SES is not the only metric that drives student success.

This research found that students experienced varying degrees of impact among the relationships of SES, cultural capital, and stigma. Some students I interviewed faced no financial insecurities yet experienced the negative stigma of community college students, such as the stereotype of being unintelligent or lazy. While others with financial insecurities, also faced the negative stigmas of community colleges. The study suggests that, despite SES and cultural capital, all students faced the negative stigma of attending a community college.

Discussion

This research relies on a qualitative questionnaire format to give voice to community college students. Interview questions were chosen to allow respondents to expand on important areas identified by the literature affecting the student’s academic life and future goal attainment. In many examples, the interviewees resonated with the questions and provided their insights into the community college experience.

The most important finding was that each student wore a different lens when entering through the doors of the community college. Some wanted the experience to be solely focused on their academics and were just passing by. Others were looking for the full student life experience comparable to what a four-year university offers.

Another important finding was that each student entered community college with a unique and often complex background. This may vary from those who have the cultural capital to have gone from high school to a four-year university in a smooth path. Yet, the life experience of those interviewed provides “real experience” and should be viewed as a positive counteractant to the negative stigma of community college students.

While the majority of findings aligned with the literature reviews, this study in particular, emphasizes the benefits of lifting profiling, boundaries, and labels of community college students. The findings highlight the usefulness of collecting and analyzing individual student responses. This approach identifies areas that can be addressed by the college to enrich the experience for their students by customizing support structures [13]. This tailored identification of needs may benefit the college by eliminating unnecessary programs identified from generalized findings of categorically derived studies.

My findings have shown the benefits of looking through the lens of community college students and stepping into their shoes. Placing specific labels on students and confining them to boxes can negatively impact not only the researcher's findings, but also the students at hand.

Limitations of this Study

Limitations of this study include the nonprobability sample selection method of participants and the limited number of participants.

Areas of Further Research

Expanding this study using a randomized design and a substantially larger portion of the student body would strengthen the impact of student voices to improve their community college experience.

The US economy is expanding careers to include more individuals requiring degrees and study paths sought by community college students. This makes identifying and solving the elements that lead to a negative stigma an important area of further research. Sampling these results over time would provide feedback for diversity and academic and financial success by these students.

Lastly, it is important to keep in mind that as our culture fluctuates, evolves, and changes, so do the voices of community college students.

Acknowledgements

I would like to express my gratitude to Dr. Alejandro Muzzio for providing his guidance and support for this research. Also, to Dr. Marian LaMonte as my editorial assistant.

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Passenger Princesses

Aaliyah Robison

Digital

Making a piece for this topic was effortless; I focus on centering women in my life and art as an artist, woman, and feminist, so a topic that explored gender inequality in a male-dominated space was very compelling. There is a strong degree of “proving oneself” forced upon women in male dominated spaces that is not presented to men, with the car community being a potent example of this. A woman must enter a community as an expert, or experience ridicule, disbelief, and ostracization from her male peers. In this piece, I decided to showcase a moment of joy and connection between women in the car community—a very slick car being enjoyed by a female driver and friends. The thought guiding this creative process was, honestly, self-indulgence—there is nothing I enjoy more than women happily taking up space, especially in communities where they are made to feel unwelcome.

Mentored by: Rebecca Bafford

The Simulation of The Factor Game, Playing Using Algorithms

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Jacob Meyerson, *University of Maryland, Baltimore County*

Mentored by: Kristel Ehrhardt, MA and Loretta FitzGerald Tokoly, Ph.D.

Abstract

The Factor Game is a game created and published by the National Council of Teachers of Mathematics. Its current use is to teach students about the different factors of numbers. We put a slight twist on the standard rules that allowed for us to explore the game in a new way. We explored what happens with those variations. In early explorations we saw that player 1 had a slight edge. We explored the whys of how the advantage can be improved upon or countered. We discovered some algorithms that, if followed, improved the chance of winning. We discuss the observations we saw, analyze the results, and in the end discuss the most effective way of winning the Factor Game.

Introduction

For centuries, humans have created their own entertainment in the form of games. Games can be models of the real world. Through participating in games, humans learn from them and develop problem solving skills. Go, checkers, and chess are all famous examples of games that stimulate the mind. Yet, within the confines of these game rules, humans not only create a form of competitive play, but also spark mathematical discussions about top methods of their play.

The Factor Game is a two-player game, originally developed by The National Council of Teachers of Mathematics (NCTM), played on a board of positive integers from 1 to n . This paper will analyze a variation of the Factor Game with significantly different rules. Each player on their turn must select a number from the board, then the value of that number is added to their score and the selected number is removed from the board. Next, all the remaining proper factors of the selected number are removed from the board and added to the opponent's score. This rule is one of the most significant changes we made to the game. The other major change this variation has is it adds the rule that each player must have the same number of turns at the end of the game. For example, suppose that it was Player One's turn and the only remaining numbers on

the board were 3 and 6, then the game would end. It is important to note that these rules fundamentally change the way in which the game is played. Finally, the game ends when there are no more numbers that can be selected. The player at the end of the game that has the highest score is the winner.

Before we start play, we must discuss some definitions. When we refer to a number, we mean a positive integer. A **prime** number is a number that is only divisible by itself and one. A **composite** number is a product of 2 or more primes; thus, it has factors other than 1 and itself. A **perfect** number is a number that is equal to the sum of its proper factors. **Proper factors** are numbers that divide the number and have a remainder of 0 and that are less than the number itself; thus 1 is a proper factor of every number. An **abundant** number is a number whose sum of its proper factors is greater than the number itself.

A **round** is where each Player has one turn and has been awarded points from the opponent's choice of number. The **Total Difference (TD)** is the number of points awarded your opponent subtracted from your chosen number. **Round Point Difference (RPD)** is the Total Difference for Player 1 minus the Total Difference for Player 2 for a round. The **top** number is the highest number on the board.

Initial Observations

We began by writing a computer program to play the game for both players, using numbers 1 - 49, by randomly selecting a number on the board for every turn and recording Player 1's starting move and the result of the game. We ran the simulation fifteen million times and found that Player 1 had a 52% chance of winning overall. However, by taking into account Player 1's starting move one finds an interesting picture.

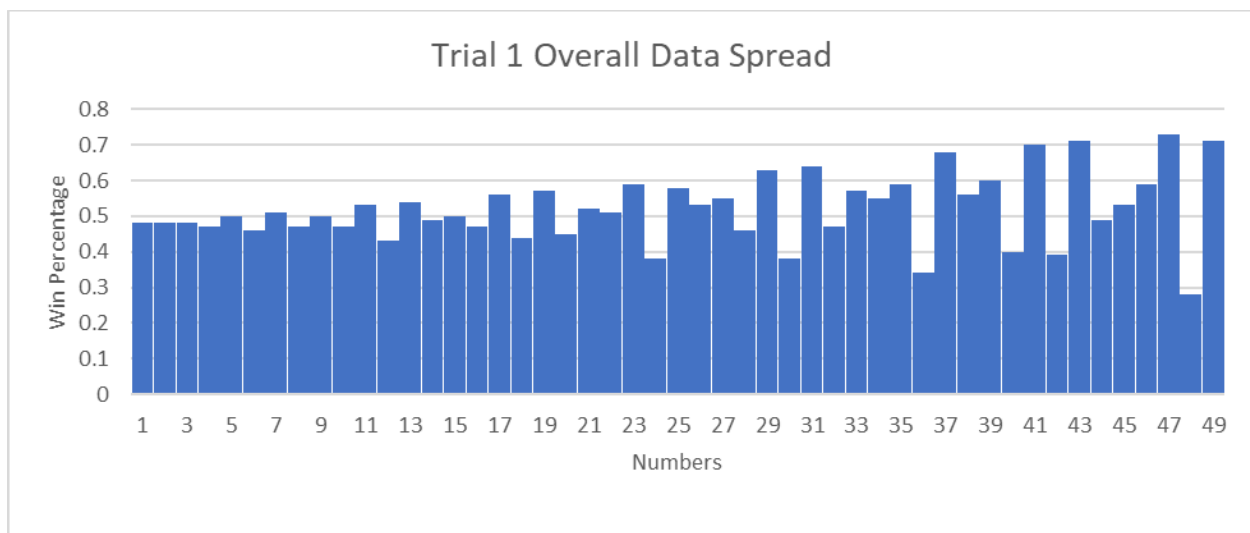


Figure 1: Chart depicting the win percentages of each starting number over all games.

One can learn several things from this graph. First, 48, which is an abundant number, has the lowest win percentage. Second, the numbers which have the highest win percentage are 41, 43, 47, and 49; the first three of which are primes, and 49 is the square of a prime. Thus we decided to consider a smaller board size to examine the different elements more carefully and to construct algorithms that are easy to use and improve one's chance of winning.

Algorithms at Play

There were numerous algorithms that were used in the games explored:

Alg. A: Player picks the greatest remaining number.

Alg. B: Player picks the greatest remaining prime.

Alg. C: Player picks the greatest remaining prime greater than top number/2, then picks the square of a prime.

Alg. D: Player only picks odd numbers (The only even prime is 2).

Alg. E: Player only picks even numbers.

Alg. F: Player only picks composite numbers.

Alg. G: Player only picks squares of primes and composites of 2 primes.

Alg. H: Player picks any number that will give the highest RPD on their side.

Throughout all the examples there are several variations between the board sizes. We changed both the board sizes and algorithms at the same time since some algorithms would not allow a competitive game to be played between both players. In addition, we saw the relationship between the board sizes and algorithms as we changed both throughout the section.

The board size increased from a size 5 board to a size 25 board because it shows how the changes with the size by itself, and along with other variables, has a significant impact on the outcome of the match. The board size can be a huge factor in the outcome between player 1 and player 2 in a match. The larger field of numbers allows player 2 more times to overcome an initial advantage of player 1 and more opportunity for player 1 to make a mistake.

Match 1: Player 1 (P1) and Player 2 (P2) both use Alg. A each pick the greatest remaining number.

Board: 1 2 3 4 5

Players	Round 1	Score
P1 awarded picked	2(awarded after P2 picks 4) 5	7
P2 awarded picked	1 (awarded after P1 picks 5) 4	5
RPD	+/- 2	Score Diff. +/- 2

Table 1: Play for Match 1.

This match 1 ends all in one round between player 1 and player 2. Since the only thing left for player 1 at the end of round 1 is to be awarded 2. Player 1 won this match because of the advantage they got when they picked the top number - which is prime on this board. They were able to be rewarded with all the points while player 2 picked a number less than the top number but was rewarded with 1 so it made the RPD even. What made the difference was player 1 being able to pick the factors of 4, being rewarded 2; since they want to stay with the same number of turns, player 1 won this match. The RPD each round gives you an accurate depiction of what happened each turn between both players, and in this case, they see the game changing play happens at the end of round 1.

Match 2 : P1 uses Alg. E, while P2 uses Alg. D ; after both players exhaust their algorithm, both players change to Alg. A.

Board: The positive integers 1 to 10 inclusive.

Players	Round 1	2	Score
P1 awarded picked	3 (awarded after P2 chooses 9) 10	0 8	21
P2 awarded picked	5,2,1 9	4 7	28
RPD	-/+ 4	-/+ 3	-/+ 7

Table 2: Play for Match 2.

Player 2 won this time because there were more numbers with factors on the even side (that player 1 had) than odd numbers. Both players want to pick numbers that will gain a high RPD. To add, with 10 being the top number, as well a number that is near abundant, it puts player 1, if player 1 chooses 10 at a disadvantage early in the game, leaving player 2 with an opportunity to win.

Match 3: P1 uses Alg. B while P2 uses Alg. F; After that both players will use Alg. G.

Board: The positive integers 1 to 15 inclusive.

Players	Round 1	2	3	4	Score
P1 awarded Picked	3,5 (awarded after P2 chose 15) 13	2,7 (after P2 chose 14) 11	4,6 (after P2 chose 12) 10	0 9	70
P2 awarded picked	1 15	0 14	0 12	0 8	50
RPD	+/- 5	+/- 6	+/- 8	+/- <u>1</u>	+/- 20

Table 3: Play for Match 3.

Player 1 had the advantage this time. Because of the nature of primes, one can pick a prime and be rewarded all the points except for the number 1. In other words, when player 1 picks a number that is a prime, the only proper factor of that number is 1, meaning a player can get a big advantage by picking primes. While player 2 picks a smaller number that may not give them the lead over player 1, the RPD may end up being negative because player 2 can pick another number that can turn into a lead for them. Since player 2 is picking numbers with 2 or more factors versus primes that have a factor of itself and 1, it gives player 1 an advantage for this match.

Match 4 : P1 and P2 uses Alg. B; After that use Alg. F.

Board: The positive integers 1 to 20 inclusive.

Players	Round 1	2	3	4	5
P1 awarded pick	0- 19	0 13	0 7	0 3	0 9
P2 awarded picked	1 17	0 11	0 5	0 2	0 15
RPD	+/- 1	+/- 2	+/- 2	+/- 1	-/+ 6
Rounds	6	7	8	9	Score
P1 awarded pick	0 14	0 6	0 20	0 12	103
P2 awarded picked	0 10	0 18	4 16	0 8	107
RPD	+/- 4	-/+ 12	0	+/- 4	-/+ 4

Table 4: Play for Match 4.

With a close match, player 2 won this game. The last rounds made the difference in this match. With both players able to pick primes, squares of prime - primes multiplied by each other (2*2, 3*3) the composites of 2 primes, but still gave player 1 a potential opportunity to get an edge. There are multiple ways this game could have ended, even with the algorithm. It seems that primes, squares of primes, and composites of 2 primes are effective game strategies.

Match 5: P1 uses Alg. E, while P2 uses Alg. D ; after that both players use Alg. G.

Board: The positive integers 1 to 25 inclusive.

Players	Round 1	2	3	4	5	
P1	awarded	5 (after P2 chose 25)	0	3 (after P2 chose 21)	0	0
	picked	22	14	4	16	6
P2	awarded	1, 2, 11	7	0	8	0
	picked	25	23	21	19	17
RPD		-/+ 12	-/+ 16	-/+ 14	-/+ 11	-/+ 11
Rounds	6	7	Score			
P1	awarded	0	0	112		
	pick	18	24			
P2	awarded	9	12	183		
	picked	13	15			
RPD		-/+ 4	-/+ 3	-/+ 71		

Table 5: Play for Match 5.

This match is a stellar example of what happens when one player picks only odd numbers. Player 2 has an advantage because of how few factors exist for primes compared to composite numbers.

Observations

There were numerous patterns within each algorithm. As well, what happens when the top number is a certain type of number, and/or when one player picks more abundant numbers than the opponent.

Given how abundant numbers behave in an active match, they would be a horrible choice to start the game. All the factors of that number will be on the board, so starting off the game by picking that number would not be so wise. However, if the player comes to this situation, they should pick the next best number as the number to start off with.

Since prime numbers are the only factors of itself and the number 1, it would be most beneficial to pick a prime number if it is the top number. Prime numbers can give you a huge advantage early, but if there is another prime number close to the first prime player 2 can counter effectively.

Analysis

There is a reason why player 1 or player 2 wins each match (or results in a draw). Numerous reasons lie in the numbers they see from each round, and the patterns and results they see from adding and subtracting each of the numbers from each other, that create a picture of why one player won over the other. Let's start with looking at what the players see the best, the final score between each opponent: The **total difference (TD)**. If they are the same, then both players struck a rare occurrence of completing turns over and over that resulted in a draw.

The TD can change in one round based on the algorithm. Strictly following the algorithm will lead a player to make a choice that they might not make if they were to write their own algorithm for the match. This strict adherence to 1 algorithm may lead them to make a less desirable choice in a round, which will shift the point difference.

Now if a player finishes each round with the bigger RDP over the other player, or most rounds, it will lead to a bigger TD that will favor their side. Since the RDP leads to the final score and TD, it is important to maximize the RDP each round when playing the Factor Game. How that would play out would be for example if a player chooses the top number (the first and highest number on the board - on the board meaning the different numbers available to pick) that is a prime number, the RPD will be that number - (1 + the opponents pick). Since the only factor of that pick is 1, and the opponents pick will be smaller than that prime number since the first player already chose the top number, their RPD will be positive on their side. The RPD is displayed as the positive and negative sign on top or bottom depending on which player got the most points out of that round with the point itself near the symbols.

Likewise, if they want to see how the RDPs in each round change over time to the end of the game, they will take the difference between the right most RDP value for a pair of RDPs in the match. It is less important than RDP, but it does tell the flow of the game and how the scores change from round to round between both players. This is called the **round point difference-difference (RPDD)**.

With the different examples shown above, only some of the numerous ways for how a game can proceed using prime, composite, abundant, perfect, and other numbers, other numbers have the same objective of maximizing the RDP each round.

Picking an abundant number when you still have numerous factors of that number still available could hurt your chances to win that match, since the other player would be awarded points, or add up to near what you picked, and then they pick their number which may have none, one, or all factors available. If player 2 prioritizes picking lower primes and/or composites with three or more factors, it will be difficult for player 1 to recover. There are also numbers whose proper factors sum close to but do not surpass the number itself such as 10 and 20, which a player must be careful before choosing as their RPD is low.

When picking a composite number, it may already have all its factors taken and you get a significant advantage. Or a number may have some of its factors still available and you are nearing the abundant number field where the number you picked will hurt your play. How much of the RPD goes your way is dependent on how many factors are available.

Perfect numbers are not common in the examples for the paper; However, they still have some utility. If all the factors are there you would be at a disadvantage because the opponent can pick the numbers, then another number. If not, the RPD will still be small but maybe more toward the opponent's side. Practically, 6 is the only perfect number in the examples.

Conclusion

Based on the trials, we found that player 1 is favored. There are many scenarios where player 2 wins but player 1 has a clear advantage since they have the first pick in the match. In the Factor Game, your strategy and how you win is based on what numbers you pick, and there is a limited number of solid number choices. With a limited number of beneficial choices, player 1 is going to pick, most if not all the time, the best choice - the top number, to start off the game. That will put them at an advantage to choose other numbers that will give them a positive RPD for them, and eventually win the game.

However, if player 1 chooses the wrong numbers, or the board has the top number as an abundant number, or the board size is favored towards player 2, player two can have a chance to come back or win against player 1. Because of the first pick advantage, player 1 is favored, but by tweaking the variables just a bit, player 2 can be the dominant player in the match. Therefore, player 2 can take advantage of player 1's mistakes.

Further Study

During this research we learned a substantial number of things about the Factor Game and the positive integers. There remains a lot of areas of further study for this game. The two biggest areas to explore are how the game changes as the board becomes larger and exactly how much of an influence changing the highest starting number has. For example, what if the highest starting number is an odd, abundant, perfect, or large composite number. Another important question is considering how the density and quantity of primes, twin primes, and abundant numbers changes as we increase the top number and how this act to advantage Player 1 or Player 2.

Three additional things to consider are adding a game clock, having each player play multiple games alternating who is going first in each round, and changing the board size every two games. Lastly, we could consider variations of the game with a board of non-consecutive numbers; for example, skip multiples of 5 or skip composite numbers that have a prime factor that is repeated three times.

Acknowledgements

For their help on the first iteration of this paper, we would like to thank Gabriel Baskerville, Onyekachi Ejike, Abdullah Nouman, and James Tang.

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Abstract that Inspired the Art

Probability and Prediction in Trading Card Games

Is it possible to predict the probability of a card being on the top of a deck?

1. The findings that I anticipated to have with this project were to figure out a methodology from Statistical Mathematics to transition a process of calculating probability from a different context and import it into fitting my scenario of Trading Card Games.
2. Create a process of testing the methodology and referencing it to pre-established predictions for results from the statistical calculator.
3. I planned to use the methodologies of a statistical calculator to input the several variables that would be present in my testing scenario and to test the results from several rounds of testing the testing method to the results of the calculator itself to prove or disprove the usage of the said calculator to serve a purpose in the established context.

“What Are The Odds?”

Elizabeth Sam

Digital Art

This topic drew me in because it sparked a curiosity and excitement in me. There’s a theme of prospection and how someone could predict the expected and have a glimmer of hope that they were right, that I found inspiring. My creative process began with researching what common images were associated with the word “probability”, and what people perceived the term to be. I ended up choosing graphic art to gain more experience in this medium and challenge myself in manipulating vector art to look stylized. The premise of the piece is to showcase someone in the process of discovering the first card in a deck of trading cards and the accuracy of their prediction all while showing the anticipation of the person as well.

Mentored by: Dave Beaudoin

