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Evaluating Interpersonal Problems in Anorexia Nervosa Through the Lens of Polyvagal Theory

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Evaluating Interpersonal Problems in Anorexia Nervosa Through the Lens of Polyvagal Theory

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By

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Abstract

Eating disorders are an increasingly prevalent issue, especially among young women. While they aren't a new phenomenon, they are historically under-researched, and remain widely misunderstood. Without understanding the causes underlying these disorders or the mechanisms working to maintain them, treating them successfully has proved to be incredibly difficult. This is especially the case with Anorexia Nervosa. Out of the six eating disorders in the DSM-5, it has the lowest treatment success rate and an alarmingly high relapse rate. Treating the disorder through weight restoration and the extinction of compensatory behaviors alone does not fully resolve the disordered pathology; interpersonal problems that have been shown to be an integral part of Anorexia Nervosa are left unaddressed by our current treatment methods. By integrating aspects of Porges' Polyvagal Theory, which asserts a link between the vagus nerve and the "Social Engagement System" that allows us to communicate interpersonally, into future therapeutic interventions, I predict that treatment success rates and quality of life after assimilation into society would increase, while rates of relapse and suicide would decrease.

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Introduction

According to the psychiatric classification guidelines provided by the DSM-5, there are eight categories of eating disorders: Anorexia Nervosa, ARFID, Binge Eating Disorder, Bulimia Nervosa, OSFED, Pica, Rumination disorder, and UFED (Diagnostic and statistical manual of mental disorders: DSM-5, 2017).

A diagnosis of Bulimia Nervosa requires that persons engage in binge eating episodes where a larger than normal amount of food is consumed within a particular time frame, while feeling a distinct lack of control over the behavior. Occurrences of binge-eating must be paired with compensatory behaviors, such as vomiting, laxatives, or diet pills. The required average frequency of binge eating episodes and compensatory behaviors has been reduced from two times per week, on average, for 3 months to at least one time a week, on average, for 3 months. Additionally, body shape and weight must largely dictate self-evaluations (Diagnostic and statistical manual of mental disorders: DSM-5, 2017). According to the NIMH, between 0.5 and 5% of females in Western countries will develop the disorder in their lifetime (NIMH, 2017).

Binge-Eating Disorder involves the same type of binge-eating episodes seen in Bulimia Nervosa, but requires that persons demonstrate a lack of compensatory behaviors in Binge-Eating Disorder. In addition to the presence of at least once weekly binge episodes for 3 months, individuals must exhibit at least three of the following: eating too rapidly, eating until uncomfortably full, eating large quantities without feeling hungry, eating alone due to embarrassment over the quantity of food being consumed,

feeling shame, guilt, depression, or disgust due to binge-eating episodes. The binge-eating episodes must cause the individual significant amounts of distress (Diagnostic and statistical manual of mental disorders: DSM-5, 2017). Previously, in the DSM-IV, Binge Eating Disorder was not included as its own standalone disorder, rather it was included as a part of "Eating Disorder Not Otherwise Specified." The diagnostic change is helpful for both patients and healthcare providers, because a more specific diagnosis, rather than a large and general category, should allow for more clarity and efficacy in treatment. Patients can fall into a mild, moderate, severe, or extreme category based on how frequently episodes are occurring. Between 2 and 7% of the population will develop this disorder (NIMH, 2017).

Pica is a lesser known eating disorder that has its own category in the DSM-5, but did not in the DSM-IV. In order to be diagnosed with Pica, an individual must consistently eat “non-nutritive substances,” such as chalk or couch cushions, for at least one month. This behavior must be inappropriate for the developmental level of the individual, and must not be a culturally accepted practice. It is possible for an individual to have Pica in addition to another eating disorder. For example, an individual could develop the habit of eating sidewalk chalk once a day, but also suffer from body dysmorphia, severely restrict their caloric intake, and have an intense fear of gaining body fat. Here, Pica would be comorbid with Anorexia Nervosa. In the DSM-IV, this disorder fell under the category of “Disorders Usually First Diagnosed in Infancy, Early Childhood, or Adolescence,” but in the DSM-V, there is no longer a specific section for childhood diagnoses.

Rumination Disorder can exist alongside another eating disorder, or exist as a standalone diagnosis. Individuals must consistently regurgitate their food for a period of at least one month; “Re-chewing or Re-swallowing” may be present, but is not required for diagnosis. The behavior must not be the result of another medical condition, such as a gastrointestinal issue (Diagnostic and statistical manual of mental disorders: DSM-5, 2017).

Avoidant/Restrictive Food Intake Disorder (commonly known as ARFID), is a more general diagnosis than that of Anorexia Nervosa or Bulimia Nervosa, for example. The psychological cause of the refusal to eat may vary widely among individuals, but the common requirement for this diagnosis is that the cause is independent from body dysmorphia or a weight concern. Often, fear of choking or vomiting due to ingesting food tends to be a motivator for food avoidance in this disorder. The refusal to engage in feeding behavior must result in significant weight loss, nutritional deficiency, and a dependence on nutritional supplementation or the use of a feeding tube. Individuals must exhibit impaired psychosocial functioning (Diagnostic and statistical manual of mental disorders: DSM-5, 2017).

Anorexia Nervosa is an eating disorder defined by four diagnostic criteria in the DSM-V. First, persistent behaviors that prevent the individual from maintaining a normal weight for their age and height must be present. This was changed slightly from the DSM-IV. The prior phrasing implied intent or active choice by the individual to refuse the

maintenance of a healthy weight. Second, the individual must demonstrate or report an intense fear of weight or body fat gain. This must be paired with Body Dysmorphia, which is clinically defined as a disturbance in the way one's body weight or shape is experienced, or a persistent lack of recognition regarding the serious threats to health and to life from the person's current low body weight (Diagnostic and statistical manual of mental disorders: DSM-5, 2017). There are two subtypes of Anorexia Nervosa: Restricting type and Binge/Purge type. Individuals with Restricting type do not engage in a binge-purge cycle like that of those with Binge/Purge type. Amenorrhea, the loss of a woman's menstrual cycle, was a diagnostic criterion in the DSM-IV, but not in the DSM-V so that the diagnostic category is equally applicable to men and girls who have not yet entered adolescence. The lifetime prevalence rate of this disorder for females in western countries is between 0.6 and 4% (NIMH, 2017). As with almost every eating disorder, with the exception of muscle dysmorphia or "Reverse Anorexia," women strongly outnumber men in terms of incidence and prevalence rates.

OSFED (Other specified Feeding or Eating Disorder) is a diagnostic category for individuals who experience significant distress from abnormal, disruptive feeding or eating patterns, but do not meet the full criteria for an eating disorder listed in the DSM-5. Often, persons demonstrate symptoms belonging to diagnoses of Bulimia Nervosa and Binge Eating Disorder, but the behaviors do not occur with the frequency required for these diagnostic categories. OSFED includes low-frequency manifestations of symptoms that are characteristic of both Bulimia Nervosa and Binge Eating Disorder. Another notable example of eating patterns that fall under this "Other specified"

category is Atypical Anorexia Nervosa. Individuals with this disorder manifest all of the symptoms listed in the diagnosis for Anorexia Nervosa, but their weight is normal for their age and height. When a person is given this diagnosis, it can have significant implications in terms of insurance coverage, as those without a more clearly defined disorder may struggle to receive help paying for treatment.

Unspecified Feeding or Eating Disorder (UFED) is similar to "OSFED" in that it is used to diagnose individuals who are experiencing distress and impairment, but do not fit the criteria for any of the eating disorders mentioned above. UFED is often used in situations where there isn't enough information to make a clear diagnosis, or the reasons for missing all diagnostic criteria aren't included (Diagnostic and statistical manual of mental disorders: DSM-5, 2017). In this way, UFED is a less specific diagnosis than OSFED, making it potentially less clinically helpful.

I would like to focus specifically on Anorexia Nervosa, because there are crucial gaps in our current treatment methods. A study by Illing et al. found that out of those with Anorexia Nervosa- Restrictive subtype (ANR), Anorexia Nervosa- Binge/Purge subtype (ANB), Bulimia Nervosa (BN), and healthy control groups (NE), ANB had statistically higher rates of attachment anxiety and avoidance than ANR or BN. Correspondingly, BN had better treatment outcomes than ANR or ANB, leading the researchers to conclude that higher levels of attachment anxiety predict less positive treatment outcomes (Illing et al., 2010). Additionally, a study by Fennig et al. examined the treatment outcomes of individuals with Anorexia Nervosa in an inpatient treatment

facility. They found that restrictive/eating disorder behaviors decreased significantly, but that core eating disorder psychology and depressive symptoms did not significantly decrease after discharge (Fennig et al., 2015). These studies highlight the disparity in positive treatment outcomes for Anorexia Nervosa compared to other eating disorders, such as Bulimia Nervosa.

Additionally, the interpersonal problems that occur with Anorexia Nervosa are a defining characteristic of the disorder, yet are still often overlooked in treatment. A study by Carter et al. showed that interpersonal problems were positively correlated with the severity of AN psychopathology. These interpersonal problems did decrease throughout the course of treatment, but remained higher than the rate of the community sample. Social inhibition, specifically, was found to predict treatment outcomes: those with higher levels of social inhibition were less likely to complete treatment (Carter et al., 2012). Similarly, Boehm et al. found that with weight restoration, depressive symptoms decreased, but social anhedonia remained present (Boehm et al., 2017). This means that even an individual who is weight restored and does not exhibit any restricting behaviors (often the main measures in determining time of discharge), may still struggle greatly with interpersonal relationships outside of treatment. A study by Hatch et al. used Event Related Potentials (ERP's) in the brain as a measure of subconscious emotion processing. They found that the AN group had reduced numbers of ERP's before and after weight gain (Hatch et al., 2010). If these individuals have problems with processing and experiencing emotion even after weight restoration, this will impact the way they conduct themselves in social engagement situations. Both social anhedonia,

in which individuals do not gain any pleasure from social situations, and Alexithymia, defined by a lack of understanding and awareness of the self's own emotions, are core parts of interpersonal personal problems that need to be focused on in treatment. Treatment effective for treating the weight-centric aspects of the disorder does not appear to be the same treatment effective for interpersonal problems.

Though there are many psychological aspects of Anorexia Nervosa that aren't visible to the outside observer, many behaviors can be spotted by family or friends. The amount of discipline required to maintain the behaviors associated with the disorder leads to it taking over the individual's life. Social interactions and activities are often pushed to the side, because most of these events involve fear foods that the individual can't bring themselves to eat. Often, attending dinners with loved ones or friends without eating the food provided, instead insisting that they will just eat at another time or that they just aren't hungry, can be incredibly isolating and uncomfortable for the individual. Naturally, the individual will receive many unwanted questions about their eating habits, which promotes already heightened anxiety levels. The paranoia of the disorder contributes to a feeling of being judged for "eating too much" or "looking like a pig." Those with AN can either start actively avoiding social gatherings or may begin cooking frequently for others, but not eating the food they cook. In this way, they are still able to immerse themselves in recipes, "foodie" Instagram accounts, and food preparation, without ingesting any calories from the meal. Similarly, individuals of both subtypes may start losing interest in things they used to enjoy. This may be due to depressive symptoms, or the overwhelming amount of time and energy devoted to

maintaining restrictive and compensatory behaviors. Low energy and irritability can occur alongside the apathetic mood simply due to the immense caloric deficit and high energy output.

Those with restrictive type Anorexia Nervosa often engage in food hiding or rearranging behaviors. During meal time, individuals may secretly spit out food into a napkin, or take it directly off their plate and stuff it into their pockets, bra, or socks to throw away later. A more subtle form of calorie avoidance is rearranging food. “Microcutting” is a common strategy used to make the food on their plate look more eaten without ingesting much of it. Slow, minuscule bites are eaten, while the food is pushed around the plate and dissected into small pieces. Both subtypes of AN will frequently go to the bathroom right after eating. In binge/purge type, they may engage in purging right after eating in an attempt to prevent digestion of the food. In restrictive type, individuals may enter the bathroom to exercise in secret, to burn off the calories they just ate. They may also spit out or flush food they had hidden during the meal.

Those who suffer from the disorder feel large amounts of fear and shame when it comes to eating, often so much that the thought of eating certain foods or quantities can cause panic attacks, hysteria, or violence (Mattocks, 2014). To combat this discomfort and anxiety, they create food rules that become more and more restrictive as the disorder progresses. These self-imposed guidelines resemble typical OCD behaviors in many ways, because once they are done once, there is no longer a choice not to do it. This can manifest in all aspects of daily life, such as needing to walk a certain number

of steps, eat a certain number of calories, or drink a certain amount of water. If a patient decided she would eat 1250 calories on Thursday, she may feel the urge to set that as her new “maximum.” On Friday, the acceptable calorie range would be anywhere below the previous number. This contributes to the rapid weight loss seen in the disorder, because as the individual whittles away at their caloric intake, the amount of exercise or activity they engage in inflates at a similar rate, increasing the weekly caloric deficit dramatically.

Body dysmorphia is a trait specific to Anorexia Nervosa, as it is not seen in other eating disorders to the same degree. Though body image issues are a common thread throughout all eating disorders, body dysmorphia is not truly synonymous with body dysmorphia. Not only is the level of distress caused by the perceived bodily flaw of a greater magnitude in body dysmorphia, it is often focused on one part of the body. The lower stomach or thighs are a common fixation point in women. The dissatisfaction with this particular body part overpowers the perception of the rest of the body. For example, during an episode of body checking, an intense period of self-examination involving pulling and poking individual body parts in front of a mirror, an individual may note the degree to which their rib cage or collar bone are protruding, but if they do not believe their lower stomach region is flat enough, a generalization occurs and results in the feeling that nothing on their body is small enough. This spiralling effect is a large contributor in allowing severely underweight individuals to believe that they need to keep losing weight. A study by Via et al. examined potential brain regions implicated in body dysmorphia. They hypothesized that the Default Mode Network would be

implicated, due to its involvement in self-related thoughts and assessment of information. 20 women with AN and 20 healthy women were shown videos of their own body and of another person's body. The neural states while processing these visual stimuli were compared to the neural state at rest. They found that those with AN had greater activation in the dorsal posterior cingulate cortex while looking at themselves, and had much less activation than the control group in the ventral posterior cingulate cortex and precuneus while looking at others. The resting state connectivity of the dorsal posterior cingulate cortex and angular gyrus was diminished in those with AN. These findings support the idea that the precuneus and cingulate cortex are some of the brain regions involved in the phenomenon of body dysmorphia. Additionally, lower functional connectivity of aspects of the Default Mode Network could be a key component of the maintenance of dysmorphic pathology (Via et al., 2016).

Current treatment methods for treating Anorexia Nervosa include Cognitive Behavioral Therapy (CBT), Dialectical Behavioral Therapy (DBT), and EMDR. Cognitive Behavioral Therapy focuses on the interaction between behaviors, thoughts, and feelings, which are known to be cyclical and highly related. Maladaptive behaviors are identified and targeted first. The cognitive piece comes next; patients are guided through various exercises in order to restructure the beliefs and thoughts that both influence and are influenced by behaviors (O'Donohue and Fisher, 2009).

Dialectical Behavioral Therapy (DBT) was first designed to treat Borderline Personality Disorder, but has been adopted for the treatment of Anorexia Nervosa in

individuals who don't respond well to CBT. DBT uses 4 main pillars: Mindfulness, Distress Tolerance, Interpersonal Effectiveness, and Emotional Regulation. By teaching individuals these skills, the goal is to reduce the need for the disordered behavior by replacing it with healthy and productive coping mechanisms. There is a distinct lack of clinical experiments on the effectiveness of DBT for Anorexia Nervosa, though it is still used in many treatment programs. A new variation of this treatment, Radically-Open Dialectical Behavioral Therapy was first published about in 2013 by Lynch et al. RO-DBT shares the same basic structure and framework as DBT, but its goal is not to treat uncontrolled issues, but overcontrolled issues. Mindfulness, Distress Tolerance, Interpersonal Effectiveness, and Emotional Regulation Skills are all still included, but Radically Open Skills are also included (Lynch et al., 2013).

Family Based Therapy (FBT) asserts that an individual with AN is not in charge of their own eating choices or behavior; the eating disorder is actually in control. Therefore, parental guardians must be put in charge of this individual until the grip of the eating disorder has loosened. This stance requires that the parents must be an integral part of the therapeutic process, so they can develop the proper tools and awareness to help guide and support their child. Weight restoration is the first priority in this treatment method, followed by a gradual transition of autonomy over eating choices back to the patient, concluded with a reshaping of the dynamic between the child and their parents. This type of treatment is meant for individuals under the age of 18, as they are still apart of the family unit at this time (Lock, Le Grange, 2012).

Eye Movement Desensitization and Reprocessing (EMDR) is often used in conjunction with CBT or DBT, because many patients with Anorexia Nervosa have histories of trauma. EMDR is a technique using bilateral eye movements paired with therapist guidance to “unlock” and process memories of trauma that can’t be accessed otherwise.

Weight restoration and elimination of restrictive and/or compensatory behavior is the most common operationalization of treatment success. In terms of this type of success, Family Based Therapy generally has the most positive treatment outcomes. In a five year follow up study from 1997, Eisler et al. assessed the progress in 80 patients with Anorexia Nervosa or Bulimia Nervosa. Those with Anorexia Nervosa and Bulimia Nervosa were divided into early and late onset groups, creating four groups from the original two. Patients either received FBT or individual therapy for one year. In the five year follow up, patients’ maintenance of weight restoration and their score on the Morgan-Russell scales were recorded. While all groups showed significant improvements, individuals with early-onset Anorexia Nervosa showed more improvement when they were treated with FBT previously, rather than individual therapy. Conversely, those with late-onset Anorexia Nervosa showed more improvement when they were previously treated with individual therapy rather than FBT.

A study by Goldstein et al. examined the effectiveness of FBT on 34 patients treated in a private practice setting. Bodyweight was recorded before and after treatment, to calculate a % change in body weight over the course of treatment. They found that 45.9% of patients reached full weight restoration (defined as greater than

95% of their expected body weight), and 43.2% of patients reached partial weight restoration (defined as less than 95% but greater than 85% of their expected body weight). Only 10.8% of patients did not achieve at least 85% of their expected body weight by the end of treatment (Goldstein, 2016). This study is important, because it is important to examine not only the efficacy of a treatment in a controlled setting, but also the effectiveness in a real world setting, such as a private practice. A study by Murray et al. compared the efficacy of Family Based Therapy to Parent Focused Therapy. In FBT, parents and siblings are included in the treatment sessions along with the patient, while in PFT, patients are not directly involved in the treatment, but parents are. The patient gets weighed and receives a short counseling session, but they do not sit in with the parents during treatment. They found that with both forms of treatment, there were significant improvements in weight, dietary restraint, positive affect, and negative affect. While there were no significant differences between FBT and PFT, this study still shows that either could be used in the treatment of Anorexia Nervosa (Murray et al., 2017).

CBT is more often used for Binge Eating Disorder and Bulimia Nervosa; when applied to Anorexia Nervosa focuses on reducing restrictive behaviors and reaching weight restoration, but the focus isn't on interpersonal problems that remain after weight restoration and symptom stabilization. CBT has been found to be reliable for treating BED and BN and is considered the "gold standard" (Agras, 2019). A study by Pike et al. randomly assigned 33 women with Anorexia Nervosa either to one year of nutritional counseling (working as a control group) or Cognitive Behavioral Therapy. The study examined time until relapse, treatment failure rate (comprised of those who relapsed

and those who dropped out within the first 10 days), and rate of “full recovery.” Full recovery was defined as meeting the Morgan-Russell criteria for “good outcome,” in addition to a lack of binge/purge behaviors and eating attitudes and weight concerns less than one standard deviation above the mean of a healthy, control group. 53% of the nutritional counseling group relapsed, while only 22% of the CBT group relapsed. Additionally, the treatment failure rate of the nutritional counseling group was 73%, compared to the 22% treatment failure rate of the group receiving CBT. None of the patients in the control group reached “full recovery,” but three of eighteen patients in the CBT group met these criteria. This study showed some efficacy in CBT for Anorexia Nervosa, but it should be noted that the efficacy rate is still quite low, and this does not present as a “gold standard” for Anorexia Nervosa like it does for BED or Bulimia Nervosa (Pike et al., 2003).

It should be noted that there is a lack of supporting research for almost all of these treatment modalities, even on the most basic and commonly noted aspects of recovery, like food restriction and body fat percentage/BMI. Little is known about how we should treat the disorder, even though many of these techniques are being used in therapists now. There is even less evidence for the successful treatment outcomes in terms of interpersonal relationships.

A study by Lynch et al. is one of only a couple studies done on Radically-Open Dialectical Behavioral Therapy (RO-DBT). The goal of RO-DBT is to provide patients with the skills to establish and maintain social relationships and bonds, as it has been

established that those with Anorexia often struggle with emotional openness and social connectedness. In the study, forty seven individuals with restrictive-type Anorexia Nervosa went through about 3 weeks of treatment with RO-DBT, on average. Their treatment outcomes were incredibly high, with 35% of those who finished the treatment in full-remission and 55% in partial remission. The patients' eating disorder psychopathologies, psychological distress, and ED related quality of life were measured; The 90% of individuals who were in partial or full remission showed significant improvements in all of these measures. This study provides support for RO-DBT as a treatment for Anorexia Nervosa, not only for weight restoration and elimination of behaviors, but also for feelings of loneliness or social problems (Lynch et al., 2013).

Though the purpose of EMDR is to work through and resolve trauma and is not specific to eating disorders in general nor Anorexia Nervosa specifically, trauma histories are incredibly common in patients diagnosed with this disorder. The processing of these traumatic memories and events can reduce the need for an individual to use eating disorder behaviors as a coping mechanism for internal turmoil. A case study by Zaccognino et al. outlined the recovery of a 17 year old girl with Anorexia Nervosa and comorbid depression and OCD like traits. Her disorder was extremely severe; At 5 foot 3 inches, she was only 62 pounds. Her restrictive behavior was rigid in nature, she was very socially isolated, and she was unaware of how dangerously underweight she was. In the past, she had undergone psychodynamic therapy and cognitive behavioral therapy, but neither were effective in treating her disorder. Notably, she scored

dismissing attachment style on the AAI, which is not uncommon for patients with Anorexia Nervosa. Over the course of 6 months, the patient attended 36 EMDR sessions interspersed with some “talk-therapy” and resource development. By the end of treatment, the patient showed great improvements in many aspects of the disorder. After she gained approximately sixty pounds, she no longer met the diagnostic criteria for Anorexia Nervosa. Her food preoccupation decreased noticeably and she was able to achieve a higher level of interoception by listening to her natural hunger cues. She was able to regulate and experience emotions without needing to exhibit eating disorder behaviors. Importantly, she experienced an improvement in her ability to interact socially with peers, family members, and other adults. Her attachment style even changed from dismissing to earned secure, which has huge impacts on her ability to navigate social situations (Zaccognino et al., 2017).

A study by McIntosh et al. compared the efficacy of CBT, a non-specific supportive clinical management, and IPT on individuals with Anorexia Nervosa. They hypothesized that CBT and IPT would perform better than the non-specific form of therapy, but in fact, they saw the opposite. After 20 sessions, the non-specific form of therapy was significantly more effective than IPT. CBT was not significantly different than either form of therapy. However, in the long term, none of the modalities ended up being significantly better or worse than another. This study is not in support of IPT for the treatment of interpersonal problems in those with Anorexia Nervosa, despite its name and specific goal (McIntosh, 2015).

Fennig et al. looked at changes in core perceptions and thoughts in 44 patients with Anorexia Nervosa who were admitted to an inpatient treatment program. This program, specifically, used both FBT and CBT in conjunction with each other during the complete inpatient phase of treatment. After weight restoration, patients moved to an outpatient half-day program for weight-stabilization and assimilation back into the community. Measurements were collected upon admission to the hospital and upon discharge from the lower level of care. Core anorexic thoughts measured using the EDI-2 consisted of 11 subscales: drive for thinness, bulimia, body dissatisfaction, ineffectiveness, perfectionism, interpersonal distrust, interceptive awareness, maturity fears, asceticism, impulse regulation, and social insecurity. The researchers also measured the intensity of comorbid disorders, namely anxiety and depression, and suicidal ideation. No significant changes were found in the intensity of any core anorexic ideations; this includes all of those related to interpersonal problems. Anxiety levels did not significantly decrease after treatment. Depression, measured by the BDI, showed a statistically significant decrease, however it may not be clinically significant as they remained within the range of clinical depression. Suicidal ideation was significantly increased at the time of discharge. Even though these patients showed increases in BMI and decreases in restrictive or compensatory behaviors, there are clearly many symptoms left unaddressed, even after completing both inpatient and transitional outpatient programs (Fennig et al., 2015).

Though it has been shown that perceived loneliness, social avoidance, and lack of interpersonal closeness contribute to the maintenance of thoughts and behaviors

seen in Anorexia Nervosa, there is a distinct lack of focus on this problem in the literature. Treatment effectiveness in terms of weight restoration and compensatory behaviors is already concerningly low for those with AN, but relapse rates need to be considered, as well. Richard et al. reported that out of 58% of patients with AN who achieved partial remission through treatment, 32.6% relapsed within the two and a half year follow up period. Relapse was operationalized as a BMI under 17.5 for 3 consecutive months (Richard et al., 2005). A 10 year follow up study from 1991 by New York Hospital-Cornell Medical Center found that out of 76 patients with AN, only 24% were free of an eating disorder. With such low success rates, paired with high relapse rates, clearly there is a factor that is not weight restoration or apparent lack of restrictive behaviors contributing to the maintenance of the disorder. I argue that interpersonal problems left over after treatment are contributing heavily to our failures to treat Anorexia Nervosa.

While interpersonal problems are a broad category, there are more specific components I would like to focus on: Attachment, Alexithymia, Anhedonia, Interoception, and Self-determination.

Attachment Theory is based on the idea that from the time we are born, we begin making attachments to those around us, predominantly our caretakers or loved ones. This is a built-in survival instinct, as a baby cannot fend for itself, and must be taken care of and protected. The attachment style that develops during infancy eventually dictates emotional regulation and communication strategies in later years of life (Illing et

al., 2010). In a study by Waters et al., they examined the stability and consistently of attachment styles over the lifespan. At one year of age, children were assessed in the Ainsworth Strange Situation, which is an experimental paradigm consisting of multiple combinations of child, caregiver, and stranger in an unfamiliar playroom. Participants were given either a secure (58%), insecure-avoidant (18%), or insecure-resistant (24%) classification. Then, once participants were either 20 or 21 years of age, the Berkeley Adult Attachment Interview was used to reassess attachment styles. Importantly, interviewers who conducted the adult assessments were unaware of the participants' results as infants to avoid bias. Participants were categorized into secure (50%), Insecure-dismissing (32%), or insecure-preoccupied (18%). Insecure-preoccupied was the adult equivalent to insecure-resistant during infancy. Insecure-dismissing was the adult equivalent to insecure-avoidant during infancy. This study found that only 36% of individuals changed their attachment style after the 20 year period. An individual's specific attachment style is likely to remain constant throughout their life, with events such as sexual trauma, loss of a family member, divorce, or a severe medical diagnosis being likely triggers for a change in style (Waters et al., 2000). Attachment theory is a relevant piece of the interpersonal problems experienced in AN, because of its large clinical implications. A study by Illing et al. looked at treatment outcomes in individuals with varying levels of attachment insecurity. They found that not only did those with restrictive type AN (ANR), binge purge type AN (ANB), or Bulimia Nervosa (BN) have higher levels of attachment insecurity than those without and eating disorder, but they also found that ANB had higher levels of attachment avoidance than both ANR and BN. ANB and ANR weren't statistically different from each other in terms of attachment

anxiety, but they were both found to have higher levels of attachment anxiety than BN. These findings are important, because the study concluded that when levels of attachment anxiety increased, eating disorder symptoms were more severe and treatment outcomes were worse (Illing et al., 2010).

Alexithymia is a difficulty in identifying and describing feelings and in distinguishing feelings of emotional arousal (Nemiah et al., 1976). A study by Courty et al. looked at the relationship between Alexithymia and eating problems and social avoidance in AN. Alexithymia was measured using the TAS-20, eating disorder symptomology was measured using the EDI, and social avoidance/anxiety was measured using the LSAS. They found that higher TAS-20 scores were associated with more severe eating disorder symptoms. Notably, interpersonal distrust, feelings of inadequacy, and interoceptive deficits were particularly important in seeing this effect. Higher levels of Alexithymia were also found to be associated with higher levels of social avoidance and anxiety. These results imply that Alexithymia is a part of the core problems contributing to the maintenance of the disorder (Courty et al., 2015). A related study by Keating et al. proposed a hypothesized model to show the interaction between Attachment Avoidance, Attachment Anxiety, Alexithymia, and Body Esteem. Using self-report data from 300 women with Anorexia Nervosa, Bulimia Nervosa, or EDNOS, statistical testing helped determine which of their proposed relationships were significant, and made a best fitting model (See Figure 1). Attachment Anxiety was found to have a direct negative relationship with body esteem. Attachment Avoidance was found to have an indirect negative relationship with body esteem, with Alexithymia as a

mediator (Keaty et al., 2013). This is clinically significant, because if attachment styles and Alexithymia interact to influence eating disorder pathology, it should be a focus in treatment.

Anhedonia is a deficit in the ability to experience pleasure in typically pleasurable situations. As food is a basic human need for life, the statistically normal human brain associates positively with food based stimuli. Those with Anorexia Nervosa generally respond negatively to food stimuli, often avoiding situations where food will be present. Additionally, the act of eating food is not a positive experience; extremely high levels of anxiety, fear, and guilt are experienced during and after ingesting food, perpetuating restrictive behavior and even elimination of ingesting food altogether. Social anhedonia is another form of anhedonia seen in Anorexia Nervosa in which individuals gain extremely limited amounts of pleasure from social interaction, leading them to seek out social interaction less frequently (Tchanturia, 2012). A study by Boehm et al. examined anhedonic symptoms in those with Anorexia Nervosa over the course of treatment, in addition to measuring depressive and ED symptomology. They were specifically interested in seeing whether or not anhedonia in AN was able to be differentiated from depressive symptoms due to caloric restriction. 35 women with non medicated AN, 33 women with a former AN diagnosis, and 63 healthy female controls were used in the study. The women in the recovered group had to have maintained a BMI over 18.5 for 6 months, menstruate, and been free from restrictive eating or binge-purge cycles. Though menstruation has since been removed from the DSM-5 diagnostic criteria for AN, I believe this study is still valid. The EDI-2 was used to measure ED pathology, the

BDI II was used to measure depression, and anhedonia was assessed using the Snaith-Hamilton-Pleasure-Scale. The SHAPS-D score excluded food related pleasure. A separate “SHAPS-food” score was obtained. Within initial assessment of the three comparison groups, the recovered AN group and the AN group did not differ in their SHAPS-D scores, but they were both significantly higher than the scores of the healthy control group. Depressive symptoms were significantly higher in the AN group than either of the other two comparison groups. Interestingly, in the second assessment of the longitudinal study, SHAPS-D scores were not significantly different than the scores from the first assessment. BDI-II scores, however, were significantly lower at the point of the second assessment, indicating that depressive symptoms changed while anhedonic symptoms did not. Weight restoration then, is successful in reducing depressive symptoms, but does not change anhedonic symptoms (Boehm et al., 2017).This is clinically significant, because if we rely on the common definition of “recovery,” there is large capacity for core AN symptoms to still exist and go untreated.

This issue was broached in a paper by Tchanturia et al. which explored a potential relationship between social anhedonia and alexithymia. The researchers argued that the clinical significance of their work lay in the fact that higher rates of symptoms untreated through therapeutic intervention are associated with higher relapse rates. Untreated symptoms not addressed by the presence or absence of restrictive behavior and the achievement of weight restoration will affect patients’ assimilation back into society. The RSAS was used to measure social anhedonia. Self-reported scores on the EDE-Q were used to assess disordered eating. The TAS-20 was used to measure alexithymia. Depression, anxiety and stress was also measured using the DASS 21.

Those with AN had significantly higher levels of social anhedonia than healthy controls, and higher levels of anhedonia were positively correlated with more severe ED symptomology. Additionally, higher levels of anhedonia were positively correlated with higher scores on the depression and anxiety measure. Interestingly, the researchers found a significant positive correlation between social anhedonia and alexithymia. An incredibly important finding that should be noted, is the lack of relationship between BMI and anhedonia in AN. When looking at Bulimia Nervosa, there was a significant inverse relationship between BMI and social anhedonia; this relationship was not significant for AN, again indicating that weight restoration is not sufficient for alleviating core AN symptomology. Depressive symptoms were diminished by weight restoration, so we can conclude that depression and alexithymia are related, but not functionally identical in individuals with AN (Tchanturia et al., 2012).

Interoception is the ability to perceive and assess internal cues relevant to homeostasis. There have been quite a few studies done on interoception in Anorexia Nervosa, because interoceptive ability is seen to be linked to emotional capability, specifically Alexithymia (Kerr et al., 2015). Visceral interoception is defined as the perception and integration of primary vagal signals related to homeostasis. A study by Kerr et al. used fMRI to examine insular functioning in healthy controls compared to individuals with restrictive type AN. Participants performed 2 different tasks: an anxious rumination task and an interoceptive attention task. Based on activation patterns, they concluded that the dorsal-mid insula activity was irregular when performing the stomach interoceptive attention task. The anterior insula had irregular activity patterns during the

heart interoceptive attention task. The dorsal-mid insula was also irregularly activated in those with AN during the anxious rumination task, which provides a link between interoception and core symptoms of the disorder. Lack of interoceptive ability may be contributing to the maintenance of the disorder. It should be noted that the AN participants were weight restored and not on any psychotropic medication. If we use the common clinical definition of recovery (weight restoration), the differences in the brain activation were still detected. This further supports the idea that weight restoration is not a sufficient marker for recovery. A study by Strigo et al. in 2013 also looked at interoceptive deficits in those recovered from AN using an fMRI, but this study was looking at pain anticipation and processing. A red cross indicated that they should anticipate high pain, a green cross indicated an anticipation for low pain, and a yellow cross indicated that there was an equal chance of the pain being high or low. The women in the recovered group were weight restored, not on medication, and free of compensatory behaviors for one year. Levels of Alexithymia were measured using the TAS-20, in addition to depression and anxiety using self-report tests. The researchers found increased activation in the cingulate, right anterior insula, and dorsolateral prefrontal cortex of the recovered AN group than the control group during pain anticipation. Increased activation in the dlPFC and decreased activation in the posterior insula during actual pain stimulation was also seen. Increases in the right anterior insula activation were positively correlated with Alexithymia in the recovered AN group. These findings have clinical significance, because they establish another link between the interpersonal deficits and provide more insight into the pathways that could be implicated (Kerr et al., 2015).

A study by Di Lernia et al. used a test battery of four assessments targeting different aspects of interoceptive awareness: IAc for accuracy, IAw for metacognitive awareness, IAs for sensibility, and IBs for buffer saturation. The IAc has participants silently count the number of times their heart beats within a certain time period. They are assessed for accuracy on this task. The IAw is a related self-report task where participants are asked to report how well they believe they did on the accuracy task on a scale from 0 to 100. Sensibility was measured using the MAIA: a self report test with 8 sub scales by which participants report their cognitive beliefs regarding body perceptions. The IBs measures levels of interoceptive processing through a verbal time estimation of interoceptive tactile stimuli. This case study focused on one woman who was diagnosed with binge purge type Anorexia Nervosa. Before treatment, her interoceptive accuracy significantly lower than the healthy control group; she scored nearly zero, indicating little to no ability to correctly perceive internal bodily cues. However, her metacognition score was statistically higher than the healthy control group, indicating that she was not consciously aware of her interoceptive deficits. She was incredibly confident that she was performing well on the task, which is consistent with known pathology in AN. The chronic refusal of human needs (food, water, sleep) is a core symptom, which leads individuals to lose functional connection within themselves and lose interoceptive ability. Her interoceptive buffer score was consistent with the rest of the test battery, indicating that she was processing statistically less interoceptive information than healthy controls (Di Lernia et al., 2019). This case study is consistent with other literature establishing an interoceptive defect in those with Anorexia Nervosa.

Self-determination theory proposes that competency, relatedness, and autonomy are both directly related and crucial for human motivation. This theory asserts that intrinsic motivation is more effective than extrinsic motivation. Competency is the sense of being adequate and proficient at a task or activity. Autonomy refers to a sense of agency and choice over oneself and one's actions. Relatedness is a sense of connection and belonging between oneself and others around them. Anorexia Nervosa is a disorder revolving around the idea of control. The thoughts that perpetuate and maintain the disorder represent an individual's constant reaching for and struggling to find a sense of control. When they deny themselves food that they physically and mentally yearn for, they feel like their discipline and control over their own "unnecessary desires" is strong. They feel as though they can transcend the human needs of sex and food. Without this restriction and denial, individuals with Anorexia Nervosa must face feelings of lack of control in their lives, caused by a combination of factors, such as familial conflict, sexual trauma, or social pressures. The fear of losing control over eating behavior and weight can be extended to a more overarching fear of losing autonomy over themselves. A study by Brockmeyer et al. examined autonomy disturbances in those with AN, those recovered from AN, a clinical control group, and a healthy control group. Specifically, they looked at the varying degrees in which individuals seek out dependency and intimacy, and their personal frustrations with these behaviors. Autonomy was additionally examined in terms of motivation for avoidance goals or avoidance goals. They found that the AN group showed higher levels of dependency avoidance than the healthy control group, in addition to lower levels of

approach motivation (intimacy) than the healthy control group. This indicates that they place greater value on retaining their autonomy. The AN group had significantly higher levels of frustration associated with these measures, indicating lower levels of satisfaction with their levels of dependence and intimacy (Brockmeyer et al., 2013). This is consistent with literature in attachment theory, because those with AN are more likely to have insecure avoidant attachment (Illing et al., 2010).

A study by Ekeroth et al. examined the relationship between eating disorders and self-reported competency levels. Using the Interest and Ability Questionnaire, the AN group was compared to a non-eating disorder group on their level of variety of interests and their reported competency or perceived ability. There was no significant difference between the two groups in the degree of variety in interests, but the AN group was found to rate themselves dramatically lower in terms of competency. The study called this phenomenon the “Perceived Competence Deficit (PCD),” and identified this as a problem unique in severity to AN over other eating disorders (Ekeroth et al., 2003). This deficit in individuals with AN has clinical implications, because it can affect appraisal processes and self-esteem, in addition to motivation (Scherer, 2015, and Brandon, 1994).

An incredibly powerful and unique article by Warin in 2006 showed Anorexia Nervosa under the lens of relatedness, specifically focusing on the aspects of belonging, desire, and secrecy. Attachment theory is implicated in this view, as the foundational and initial premise is that individuals with AN experienced social and/or familial issues in which they developed insecure attachment patterns and tools of

communication not sufficient for developing and maintaining intimacy. This article is unique in the analysis that follows; individuals with this disorder who struggle interpersonally use Anorexia Nervosa as a replacement relationship. Rather than seeking closer relationships with those around them, they isolate themselves from others, simultaneously strengthening their relationship with “Ana,” a personified version of the disorder. Here, the eating disorder serves a function by giving them a similar comfort that interpersonal intimacy would, in addition to reducing feelings of anxiety with compliance to “her.” Relatedness is a multi-faceted concept for Anorexia Nervosa, as the disease actually provides a community. However, this community is far from supportive. By nature, Anorexia Nervosa is an incredibly competitive disorder. Individuals are often perfectionists who are driven to not only be the best they can be, but to be the best. The body dysmorphia and lack of self-esteem and self-worth contribute to immense feelings of insecurity, which translate to a high frequency of judgement on oneself and others. While many of those with Anorexia Nervosa are athletes, namely gymnasts, dancers, or runners, it becomes another sport in itself to be the “best anorexic.” In addition to the obsessive-compulsive aspects of the disorder where food rules are created and adhered to continuously, the internal pressure to compete against others with the disorder is an incredibly strong driver of behavior and pathology. The article by Warin features many first hand accounts of women in treatment centers describing the social dynamics that develop. Two women, Sonya and Amanda, highlight how dramatic the competition will go. They both agreed that the “best anorexic” is the one who is the most thin and has the most health problems. Warin broaches the idea of an “outside anorexic,” where an individual isn’t viewed as sick

enough by the other members of the treatment group. Meal compliance and weight gain prohibit you from reaching the “in group”, while heart attacks, strokes, and comas all improve an individual’s status. For many, the only way to win is to die; that is the ultimate goal. Those who make it into the media for passing away from the disease are often viewed as idols or inspiration for those currently experiencing the disorder. Relatedness in Anorexia Nervosa comes in two main forms: within oneself and outside of oneself. Both are central to the pathology and symptomology of the disorder, and help to explain why this disorder is so uniquely hard to treat effectively.

Understanding the neural mechanisms responsible for the interpersonal problems seen in Anorexia Nervosa is crucial for developing both effective treatment methods and preventative measures. A theory I believe is both central and vital in our understanding of the social aspects of AN is Polyvagal Theory, proposed by Stephen Porges. His book, *The Pocket Guide to the Polyvagal Theory (The Transformative Power of Feeling Safe),* outlines the many functions of the vagal pathway in response to stress and trauma. The vagus nerve is the tenth cranial nerve which connects the brain stem to more peripheral organs in the body, including the lungs, heart, and stomach. Additionally, the vagus nerve has connections to striated muscle in the face. 80% of the nerve fibers are bringing sensory input from the periphery, while 20% of the nerve fibers are bringing motor output to the periphery. This bidirectionality is important, because it highlights the role of the vagus nerve in connecting the mind and body, a topic that is very relevant to AN.

We have two vagal pathways, an “older” pathway and a “newer” pathway. Both are still apart of the parasympathetic nervous system, responsible for generally decreasing the level of arousal in the body. The older vagal pathway is non-myelinated and has connections with sub-diaphragmatic control, more specifically, the digestive system. For this reason, problems with this pathway are associated with nausea and digestive issues. It is largely responsible for the immobilization response to trauma (i.e. dissociation, fainting, or freezing). This response limits the amount of oxygen available to the brain paired with an extremely low heart rate and breathing. Many animals, use this more primal method of immobilization as their primary trauma response. Humans, on the other hand, have trouble switching out of an immobilized state, so this is not our “ideal” stress response in most situations. The “newer” vagal pathway is myelinated and has supradiaphragmatic control, notably of the lungs and heart. A functioning “newer” vagus will keep the heart in constant periodic oscillations. Humans developed this pathway evolutionarily to allow us to calm down and inhibit our sympathetic nervous system, rather than using the unmyelinated vagus as seen in earlier creatures that exhibit immobilization responses. This calming response inhibits our fight or flight reaction, and prevents us from entering a defense state. Ideally, we want to mobilize in a safe, calm state, rather than a defense state (Porges, 2017).

Along with an established response to trauma, our bodies have a predetermined processes to determine our safety. “Neuroception,” the term used by Porges, is the subconscious assessment of risk that your body is constantly doing to determine whether your nervous system senses threat or feels safe. This process is a precursor to

either of the parasympathetic responses or the sympathetic response. Porges' idea is incredibly well explained by a model used by Klaus Scherer in his 2015 paper, "When and Why Are Emotions Disturbed? Suggestions Based on Theory and Data From Emotion Research." The purpose of Scherer's Component Processing Model (CPM) is to outline how emotions arise in the brain. The process starts with an external stimulus or event that influences the individual. This leads directly to the part of his model called the "appraisal," in which an evaluation of the event and how it affects the individual occurs. There are four key parts to the evaluation or appraisal: relevance, implications, coping potential, and normative significance (See Figure 2) (Scherer, 2015).

Relevance is linked to reward systems that determine how much reward value should be placed on the stimulus under question. Vocks et al. examined the functioning of reward systems in AN using a tastant driven experimental paradigm. Both the restrictive type AN condition and the healthy control condition had twelve female participants. In order to prevent any confounds, all of the participants in the control condition were assessed via fMRI during the same phase of their menstrual cycle. In order to induce the hunger condition, all participants were given a standardized breakfast and instructed not to eat for the remainder of the day until the time of the scan. After the scan for the hunger condition was concluded, all participants were fed a standardized meal, then the scan for the satiated condition was performed. During each of the conditions (hunger vs. satiety), participants were given chocolate milk and water in alternating order for a standardized duration each time. Brain imaging, subjective ratings of valence, heart rate were recorded. As expected, those in the AN group consumed less food to reach a feeling of satiety, and drank less chocolate milk overall.

Though the chocolate milk was rated less appealing in states of satiety than in states of hunger for both the AN and control groups, the chocolate milk was always rated significantly less appealing to the AN group than the control group. In the hunger condition, those in the AN group showed activation in the right amygdala and in the left medial temporal gyrus compared to the healthy controls. The healthy control group showed activation in the left insula when consuming the chocolate milk in a satiated state, while the AN group did not. These results support the idea that food stimuli are fear and anxiety inducing for those with AN, as shown by the involvement of the amygdala. The decreased activation of the insula when presented with food stimuli in those with AN supports the idea that their reward circuitry may be functioning abnormally (Vocks et al., 2011).

The implication component of the appraisal process looks at the stimuli's effects on the health and long-term goals of the individual. This component can contribute to the maintenance of the disorder by way of the flawed cognitions held by individuals with AN. As discussed earlier, the firsthand accounts of women with AN collected by Warin outline many of these cognitions. Their goals are not only highly motivated, but are directed in ways that propel their eating disorder forward. Being the "best anorexic" is an intense goal that requires planning and discipline to achieve (Warin, 2006).

The coping potential component of the appraisal process weighs how many mental and physical resources will be required to recover from the external stimulus or event. This is highly related to self-esteem in that those with low levels of self-esteem underestimate their ability to take on and overcome challenges (Brandon, 1994). They

may chronically misjudge their coping potential for an event, devoting a large number of resources to every event. The human body has a finite amount of resources, so the stores cannot sustain this for an extended period of time, and will eventually run out. Inaccurate assessment of an individual's ability to cope can maintain and worsen the anxiety that is already felt in extreme amounts by those with AN.

The normative significance of the event focuses on its importance to the individual's relationship with its social group. This is particularly important to Anorexia Nervosa, because of our society's strong drive for thinness. The media glorifies being thin so much that thinness has become a status symbol. Individuals with AN often believe that the more weight they lose, the more respect they will receive from others and the more worthy they will be as people. Frequently, those with AN have a fear of others believing they "let themselves go" or "became lazy", therefore restrictive behaviors and cognitions that promote weight loss are weighed more heavily here.

All of these components directly affect the appraisal process and contribute to the maintenance of the disorder through flawed appraisal processes. Though the process of neuroception, in principle, is meant to operate flawlessly to determine safety, this doesn't appear to be the case. Neuroception can be chronically flawed, especially in the presence of anxious pathology and behavior, a hallmark of AN.

According to Polyvagal theory, anxiety arises when the sympathetic nervous system is overactive, and the newer, myelinated vagal pathway is under active. When

this imbalance occurs, an individual's "alarm system" is constantly activated and neuroceptive processes are much more likely to deem non-harmful stimuli as threats. Additionally, the upregulation of the sympathetic nervous system affects the muscle tone of the middle ear. The transfer of sound to the inner ear is altered so that individuals are better able to hear low-frequency sounds (such as footsteps approaching from behind), but less able to hear high-frequency sounds and understand human voices. This change contributes to hyper-vigilance and problems with being present in conversion, which influence an individual's degree of social impairment (Porges, 2017).

Safety is a crucial element of the Social Engagement System in that neural circuits for social behavior and emotion regulation are only available when the nervous system "thinks" you're safe. The sympathetic nervous system, responsible for general arousal, directly inhibits our Social Engagement System (SES). The SES involves the cortex and brainstem, the cranial nerves that innervate the face, throat, ears, and neck, and the environment. Proper functioning of this system is necessary for successful communication and social interaction. Improper functioning leads to an inability in individuals to succeed and benefit from social interaction. They may have flat affect, lack of eye contact, and have trouble picking up social cues. This phenomenon is also compounding in nature: anxiety causes inhibition of the SES, social interaction is incredibly difficult without proper SES functioning, social interaction induces more anxiety in the individual, more anxiety further inhibits systems and incentivizes individuals to further isolate and avoid social interaction, and loneliness due to lack of social interaction causes more anxiety.

To summarize, often times, due to trauma, our bodies are stuck in high alert mode in which we don't feel safe. Our neuroception is constantly viewing situations as dangerous, whether they truly are or not. Because of this, we may be stuck in a defensive state- whether it be immobilization or mobilization, which prohibits healing and down regulates our social engagement system. We need to feel safe in order to have the ability to engage socially. Our myelinated vagus plays a large role in helping us calm our central nervous system down. We want to be able to mobilize in a safe state, rather than mobilize in a defensive state in order to positively engage socially.

Before developing reliable methods of measuring the effects of the vagus nerve, Porges needed to operationalize "stress," as it has many working definitions not only across fields, but even within disciplines. He posited that the most useful definition of stress would be thought of in terms of the Autonomic Nervous System. The body's homeostatic state is largely maintained by the Parasympathetic Nervous System (PNS), which includes the vagus nerve. If stress is defined as anything that disrupts homeostasis in the body, then measuring PNS tone would be a useful tool for examining both stress and stress vulnerability. Under this definition, decreased PNS tone would indicate higher levels of stress, and often low PNS tone would happen in concert with high SNS tone, as the Sympathetic Nervous System (SNS) is responsible for increasing arousal in the stress response. The PNS tone before a challenging or stress-inducing stimuli can be measured as an indicator of stress vulnerability.

When measuring PNS tone, researchers are specifically looking at the amplitude of respiratory sinus arrhythmia (RSA) via the cardiac vagus. The greater the amplitude of the RSA, the greater the response potential of the individual. Conversely, lower RSA amplitude indicates a lower response potential, which is maladaptive for optimal functioning. Ideally, humans want a large range of behavioral flexibility to handle varying stressors effectively. A study by Nakai et al. in 2015 examined vagal and sympathetic tone in individuals with AN using a heart rate variability measurement. They found that compared to a healthy control group and those with short illness duration AN, those with long illness duration in AN showed parasympathetic withdrawal and high sympathetic tone (Nakai, 2015). These results support the ideas proposed by Porges.

Though the vagus nerve is bilateral, Porges places emphasis on the vagal pathways in the right hemisphere, as it has been shown that the right branch of the vagus is a key player in RSA, and therefore a key player in regulating PNS tone. Importantly, there is research using EEG supporting the lateralization of emotion in the brain, such that the right hemisphere is associated with processing and identifying negative emotions. Voeller et al. showed that right hemisphere dysfunction in children is associated with attentional, social, and emotional problems, such as poor eye contact, shyness, and hyperactivity (Voeller et al., 1986). Silberman and Weingartner supported the idea that the right hemisphere is functionally dominant in regulating autonomic function. They proposed that identifying negative stimuli quickly and efficiently is important for survival, so if the right hemisphere is coordinated in its efforts to identify

stimuli and react appropriately, individuals would increase their fitness (Silberman and Weingartner, 1986).

This is important in terms of Polyvagal Theory and in light of Scherer's CPM, because if an individual is experiencing chronically flawed appraisals/evaluations and their interoceptive processes are biased towards identifying even neutral stimuli as negative or threatening, the physiological stress response comprised of low PNS tone and high SNS tone will be recruited often. When the sympathetic nervous system is highly active and the parasympathetic nervous system isn't optimally functioning to maintain homeostasis, the Social Engagement System necessary for interpersonal interactions is inhibited.

The social engagement system is recruited when a normal human ear hears the auditory stimulus of a human voice. The sound travels through the middle ear and activates the neural mechanisms to tighten the ossicle chain in the ear. This allows the sound to be properly processed by the auditory cortex and to elicit change in facial muscles and autonomic state. Porges argues that the range of tones found in most music is the same as the range for human voices (middle C to two octaves above). Therefore, when music is heard by the human ear of an individual, the same neural pathways are activated and the Social Engagement System is recruited (Porges, 2011). Implementing the benefits of music in addition to other therapeutic intervention should both increase the receptivity of the individual to therapy and aid in healing interpersonal problems. Increasing receptivity to the therapist should aid in a faster rate of working

through traumas, weight restoration, and extinction of ED behaviors. Healing interpersonal problems, will not only increase the quality of living for recovered individuals, but also hopefully decrease relapse and suicide rates. There is precedent for the use of music therapy in treating related disorders, such as depression and anxiety. A study by Feng et al. examined the efficacy of music therapy on patients with Major Depressive Disorder. After 10 days of music therapy, participants' scores on a Verbal Fluency Test were higher and there was more activation in brain regions such as the Dorsolateral Prefrontal Cortex, Orbitofrontal Cortex, and the Ventromedial Prefrontal Cortex (Feng et al., 2019). Additionally, a study by Grace Thompson looked at the effects of music therapy on the family and social dynamics of children on the Autism Spectrum. She found that mothers reported improvements in their children's social and communicative abilities, in addition to creating a stronger bond between mother and child. This new confidence in the mother role allows for a better understanding of their child's needs (Thompson, 2017).

Experimental Proposal

Methods:

First, use HRV Analysis to compare the Respiratory Sinus Arrhythmia (RSA) of the rAN group compared to the healthy control group. Additionally, both groups would be administered self-report measures on three aspects of interpersonal problems one time before any therapeutic intervention was started. The EDI-2 would be administered to the rAN group. An fMRI would measure the insular activation of both groups during an interoceptive task in which participants must attempt to count how many times their heart beats in a minute. Half of the rAN individuals would be randomly assigned to the treatment paradigm without the vagal component, while the other half would be randomly assigned to the same treatment paradigm with the vagal component included. Treatment without music therapy would consist of 24 sessions, 60 minutes in length, over the course of 3 months using FBT techniques. The rAN group would receive 24 sessions of FBT, 45 minutes in length, paired with 24 sessions of music therapy, 15 minutes in length, over the course of 3 months. After treatment is complete, the same techniques would be used to measure the RSA of both rAN groups and the healthy control group. The control group would be measured to ensure that RSA doesn't just change with time and multiple measures. The same three self-report measures would be administered to all three groups one time the day after treatment has finished, in addition to a repetition of the fMRI measurement of insular activity during the heart interoceptive task. The rAN groups would also be administered the EDI-2. A follow up after 5 and 10 years with the ED measurements and interpersonal measurements would assess the relapse rate of those in the two rAN groups.

Ethics:

This study will be done in accordance with the Belmont Report regarding the rights of participants in study, and will be approved by the IRB. As the participants in this study are under the age of 18, parental consent and participant assent will be documented prior to its commencement.

Procedure:

Participants: 30 non-medicated females who meet the DSM-5 diagnostic criteria for restrictive type Anorexia Nervosa (rAN) and 30 matched healthy female controls. Participants in each group should be between the ages of 14 and 17. Participants will be recruited from existing outpatient treatment facilities.

Statistical Analysis:

Using SPSS, a t-test would be used to compare the initial RSA's and all interpersonal measures of the healthy control and rAN groups. An ANOVA would be used to compare the post-treatment RSA's of the rAN group with music therapy, rAN group without music therapy, and the healthy control group. T-tests would be used to compare the initial, five, and ten year follow up of interpersonal and eating disorder severity measures of the rAN group with music therapy and the rAN group without music therapy

Measures:

Eating Disorder Inventory-Two (EDI-2) is the second version of the EDI. A major benefit of the EDI-2 over the EDI is the added scales regarding avoidance of sexual relationships and social insecurities. This test uses 11 subscales: Drive for thinness, Bulimia, Body dissatisfaction, Ineffectiveness, Perfectionism, Interpersonal distrust, Interoceptive awareness, Maturity fears, Asceticism, Impulse Regulation, and Social Insecurity. Higher scores indicate more severe ED symptoms on this scale (Garner, 1991).

Revised Social Anhedonia Scale (RSAS) to measure levels of social anhedonia. This self-report measure consists of 40 true or false statements regarding social relationships. Specifically, it measures schizoid indifference, associability, lack of social enjoyment and indifference towards others (Eckblad, 1982).

The Toronto Alexithymia Scale (TAS-20) is a 20 question self-report measure using a five point Likert scale with three subscales: difficulty identifying feelings, difficulty describing feelings, and externally oriented thinking. Five of the items are reverse-scored. Scores of 61 or above indicate Alexithymia (Bagby et al., 1994). TAS-20 is used to measure levels of alexithymia, which has been found to be related to social avoidance and anxiety (Courty, 2015).

Liebowitz Social Anxiety Scale (LSAS) is a 24 item scale assessing social anxiety and avoidance in both social situations and performance situations using a 3

point Likert scale for both. Higher scores on this measure indicate more severe social anxiety and avoidance (Liebowitz, 1987).

Heart Rate Variability (HRV) Analysis for measuring Respiratory Sinus Arrhythmia (RSA). SDNN (standard deviation of all R-R intervals) has been shown to be an accurate measurement of RSA over a 24 hour period (Shaffer and Ginsburg, 2017). R-R interval refers to the distance between the peaks of two measured heartbeats. A respiration source would also be included in the HRV setup to increase validity of the RSA measurement.

fMRI would be used for measuring activation patterns in the Insular region of the brain, following protocol used by Kerr et al. in 2015.

Expected Results:

I predict that those with rAN would have lower RSA than the healthy control group, indicating the presence of parasympathetic withdrawl/ low PNS tone in individuals with rAN. I would also expect that the healthy control group would perform better on the heart interoceptive task and show more insular activation than the rAN group. Additionally, those with rAN would initially report higher levels of social anhedonia, social avoidance and anxiety, attachment avoidance and anxiety, and alexithymia than the control group. I expect that the rAN group treated with FBT without music therapy will report more severe ED symptomology, higher levels of all interpersonal problems, a poorer performance on the heart interoceptive task, and less insular activation in the initial post-treatment assessment than the rAN group treated with FBT with music therapy. In the 5 year and 10 year follow up, I would expect the

relapse rate of those treated with FBT without music therapy to be higher than that of the FBT with music therapy group. “Relapse” would be defined as BMI under 18 for 3 months.

Discussion:

A reduction in ED severity should be seen in both groups due to the FBT, but in combining aspects of both FBT and music therapy, we would expect an amplifying effect that greater reduces ED severity, but additionally aids in solving interpersonal problems. The additional music therapy should activate the Social Engagement System and increase vagal/ PNS tone of individuals who showed vagal withdrawl before starting treatment. By more completely addressing the eating disorder, we would expect the relapse rates to be less than those treated with FBT alone. With reduced need for social isolation and avoidance, individuals will form close relationships with greater ease, increasing their post-treatment quality of life, and reducing the risk for relapse and suicide. Therefore, I argue that while weight restoration and extinction of ED behavior are important criteria for recovery, I believe that they are not the only aspects of recovery needed; improvements in interpersonal capabilities must be addressed as well.

If the results of the study were not what was expected, and there were perhaps no difference between the ED severity and prevalence of interpersonal problems of the rAN group treated with music therapy and FBT and the rAN group treated with just FBT, we could come to a variety of conclusions. First, assuming the RSA’s of the rAN group without music therapy were higher than that of the rAN group with music therapy, the

duration of music therapy may not have been long enough to cause a significant difference, or participants may not have engaged enough with the music. If the RSA's of the rAN groups with and without music therapy were the same, the music therapy might not be the proper therapeutic intervention for activating the social engagement system and increasing PNS tone. Another method may need to be looked into to reach this result. Second, it would be valuable to ensure that the therapists administering the FBT were doing so in a uniform and structured manner. If there was variation in the way the FBT was being administered, different groups may respond with different success rates.

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type anorexia nervosa: An fMRI study. Journal of Psychiatric Research 45:395 403.

Appendix

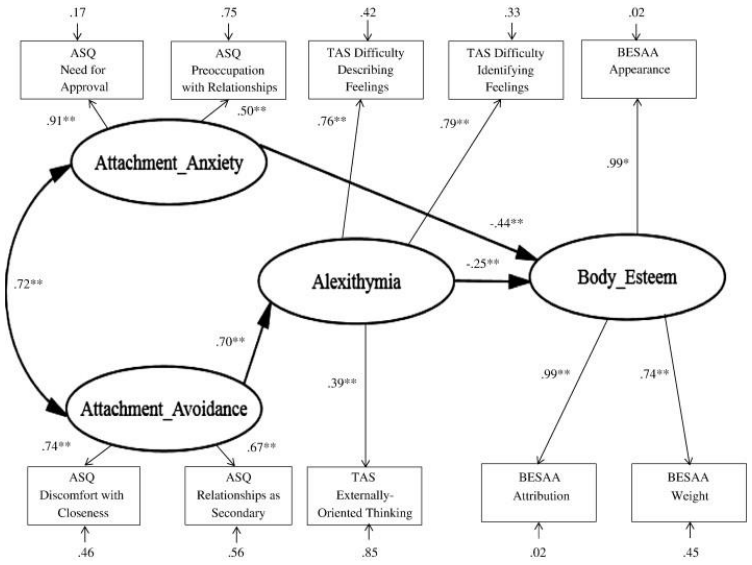

Figure 1. Model explaining the relationship between attachment avoidance and anxiety, alexithymia, and self-esteem regarding body image with only significant relationships included.

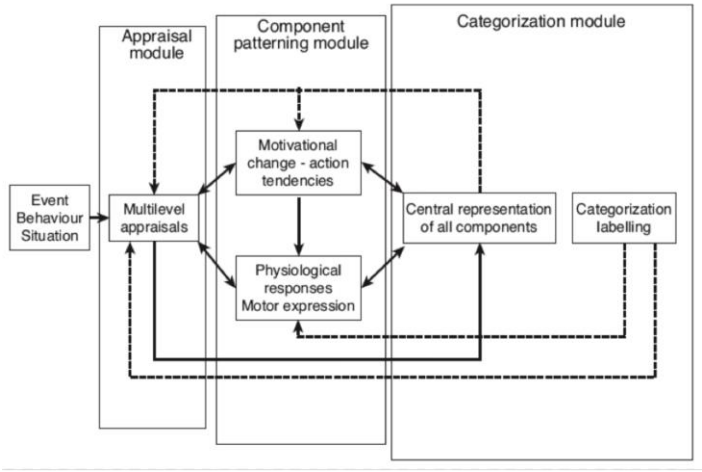

Figure 2. Three phases of the Component Processing Model

Annotated Bibliography

Boehm, I., Flohr, L., Steding, J., Holzapfel, L., Seitz, J., Roessner, V., & Ehrlich, S. (2017). The Trajectory of Anhedonic and Depressive Symptoms in Anorexia Nervosa: A Longitudinal and Cross-Sectional Approach. European Eating Disorders Review, 26(1), 69–74. doi: 10.1002/erv.2565

The paper's focus on social anhedonia is related to the Polyvagal theory and Social Engagement System that I was planning to focus on in my work. Porges noted that individuals with an improperly functioning myelinated vagal pathway and an overworking sympathetic nervous system actually cannot benefit from the social interaction they may have. The researchers found that with weight restoration, depressive symptoms decreased, but anhedonia remained present, indicating that it should be treated separately from a comorbid depressive disorder or depressive symptoms caused by a lack of nutrition. This is a key finding with large clinical implications. It is also interesting to note that the "recovered group" had a much higher rate of comorbid disorders. When did they develop? Before or after recovery?

Boucher, K., Côté, M., Gagnon-Girouard, M., Ratté, C., & Bégin, C. (2018). Eating Pathology Among Patients With Anorexia Nervosa and Bulimia Nervosa. The Journal of Nervous and Mental Disease, 206(10), 776-782.

This article not only supports the link between low self-esteem as a predictive factor for Anorexia Nervosa, but also found that "hiding the self" is an important factor associated with Vulnerable Narcissism. This is important to my research, because exhibiting these

behaviors indicates a struggle with valuing the self and experiencing pleasure. This can be extended to a sexual context, as well.

Brown, H., & Grange, D. L. (2011). Brave girl eating: A family's struggle with anorexia. New York: Harper.

This book shines light on the disorder from a different perspective than that of my personal experience; The mother of a young girl struggling with Anorexia Nervosa outlines how the disorder impacted each member individually as well as the family unit as a whole. The author also incorporates relevant working theories on eating disorders, like that of Walter Kaye.

Carter, J. C., Kelly, A. C., & Norwood, S. J. (2012). Interpersonal problems in anorexia nervosa: Social inhibition as defining and detrimental. Personality and Individual Differences, 53(3), 169–174. doi: 10.1016/j.paid.2012.02.020

This article focuses on interpersonal problems as a characteristic of Anorexia Nervosa, which is incredibly relevant and valuable to my thesis topic. The researchers found that social inhibition didn’t go away after treatment, which highlights a possible need for greater use of interpersonal therapy methods. As the article pointed out, those struggling with Anorexia Nervosa often avoid relationships in an effort to avoid emotions and needs, which can make life outside of treatment difficult. Another important finding

is that individuals with Anorexia Nervosa still have higher levels of interpersonal problems than others.

Costin, Carolyn. The Eating Disorders Sourcebook: A Comprehensive Guide to the Causes, Treatments, and Prevention of Eating Disorders (Sourcebooks). McGraw-Hill Education. Kindle Edition.

Costin's book is my all time favorite, go-to resource for eating disorders. Not only does she clearly outline the diagnostic criteria, she goes over treatment options and therapies, and gives advice to parents or friends of the individual who is suffering with the disorder.

Courty, A., Godart, N., Lalanne, C., & Berthoz, S. (2015). Alexithymia, a compounding factor for eating and social avoidance symptoms in anorexia nervosa. Comprehensive Psychiatry, 56, 217–228. doi: 10.1016/j.comppsych.2014.09.011

Individuals with Alexithymia struggle to identify and show emotions, which can lead to, or worsen existing, social avoidance. When social situations are a major stressor and bring about anxiety, those struggling with Anorexia Nervosa may be more likely to use an eating disorder behavior to cope with the negative affect. In this way, Alexithymia contributes to the maintenance of the eating disorder behaviors and pathology.

Fennig, S., Klomek, A. B., Shahar, B., Sarel-Michnik, Z., & Hadas, A. (2015). Inpatient treatment has no impact on the core thoughts and perceptions in adolescents with anorexia nervosa. Early Intervention in Psychiatry, 11(3), 200–207. doi: 10.1111/eip.12234

The researchers found that inpatient treatment did not have any positive effect on the core thoughts behind the eating disorder, nor did it eliminate depressive symptoms. The only thing that got better were the restrictive/eating disorder behaviors. This paper was beneficial to my topic, because it is important to question and challenge the efficacy of treatment methods currently in place to treat more than just the behavioral piece of the eating disorder.

Grabhorn, R., Stenner, H., Stangier, U., & Kaufhold, J. (2006). Social anxiety in anorexia and bulimia nervosa: the mediating role of shame. Clinical Psychology & Psychotherapy, 13(1), 12–19. doi: 10.1002/cpp.463

Social anxiety and shame are higher in Anorexia Nervosa and Bulimia Nervosa than in depression and anxiety disorders. I found it valuable that these researchers decided to include shame in this study, because this feeling is not always fully addressed by conventional treatment methods. This paper led me to a new idea regarding the persistence of social anxiety and shame after weight restoration.

Hatch, A., Madden, S., Kohn, M., Clarke, S., Touyz, S., Gordon, E., & Williams, L. (2010). Emotion brain alterations in anorexia nervosa: A candidate biological marker and implications for treatment. Journal of Psychiatry and Neuroscience. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2895157/.

This study used Event Related Potentials (ERP's) in the brain as a measure of subconscious emotion processing. They were looking to see if there was a difference in ERP's when viewing an emotion stimuli between subjects with AN and healthy subjects. They found that the AN group had reduced numbers of ERP's before and after weight gain. If these individuals have problems with processing and experiencing emotion even after weight restoration, this will impact the way they conduct themselves in social engagement situations.

Hempel, R., Vanderbleek, E., & Lynch, T. R. (2018). Radically open DBT: Targeting emotional loneliness in Anorexia Nervosa. Eating Disorders, 26(1), 92–104. doi: 10.1080/10640266.2018.1418268

Article emphasizes the importance of interpersonal relationships in mental health. The goal of RO-DBT is to provide individuals recovering from Anorexia Nervosa, who have been shown to lack emotional openness and social connectedness, the tools to cultivate and maintain these relationships and bonds. I found this paper incredibly useful, because I had never heard of this specific type of DBT before.

Illing, V., Tasca, G. A., Balfour, L., & Bissada, H. (2010). Attachment Insecurity Predicts Eating Disorder Symptoms and Treatment Outcomes in a Clinical Sample of Women. The Journal of Nervous and Mental Disease, 198(9), 653–659. doi: 10.1097/nmd.0b013e3181ef34b2

This article focused on three things: insecure attachment rates in ANR, ANB, BN, and NE groups, “Need for Approval” rates (indicator of anxious attachment), and treatment outcomes among the different groups. ANB was found to have the highest attachment anxiety and avoidance. Higher “Need for Approval scores” were associated with worse ED symptomology. Finally, BN had better treatment outcomes than ANR or ANB.

Kaye, W. H., Wierenga, C. E., Bailer, U. F., Simmons, A. N., & Bischoff-Grethe, A. (2014). Nothing Tastes as Good as Skinny Feels: The Neurobiology of Anorexia Nervosa. Focus, 12(4), 437-449. doi:10.1176/appi.focus.120413

This is quite a comprehensive article identifying both predictive personality traits of Anorexia Nervosa and potential differences in reward systems between healthy and AN individuals. I was mainly interested in the findings on reward, because the dysfunction of reward systems in these individuals as strong implications in recovery with food and with future sexual interactions.

Keating, C., Castle, D. J., Newton, R., Huang, C., & Rossell, S. L. (2016). Attachment Insecurity Predicts Punishment Sensitivity in Anorexia Nervosa. The Journal of Nervous and Mental Disease, 204(10), 793–798. doi: 10.1097/nmd.0000000000000569

This article further supports the idea that individuals with AN are likely to have an insecure attachment, either anxious or avoidant. Though both types of insecure attachment were seen in higher rates in AN than control group, only anxious attachment was found to have a positive relationship with sensitivity to punishment. The SPSRQ was used to measure sensitivity to punishment and reward.

Keating, L., Tasca, G. A., & Hill, R. (2013). Structural relationships among attachment insecurity, alexithymia, and body esteem in women with eating disorders. Eating Behaviors, 14(3), 366–373. doi: 10.1016/j.eatbeh.2013.06.013

This study tested individuals with AN, BN, and EDNOS. The authors found that when attachment insecurity (specifically attachment avoidance) increased, body esteem decreased, with Alexithymia as a mediator. This article is important to my research, because it has major therapeutic implications for treatment based on differing attachment styles.

Merwin, K. E., Osullivan, L. F., & Rosen, N. O. (2017). We Need to Talk: Disclosure of Sexual Problems Is Associated With Depression, Sexual Functioning, and Relationship Satisfaction in Women. Journal of Sex & Marital Therapy, 43(8), 786–800. doi: 10.1080/0092623x.2017.1283378

Undisclosed sexual dysfunction in women is associated with depressive symptoms. Communication skills are needed to disclose sexual problems, but vocalizing needs is not something that comes easy to many individuals with an eating disorder. This can put women at a higher risk for unhealthy dynamics when coming into a relationship during or after an eating disorder.

Pinheiro, A. P., Raney, T. J., Thornton, L. M., Fichter, M. M., Berrettini, W. H., Goldman, D., … Bulik, C. M. (2010). Sexual functioning in women with eating disorders. International Journal of Eating Disorders, 43(2), 123–129.

This article looked at different aspects of sexuality, including physical intimacy, libido, and sexual anxiety in women with eating disorders. The results that I found most interesting were those regarding libido and sexual anxiety. Those with restrictive type Anorexia Nervosa had the highest loss of libido out of the eating disorder types. In addition, those with highly restrictive diets who have reached incredibly low BMI's are likely to report high levels of sexual anxiety.

Porges, S. W. (2017). The pocket guide to polyvagal theory: The transformative power of feeling safe. New York, NY: W.W Norton & Company.

This book was pivotal in my understanding of the Polyvagal Theory, which is most applicable to trauma victims, and is a key focus in eating disorder recovery. Anorexia sufferers often have down-regulated vagal pathways and unregulated sympathetic nervous systems, contributing to their state of anxiety that the eating disorder behavior is used to combat. This book is relevant to my thesis topic, because I'm examining Anorexia's effect on social relationships.

Shapiro, F. (2017). Eye Movement Desensitization and Reprocessing (EMDR) Therapy, Third Edition Basic Principles, Protocols, and Procedures. New York: Guilford Publications.

This book is an extremely thorough overview of EMDR as a whole. I found it beneficial, not only for my general knowledge on treatment methods for eating disorders, but also for its applications in treating trauma in general. The unique way that traumatic memories are stored has implications for the individual even after weight restoration.

Scherer, K. R. (2015). When and Why Are Emotions Disturbed? Suggestions Based on Theory and Data From Emotion Research. Emotion Review, 7(3), 238-249. doi:10.1177/1754073915575404

In this paper, Klaus Scherer explains his Component Process Model and its applications to the four functions of emotion that he proposes. He later discusses the concept of dysfunctional emotions: why they occur, how long they should last, and what we should do about them. This paper is helpful, because inappropriate appraisal processes are important in the maintenance of disordered thoughts in Anorexia Nervosa and other eating disorders.

Schechter, J. O., Schwartz, H. P., & Greenfeld, D. G. (1987). Sexual Assault and Anorexia Nervosa. International Journal of Eating Disorders, 6(2), 313–316. https://doi-org.ccl.idm.oclc.org/10.1002/1098-108X(198703)6:2_<313::AID EAT2260060214>3.0.CO;2-P

This is a case study describing two cases of women who either developed or experienced an increase in the symptomology of Anorexia Nervosa after being sexually assaulted. Though case studies are limited in their external validity, I believe they can still provide important information regarding possible causes or triggers of the disorder. I found this article useful, because many individuals who develop eating disorders have a history of sexual trauma.