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**DELAY DISCOUNTING MECHANISMS IN EATING DISORDERS: A
CALL TO ARMS**

by

Rowan Crowder

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of the requirements for the degree**

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Delay Discounting Mechanisms in Eating Disorders: A Call to Arms

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Abstract

Delay discounting, or temporal discounting, is a measure of impulsivity that describes the devaluation of a reinforcer as a function of its receipt in time. Several studies have shown that individuals diagnosed with a variety of behavioral maladies such as obesity/over-eating, substance abuse, cigarette smoking, heavy drinking, and problematic gambling exhibit greater discounting rates. To be specific, they are more impulsive and less willing to wait for delayed reinforcement than healthy controls. Several of these studies have found that obese women discount at a steeper rate than non-obese women, similar results have been shown in binge eating disorder. The relationship between discounting and other topics relating to food and eating is well documented in the literature. However, after extensive literature review only one article pertaining to delay discounting and its implications in bulimia nervosa, and three articles pertaining to delay discounting and anorexia nervosa were found. The following is an exploratory paper analyzing and discussing the possible implications and relationships between characteristics of delay discounting and eating disorders seen in the current literature. Several of the observed relationships found in the literature may warrant further investigation to aid in our understanding of these disorders and possible novel treatments. A number of studies have shown that delay discounting can be reduced. If there is additional evidence of delay discounting's role in eating disorders, it may be possible to develop new and effective therapeutic techniques to decrease or increase the discounting rates seen in these disorders.

Keywords: Delay discounting, temporal discounting, eating disorders, impulsivity

Delay Discounting Mechanisms in Eating Disorders

Eating disorders are severe mental illnesses that result in a number of poor health outcomes including organ failure, tooth decay, sores in the mouth and throat, and even death. Approximately four percent of the population has been diagnosed with an eating disorder. The current literature shows that behavioral therapies such as dialectical behavior therapy (DBT) and family therapy are effective in treating these disorders. However, only about 60% of people who seek treatment will actually recover from their disorder (American Psychiatric Association [APA], 2013). While a little over half of the individuals with these disorders do recover, the remaining 40% stay at an extremely high risk for irreversible medical complications as well as death. As eating disorders are complex, multifaceted, and hard to treat it is imperative that we continue to search for possible causes, impacts, and treatments for these disorders.

One area of research that is sparse in the literature is the role of delay discounting behavior in anorexia nervosa, bulimia nervosa, and binge eating disorder. Delay discounting has been shown to play a part in numerous behavioral maladies such as drug abuse (Reynolds, 2006), problematic gambling (Alessi & Petry, 2003), cigarette smoking (Bickel, Odum & Madden, 1999), obesity (Weller, Cook, Avasar & Cox, 2008), and heavy drinking (Field, Christiansen, Cole & Goudie, 2007). The literature has also shown several effective procedures for reducing delay discounting in these populations and thus reducing these problematic behaviors (Stein et al., 2013; Stein, Renda, Hinnenkamp & Madden, 2015; Mazur & Logue, 1978). With additional study on the relationship between discounting behaviors and eating disorders it may be plausible, if there is significant evidence, that similar techniques used to reduce discounting in these populations may also be used with those diagnosed with an eating disorder. This would provide

new and possibly extremely effective treatment techniques. However, there is not enough research in this area to make supported conclusions.

The following paper will explore the significant connections between various aspects of these two topics and provide support as to why this research should become a focus in both the eating disorder and delay discounting fields. These connections include impulsivity as seen in eating disorders, adolescence as it pertains to eating disorders and delay discounting, discounting patterns seen in obesity, and comorbid disorders of eating disorders and delay discounting's role in these disorders. However, before delving in to the relationships between delay discounting and eating disorders it is important to make sure both are thoroughly explained and understood. Without a solid foundational understanding of what each of these terms mean it will be difficult to find possible significant relationships. The following are detailed explanations of the basic principles and facts behind the behavioral phenomenon of delay discounting as well as the three eating disorders that this paper will focus on.

Delay Discounting

Delay or temporal discounting has been a popular topic in the behavioral and behavioral economic literature. The term itself defines the tendency for an organism to discount or devalue a reinforcer as a function of its receipt in time (Odum, 2011). That is, as the amount of time it takes for a reinforcer to be delivered increases, the less valuable that reinforcer becomes to an organism. However, this decline is not a linear function. Discounting behavior is best described by a hyperbolic function. When the delay in time is short the value of a reinforcer declines swiftly but as the delay is increased this devaluing becomes less steep or shallower, this pattern can only be accurately portrayed by a hyperbolic function (Odum, 2011).

Delay discounting can be thought of as a method of describing choice behavior. Consider having the choice between 1,000 dollars and 800 dollars. When presented these amounts of money at the same time the 1,000 dollars should be the more valuable option and the choice an individual will be most likely to make. However, if we say that the 800 dollars is available right now but you must wait for three months to receive the 1,000 dollars many people will make a different choice. In this situation someone may now prefer to have the 800 dollars that is immediately available. The larger sum of money has lost some of its value because it has been delayed in time, this is the basic principle of delay discounting. This change in choice is what is known as a preference reversal which is accounted for by the previously mentioned hyperbolic function. When an organism views the different amounts as being equal, that is, they do not have a preference between the rewards, this is known as the indifference point. Preference reversals and indifference points are what researchers in this field focus on to define an organisms discounting behaviors.

It is important to note that the amount or quantity of a reinforcer is not the only thing that can be compared in these choice situations, for example, we are often presented with reinforcers that are completely different from one another and have different values. An example of this can be described by drug taking behaviors. Many substance abuser are faced with the decision between using their substance of choice and several other more positive life outcomes such as better health and relationships. Using a drug such as heroin is intrinsically less valuable than having stable relationships and good health for many. However, when heroin is immediately available it will be more reinforcing than the long term consequences of not using the drug. This is because these consequences or reinforcers will not be redeemable for a significant amount of

time. Delay discounting is applicable in a number of similar choice situations and accurately describes both human and non-human animal behavior.

Looking at these choice situations, when an organism selects the smaller less valuable reinforcer (the smaller sooner) we consider this to be making an impulsive choice. When an organism selects the more valuable delayed option (the larger later) we then consider this to be the more self-controlled choice. While this is only a superficial explanation of the basic underlying principles of delay discounting it will provide enough background knowledge to begin developing an understanding of the possible relationships between these principles and eating disorders.

Eating Disorders: Anorexia Nervosa, Bulimia Nervosa, and Binge Eating Disorder

Eating disorders are a class of psychological disorders classified in the Diagnostic and Statistical Manual-V (DSM-V) as a disturbance in eating and/or eating related behaviors. This disturbance results in an altered caloric intake that produces impairment in physical health and psychological functioning. These disorders most often effect younger females but can also be seen in males and older adults. The term eating disorder itself is an umbrella term for a number of different diagnoses, this section will focus on and describe three: anorexia nervosa, bulimia nervosa, and binge eating disorder.

Anorexia Nervosa

Anorexia nervosa (AN) is the most recognizable and publicized disorder of the three aforementioned. The DSM-V outlines several criterion to meet the diagnosis of AN including the restriction of caloric intake leading to a significantly low body weight, an intense fear of gaining weight, participation in behaviors to avoid weight gain despite an already low body weight, and a

disturbance in the way one experiences their weight or body shape. This disturbance can often lead to a failure to recognize the seriousness of an individual's current low weight. AN is further broken down into the classification of two subtypes: restricting subtype (AN-R) and binge-eating/purging subtype (AN-BP). The latter is often overlooked and/or mistaken as bulimia nervosa (BN). Individuals diagnosed with AN-R do not engage in bingeing behaviors or purging behaviors. These individuals accomplish weight loss through the restriction of caloric intake through dieting, fasting, and excessive exercise behaviors. AN-BP is characterized by engaging in a recurrent pattern of binge eating and subsequent compensatory behaviors such as self-induced vomiting (purging) and the misuse of laxatives. However, these compensatory behaviors do not always have to follow a binge and can occur after only a small intake of calorie containing foods and beverages. It is important to note that one of the main distinctions between this subtype of anorexia nervosa and bulimia nervosa is that individuals diagnosed with AN-BP will still stay at a lower than healthy weight while many individuals with BN are in a healthy weight range. Essentially, the defining difference between bulimia nervosa and anorexia nervosa binge/purge subtype is the specific criterion as outlined in the DSM-V that an individual meets.

Anorexia nervosa is associated with the highest mortality rate among all psychological disorders. This high mortality rate is a result of the medical complications caused by malnutrition such as various organ failures including the heart. Anorexia nervosa also has one of the highest suicide rates among those diagnosed with a psychological disorder. Approximately 1% of the population has been diagnosed with anorexia nervosa and many more go undiagnosed (Smink, Hoeken & Hoek, 2012).

Bulimia Nervosa

As previously mentioned, bulimia nervosa (BN), can often be confused with AN-BP as the two disorders have extremely similar topographies, however, an individual's weight can help distinguish between the two as well as various other criterion. The DSM-V outlines several criterion that must be met in order for a diagnosis of bulimia nervosa to be made. These criterion include recurrent episodes of binge eating followed by inappropriate subsequent compensatory behaviors (purging, laxative use, excessive exercise, etc.), and an individual's self-evaluation is unduly influenced by both body shape and weight. Purging behaviors can lead to an imbalance of electrolytes and fluids as well as the loss of stomach acid. Continually purging may lead to the loss of tooth enamel as well as sores forming in the mouth and throat due to the continual regurgitation of gastric acid. Bulimia nervosa peaks in older adolescents and young adults effecting approximately 1.5% or 4.7 million people in the United States. Individuals with bulimia nervosa have an elevated mortality rate resulting from suicide and medical complications linked to the disorder.

Binge Eating Disorder

Binge Eating Disorder (BED) is perhaps the least well known, or the least talked about, of the three aforementioned eating disorders. BED is diagnosed in individuals who meet the following criteria: recurrent episodes of binge eating associated with eating rapidly, eating until feelings of being uncomfortably full, eating when not feeling hungry, eating alone due to embarrassment, and feeling disgusted or guilty with oneself afterwards. Individuals with binge eating disorder do not use subsequent compensatory behaviors after an episode of binge eating as seen in bulimia nervosa. The episode of a binge is also marked with distress regarding its occurrence. Binge eating disorder is reliably associated with obesity and being overweight in individuals who seek treatment. It is important to note, however, that the majority of obese

individuals do not engage in recurrent binges like those who have been diagnosed with BED and not everyone with this disorder meets the criterion to be considered obese. Many individuals with BED experience an impaired quality of life as associated with the medical risks of being clinically overweight as well as poor life satisfaction.

Literature Review of Existing Evidence

There has been minimal and conflicting research done in the realm of delay discounting's possible underlying role in eating disorders. Much of the literature focuses on binge eating disorder and delay discounting. Discounting has also appeared a number of times in studies with obese and overweight individuals. These research data will be discussed later in this paper and as such will not be discussed here. This literature review will focus on articles involving delay discounting and anorexia nervosa as well as bulimia nervosa. To my knowledge, there has only been one study to date to investigate delay discounting in individuals diagnosed with bulimia nervosa and three to investigate delay discounting in individuals diagnosed with anorexia nervosa.

Studies on Bulimia Nervosa

Some of the core symptoms of bulimia nervosa involve binge eating followed by compensatory behaviors, these symptoms appear to involve making choices between larger later outcomes and smaller sooner ones e.g. delay discounting. Bingeing behaviors and subsequent purging or other compensatory behaviors can be thought of as the smaller sooner impulsive choice whereas refraining from these behaviors can be viewed as the larger later self-controlled choice. With this paradigm, we would then hypothesize that individuals with bulimia nervosa discount at a steeper rate than healthy controls. This has been cautiously supported in the existing

literature. In a study comparing 39 individuals with bulimia nervosa and 53 healthy controls it was found that individuals diagnosed with BN showed steeper discounting patterns than healthy controls on a hypothetical monetary discounting task (Kekic et al., 2016). Individuals with BN showed a higher preference for immediately available rewards and were less willing to wait for greater but delayed rewards than their healthy counter parts. This pattern of elevated discounting rates follows those of other populations delay discounting describes such as drug abusers and cigarette smokers.

A previous study conducted in 2014 showed similar, but preliminary, results to the aforementioned, however, the study was not conducted with individuals diagnosed with bulimia nervosa. Kekic et al. (2014) found that individuals characterized as being less impulsive on a discounting task were more susceptible to the anti-craving effects of a transcranial direct current stimulation in 17 healthy women with frequent food cravings. Individuals that use binge behaviors such as those with bulimia nervosa and binge eating disorder typically have preliminary food cravings before the disordered eating behaviors occur. Transcranial direct current stimulation has been shown to reduce these food cravings, however, those characterized as more impulsive on a temporal discounting task were less effected by the intervention than those that made more self-controlled choices. These results provide preliminary evidence which is supported in Kekic et. al.'s later study. These two articles taken together show some evidence supporting the conclusion that delay discounting may play an important role in bulimia nervosa. However, with only one study done pertaining to bulimia nervosa specifically replication and more work in this area is required to make accurate conclusions and devise clinical implications.

Studies on Anorexia Nervosa

Anorexia nervosa presents a particularly interesting problem in regards to delay discounting. The majority of psychological maladies that delay discounting has been shown to play a part in typically involve individuals that discount too much, that is, they are unwilling to wait for later rewards and show problematic impulsivity. In a healthy individual we can look at food choice behaviors, for example, for a dieter, eating a piece of chocolate cake may be the immediate smaller sooner reinforcer whereas refraining from the dessert and sticking to a diet for their ideal body can be seen as the larger later reinforcer. Anorexia nervosa seems to follow a similar paradigm, however, it has been taken to an unhealthy extreme. Anorexia nervosa is characterized by the restriction of calorie containing food and beverage items- while putting off the chocolate cake may be the appropriate self-controlled choice putting off the majority of caloric containing foods is no longer healthy. In this sense, these individuals are too self-controlled. A preliminary study was able to provide evidence to support this hypothesis.

It was found that individuals with anorexia, specifically the restricting subtype, discounted the value of a monetary reward less steeply than healthy controls (Steinglass et al., 2012). While these findings are promising, with any eating disorder research, particularly using individuals with anorexia nervosa, it must be taken into account that malnutrition may affect the results of the study and have an impact on temporal choice. A later study conducted presented conflicting results to the Steinglass et al. study. A study conducted with individuals suffering from acute anorexia nervosa, weight recovered anorexia patients, and healthy controls did not find significant differences in the rate of discounting between healthy controls and individuals with acute anorexia or who have undergone weight restoration (Ritschel et al., 2015). Ritschel et al. posits that the altered self-control seen in anorexia may only be apparent in disorder related reinforcers such as food, both of the aforementioned studies used hypothetical monetary

discounting tasks. It is important to note here that to date there is not and extremely well developed discounting task that uses food that would accurately describe discounting trends in these disorders. Ritschel et al. also makes the important note that the individuals in the Steinglass et al. study were, on average, older than those used in the current study. Age is a known factor that influences delay discounting with older individuals discounting less steeply than younger individuals. A follow up study to the previously mentioned Steinglass et al. study adds another piece of evidence to the slowly growing pool of articles on this topic. Decker, Figner & Steinglass (2015) conducted a study with 59 inpatient individuals diagnosed with anorexia nervosa and 39 control subjects, they tested the AN group on a measure of delay discounting before and after treatment. Before treatment the AN group showed a similar pattern to those in the Steinglass et al. (2012) study, that is, they discounted less steeply than those in the control group. However, after treatment these differences disappeared and there was no evidence for a difference in discounting between the AN (now in recovery) group and the control group. The treatment used consisted of weight restoration indicating the role of a lowered body weight that results from anorexia nervosa in discounting behavior. These results suggest then that perhaps what we should be looking at is the effects malnourishment play in decision making and the negative effects on the brain areas involved with making temporal choices as well as the mind set individuals with an active eating disorder find themselves in.

While the aforementioned studies conducted with bulimia nervosa and anorexia nervosa have provided us with promising results there is still a lack of research being conducted in this area. I would argue that delay discounting has great potential in the realm of understanding and treating eating disorders and should not be pigeonholed into focusing on problems of addiction where the majority of the research lies today. The following sections provide evidence and

arguments as to why more studies and funding should be geared towards the potential underlying role of delay discounting in anorexia nervosa, bulimia nervosa, and binge eating disorder.

Impulsivity

Delay Discounting as a Measure of Impulsivity

A number of studies equate impulsivity and delay discounting (Odum, 2011; Ainsle, 1975; Crean, DeWit, & Richards, 2000). In fact, it is rare to find one term in an article without the other. Many authors will go a step further and use the two interchangeably. While there may be minimal research conducted on delay discounting and eating disorders there is a reasonable amount of literature on the role of impulsivity in eating disorders. With the interchangeability of these two terms it would then intuitively seem that since there is literature on the relationship between impulsivity and eating disorders there is reason to suspect important relationships between delay discounting and eating disorders. The fact that delay discounting and impulsivity are so closely related with impulsivity being important in eating disorders this relationship warrants further investigation into the possible implications of delay discounting.

Impulsivity as Seen in Eating Disorders

As aforementioned, there is minimal published literature on delay discounting specifically in eating disorders, however, several studies have investigated impulsivity's role in this group of disorders. The majority of these studies indicate higher rates of impulsivity in individuals diagnosed with eating disorders when compared to healthy controls. With these results and the relationship between delay discounting and impulsivity it intuitively makes sense that those with a diagnosed eating disorder would discount at a steeper rate. While preliminary

studies begin to support this hypothesis for certain disorders we do not yet have enough evidence to make accurate evidence based conclusions.

Superficially it would seem like individuals who binge consume food and beverages and/or purge are more impulsive than those who restrict caloric intake, this has been cautiously confirmed in the existing literature with delay discounting. On the other hand, the very nature of restriction leaves minimal room for impulsive decision making whereas many who go on binges often appear to do so on what seems like impulse. To investigate this, Rosval et al. (2005) tested various measures of impulsivity among women with active eating disorders (bulimia nervosa (BN), anorexia nervosa-restrictive subtype (AN-R), and anorexia nervosa-binge/purge subtype (AN-BP)). Their results showed that compared to healthy controls, women with an active eating disorder, regardless of specific diagnosis, showed higher rates of cognitive impulsivity on the Barrat Impulsivity Scale (BIS). Cognitive impulsivity is often defined as quick decision making. Therefore, Rosval et al.'s study indicates that an individual diagnosed with either AN-R, AN-BP, or BN is more likely to make quick decisions than healthy controls. It is, however, important to note that improper nutrition for an extended period of time can have negative effects on cognitive function which may, in part, explain the observed differences. None the less, these results indicate that there are underlying difference in impulsivity levels among women with active eating disorders and healthy controls. However, those women who were identified as using binge/purge behaviors were shown to have higher motoric impulsivity than any other group. Motoric impulsivity describes taking action without thinking it through. Kane et al. (2004) and Diaz-Marsa et al. (2008) found similar results to support these conclusions. Looking back at the existing literature where it was found that individuals with bulimia nervosa and binge eating disorder discount more steeply than healthy controls these results make sense. Individuals

who use binge/purge behaviors show higher motoric impulsivity where they act without thinking whereas individuals with anorexia nervosa did not show these differences as they typically behave less impulsively but show differences in cognitive measures of impulsivity.

These differences allow eating disorders characterized by binge/purge behaviors and those characterized by restricting behaviors to be thought of as on opposite sides of a scale of motoric impulsivity. This allows eating disorders to be classified by rates of impulsive behaviors (Waxman, 2009). While individuals who use binge and purge behaviors have reliably been shown to score higher on measures of motoric impulsivity than those who restrict and healthy controls these studies did not look at the two behaviors separately. Purging subgroups represent a more clinical population than those who do not purge as the behavior itself introduces numerous health risks. Using purging as a compensatory behavior has been shown to be a strong predictor of impulsive behaviors. Individuals who purged scored higher on various measures of impulsivity than those who did not use the behavior (Waxman, 2009). It is hard to break apart the relationship between purging and impulsivity and binge eating and impulsivity in these studies. It can be concluded, however, that impulsivity does not necessarily allow for the differentiation between various eating disorders but more so the presence or absence of specific behaviors such as purging behaviors. In the literature already conducted on delay discounting in eating disorders many of these trends remain stable.

Adolescence

Adolescence and Delay Discounting

Stereotypically speaking, adolescents are notoriously known for being impulsive and focusing on the here and now rather than the big future picture. Many researchers believe this is

due, in part, to the maturity of the prefrontal cortex or lack thereof. In the discounting literature this trend of adolescent's elevated impulsivity is reflected. In general, as individual's age they begin to discount less steeply, that is, as age increases an individual's discounting rate will decrease (Green, Myerson, & O'Donoghue, 1999). The question then becomes when and how do our discounting behaviors change as we age, does some internal change occur or do we simply learn more about our environments as we age.

Looking specifically at adolescents, one study's results show that individuals aged 13 and younger have been found to have lower indifference points and steeper discounting rates than individuals aged 16 and older. This may suggest that between the ages of 13 and 16 some process occurs that significantly changes how adolescents discount future rewards (Steinberg et al., 2009). However, it is important to note that these observed differences in discounting may, in part, be due to differences in future orientation and the way young people evaluate delayed rewards rather than impulsivity. This conclusion made by Steinberg et al. may be more related to the delay of gratification more so than delay discounting principles. While the two are closely related they are slightly different which is important to keep in mind. However, a study that looked at these differences across the lifespan found similar results and included children, young adults, and older adults. As individuals get older they discount future rewards less, that is, as an individual ages they are more willing and able to wait for rewards. This decrease in discounting was shown as a decrease in the parameter k (Green, Myerson, & O'Donoghue, 1999). The parameter k is defined as how much the value of a reinforcer is effected by delay, it is widely referred to as a representation of impulsivity and can be seen in the hyperbolic discounting function (O'Donoghue, 2011). What we can broadly gather from these studies is that adolescents discount significantly more than older adults and an important change in discounting behaviors

seems take place between the ages of 13 and 16. This may play a role in eating disorders as they often begin during this time period as will be discussed below.

Adolescence and Eating Disorders

Eating disorders have been stereotypically categorized as a disorder most commonly effecting young white females of middle to upper social economic status. While the stereotypical mold of these disorders is not true in all cases, incidence rates of anorexia nervosa are highest in females aging 15 to 19 constituting approximately 40% of the population that has been identified as having this disorder (Smink, Hoeken & Hoek, 2012). The same article found similar statistics when looking at the incidence rates of bulimia nervosa. The group with the highest incidence rates of bulimia nervosa were females aged 16 to 20 with 300 per 100,000 people being diagnosed, however, there is some evidence that suggests that the age of onset of bulimia nervosa may be decreasing. This implies that younger individuals are now being diagnosed with the disorder or professionals have been better able to detect incidences of bulimia. Smink, Hoeken & Hoek (2012) also found that binge eating is common in adolescents with 10.1 per 1,000 people identified as having binge eating behaviors. The DSM-5 goes on to support these findings by stating that it is extremely rare for anorexia nervosa or bulimia nervosa to begin before the onset of puberty or after the age of 40 suggesting that the most common group to be diagnosed with these disorders are adolescents and young adults.

While the onset age of puberty is the subject of a lot of debate it is safe to say that it occurs somewhere between the ages of 10 and 13 in the average female (Walvoord, 2010). It is important to note that puberty itself may also be a risk factor for the development of an eating disorder, especially in females who had poor body image prior to the onset of puberty (Ackard & Peterson, 2001). However, the aforementioned results indicate the possible significant

relationship between delay discounting and eating disorders. The age group where eating disorders are most common is the same age group that shows elevated discounting rates, this may suggest the important role of adolescence as well as the underlying role of delay discounting in eating disorders.

Looking back on the previous findings of delay discounting studies in adolescents, individuals aged 13 and younger have been found to discount more steeply and have lower indifference points than those aged 16 and older. The onset of an eating disorder typically occurs after the onset of puberty, that is, around the ages of 13 to 16 in most individuals. There may be an important change that occurs during this age period that is linked to both discounting rates and the onset of an eating disorder. However, future research must be conducted in this area to confirm the possible relationship between these two phenomena or conclude it is just a coincidence.

Binge Eating Disorder, Obesity, and Delay Discounting

Delay Discounting in Obesity

Research has shown that obese women discount more steeply than healthy controls. That is, they show preference for the more immediate yet smaller reward and are unable to wait for a delayed larger reward in a monetary discounting task (Weller, Cook, Avsar & Cox, 2008). A reason for this observed difference may be due to differences in obese women's ability to endure delay as compared to healthy controls. In today's fast paced society we are surrounded by food options that are fast, convenient, and typically unhealthy. These food options are available to us immediately where as many other healthier options require time to prepare. In delay discounting terms, fast food represents the smaller sooner reward where a healthy meal represents the larger

later. The same idea applies to exercise as well, going to the gym or exercising somewhere else requires work and perhaps travel time whereas sitting on the couch and watching television requires minimal effort or movement. The couch is available immediately whereas exercise equipment may be delayed in time. With these analogies it then becomes easy to see why obese women have been shown to discount and endure delays differently than non-obese women. We are all faced with similar choices, however, not all of us are obese indicating a difference in the underlying discounting behaviors of certain individuals. To support this hypothesis, obese individuals categorized as more impulsive, that is, they discount more steeply were found to consume more calories from foods prepared in restaurant as well as those that did not require any preparation to consume such as a package of chips (Appelhans et al., 2012). So, in other words, obese women were found to eat more foods that required minimal to no preparation or effort to obtain than those foods that required some type of preparation to be ready to eat. Foods that do not require any preparation are typically those that are prepackaged such as yogurt, chips, microwaveable foods, etc. as well as food bought from restaurants including fast foods. In general, these foods are going to be more calorie dense than foods that require preparation such as homemade chicken. This study indicates that perhaps the main factor in food choice is the delay to its receipt in time. Obesity then becomes a problem of being unable to endure delayed food, or waiting for the healthier option.

Delay Discounting in Binge Eating Disorder

As classified by the DSM-5 binge eating disorder or BED is characterized by consuming a very large amount of food coupled with feelings of losing control. As compared to obese individuals those diagnosed with BED exhibit more eating pathology as well as more chaotic eating patterns. Delay discounting has been shown to play a part in a number of disorders

involving abuse of substances or behaviors such as pathological gambling (Alessi & Petry, 2003), cigarette smoking (Bickel, Odum & Madden, 1999), drugs (Reynolds, 2006), and many more. It may then be the case that individuals with binge eating disorder following similar behavior patterns as these addicts except the substance of abuse is food. Manwaring et al. (2011) found that women diagnosed with BED discounted probabilistic and delayed rewards more steeply than both obese women without BED and healthy controls. These results indicate that women with BED are less willing to wait than both obese women and healthy controls. This perhaps indicates underlying differences between these groups. It is important to note here that while many individuals who have been diagnosed with BED are also obese it is not true in all cases. A systematic review of the literature on impulsivity in obese individuals with and without BED came to a similar conclusion. It may be that people with binge eating disorder represent a special subgroup of the obese population that can be characterized by increased impulsivity as it relates to food (Schag, Schonleber, Teufel, Zipfel & Giel, 2013). With this evidence it seems warranted that delay discounting be continued to be considered as a player in not only binge eating disorder but other eating disorders as well such as anorexia nervosa and bulimia nervosa. Further research into the relationship between impulsivity, discounting, and eating disorders has the potential to shed light on possible new treatment option for these deadly disorders.

Comorbid Disorders

Comorbidity in Eating Disorders

Many psychological disorders are comorbid with each other. What this means is that they occur at the same time, in fact it seems to be a rarity to only be diagnosed with a single disorder. It is much more commonplace to have at least two diagnoses. Eating disorders are no different. With the diagnoses of an eating disorder a variety of other psychological maladies are often

diagnosed as well including different forms of anxiety, depression, and suicidality as well as many others. The following sections will focus specifically on obsessive compulsive disorder (OCD) as well as obsessive compulsive personality disorder (OCPD), depression, and suicidality.

OCD and OCPD. OCD is a form of anxiety characterized by obsessive thoughts followed by compulsions or behaviors that a person feels the urge to engage in repetitively in order to avoid an imagined (or real) negative outcome. Similar to OCD is obsessive compulsive personality disorder or (OCPD). OCPD is characterized by a preoccupation with details, perfectionism, inflexibility, and rigidity (APA, 2013). Anxiety disorders such as OCP and related OCPD are often found in individuals who have been diagnosed with an eating disorder. In support of this, one study found that the prevalence of anxiety disorders was higher in individuals diagnosed with an eating disorder than in the general population. This conclusion remained stable for individuals with both anorexia and bulimia nervosa. Obsessive compulsive disorder (OCD) specifically was found to be comorbid with disordered eating (Kaye et al., 2004). Similar results have been found with personality disorders. In a sample of 105 individuals diagnosed with an eating disorder 69% met the criteria for a comorbid personality disorder such as OCPD (Braun, Sunday & Halmi, 2009).

Depression. Major depressive disorder is characterized in the DSM-V as having a depressed mood most days, a decreased interest in most activities, changes in eating habits, feelings of worthlessness, and fatigue. Depression is a commonly diagnosed disorder as it has a prevalence rate of approximately 7% with 16 million Americans suffering from the disorder (APA, 2013). This percentage is even higher in the population of individuals diagnosed with an eating disorder. In a sample of 105 individuals diagnosed with an eating disorder 81.9% of them

had an Axis I disorder as outlined by the DSM-III with depression and anxiety being the most common (Braun, Sunday & Halmi, 2009). Other studies have replicated these results by finding a similarly high rate of comorbidity between eating disorders and depression (O'Brien & Vincent, 2003).

Suicide. Individuals with almost any psychological malady have a slightly elevated risk of thinking about, attempting, and committing suicide. In eating disorders especially this elevated risk is evident. In a meta-analysis of 36 studies it was found that individuals with eating disorders have a significantly higher suicide rates than other disordered populations (Arcelus, Mitchell & Wales). According to the DSM-V one of the leading causes of death among individuals with eating disorders, specifically anorexia nervosa, is suicide. These results suggest that there may be some underlying factor that is found in individuals with eating disorders that may be linked to this higher rate of suicide.

Comorbid Disorders and Delay Discounting

OCD and OCPD. Research has been shown that similarly to anorexia nervosa, those diagnosed with OCPD show less discounting than healthy controls suggesting problematic self-controlled behavior (Pinto et al., 2014). To date, OCPD and anorexia nervosa are the only two psychological disorders to show any evidence that individuals with these behavioral maladies discount less steeply than healthy controls. In the typical delay discounting paradigm problematic behaviors are characterized by steeper discounting rates. As previously stated, personality disorders such as OCPD are commonly found with eating disorders. The fact that OCPD and anorexia nervosa show similar discounting patterns and occur together in many individuals may suggest that excessive self-control as seen in discounting tasks may be an underlying cause or possible effect of these disorders.

Depression. A 2014 study comparing depressed cigarette smokers, depressed non-smokers, not depressed smokers, and not depressed non-smokers on a monetary delay discounting task found applicable results. Imhoff, Harris, Weiser & Reynolds (2014) found that steeper, more impulsive, discounting was associated with higher depression scores on the Beck Depression Inventory (BDI). Standing alone these results show that delay discounting can play a role in a number of psychological maladies apart from addictive behaviors. As depression is often found together with eating disorders this alone would warrant more research into the relationship not only between delay discounting and eating disorders but delay discounting in a number of problematic psychological disorders.

Suicide. In anorexia nervosa specifically, suicide is a major contributor to the mortality rate of the disease. It is important to take note of the difference between high-lethality suicide attempts, such as using a firearm, and low-lethality suicide attempts, such as consuming certain over the counter medications. Many high-lethality suicides and attempts are often thought out and planned whereas more often than not low-lethality attempts appear to be more spontaneous in nature and often attempted on impulse as a response to an elevated emotional state. Dombrowski et al. (2011) found that individuals who had made these low lethality attempts showed a higher preference for immediate reward than non-suicidal control participants. That is, individuals who had attempted a low-lethality suicide discounted at a steeper rate than healthy controls. The same study also found that individuals who had planned out more lethal suicide attempts were in fact more willing to wait for a discounted reward. As previously mentioned, the suicide rate in eating disorders, specifically anorexia nervosa, is higher than in other populations. It can then be assumed that these individuals are more likely to use high-lethality attempts as many of them do unfortunately die. If we assume that individuals with anorexia nervosa are

using these high-lethality attempts then research would suggest that these individuals discount at a shallower rate than healthy controls. This has been tentatively supported by the delay discounting literature in anorexia nervosa. These pieces of evidence taken together are a strong indicator that problematic self-control as seen in a delay discounting task in AN has important implications that warrant investigation. Delay discounting may be an underlying cause for both eating disorder behaviors as well as the suicide rates seen in these disorders, however, there has been no research to my knowledge done assessing discounting in suicidality and eating disorders together.

Treatment Implications and Future Research

All of the previously mentioned research suggests that delay discounting may play an important role in the understanding of eating disorders and at the very least suggest that more research needs to be conducted in this area. Many of the current therapy techniques used to treat eating disorders include mindfulness techniques, dialectical behavior therapy (DBT), cognitive behavioral therapy (CBT), as well as family therapy. While these techniques have all been proven to be useful both statistically and in practice it would be naïve to think that these are the only effective treatments as eating disorders are extremely multifaceted and complex. If delay discounting is found to be an important piece to the puzzle as it pertains to eating disorders it then makes sense that perhaps by increasing or decreasing the tendency of an individual to discount a reward we may see positive treatment outcomes in those suffering from an eating disorder.

While few studies have been conducted using treatment and interventions in groups marked as discounting too much or too little, the available evidence points in a positive direction. In a study conducted with stimulant addicts it was found that using a working memory training

technique decreased the rate at which individuals in the experimental group discounted (Bickel, Yi, Landes, Hill & Baxter, 2011). Another 2011 study found similarly reduced rates of discounting following an intervention. In a group of psychiatric patients with a history of cocaine use discounting rates were significantly reduced following a money management intervention, which in turn led to less future cocaine use (Black & Rosen, 2011). While both of these studies were conducted with substance users their results may have possible implications in eating disorders such as binge eating disorder where food can be thought of as an abused substance. Following this paradigm, it would be appropriate to hypothesize that we could reduce discounting in this population and in turn reduce binge eating behaviors following similar interventions.

Perhaps a more generalizable technique is a fading procedure used to decrease discounting rates. A fading procedure involves having both the smaller sooner reward and the larger later reward both delayed in time for the same amount of time. For example, the larger later and smaller sooner rewards may both be delayed by five minutes at the beginning of training. As training proceeds the amount of time to the smaller sooner reward is gradually reduced while the delay to the larger later reward remains the same. In an experiment using pigeons, birds that were exposed to the fading procedure chose the larger later reinforcer significantly more than birds who were not exposed to this procedure (Mazur & Logue, 1978). Similar results were found in humans in both adults and children (Dixon & Holcomb, 2000; Schweitzer & Sulzer-Azaroff, 1988). These studies provide promising results that we may be able to reduce discounting in populations marked as discounting an excessive amount such as those who use purging behaviors during the course of their eating disorder as in bulimia nervosa and the binge-purge subtype of anorexia nervosa.

Along with a fading procedure, another line of research into ways to reduce discounting is delay exposure training. Delay exposure training is fairly self-explanatory but it essentially involves exposing an organism to delayed reinforcers prior to free choice sessions. Rats that have been exposed to delay exposure training have been shown to exhibit less impulsive behaviors, that is, they discount delayed reinforcers less steeply than controls that did not receive delay exposure training (Stein et al., 2013; Stein, Renda, Hinnenkamp & Madden, 2015). In a re-assessment 120 days after the initial training the reduction in discounting following delay exposure training was still seen (Renda & Madden, 2016). Based on these studies as well as those previously mentioned there is a clear trend in the literature suggesting that it is entirely possible to reduce discounting in problem populations such as individuals with drug addictions. With further research it may be possible to find similar reductions in discounting as it pertains to eating disorders leading to new treatment options.

However, a reduction in discounting may only be helpful for eating disorders that do not involve the restriction of caloric intake (e.g. bulimia nervosa and binge eating disorder). It has been posited that anorexia nervosa may stem from an issue of excessive self-control that is, not discounting enough. To my knowledge, there has not been a study investigating ways to possibly decrease excessive self-control rather than attempting to increase self-control while decreasing discounting. Future research in this area could provide an exciting new direction for delay discounting research as well as treatment prospects for eating disorders.

Future research should be conducted in all of the aforementioned areas. It is also important to note that the majority of discounting tasks are conducted with hypothetical money or substances of abuse, rarely is food used. While there is a discounting task involving food items it is not a well-designed scale. From my experience using a food discounting task I was

asked to select a preferred food item and then select varying amounts of that item across varying delays. However, unlike money, it is very easy to be satiated by food reinforcers. It may be that we are more likely to choose impulsively on this scale because we simply do not want such a large quantity of that food item. When asked if I wanted 5 cookies right now or 100 in a few months I would select 5 cookies, the impulsive choice, because I do not ever want 100. In terms of anorexia nervosa where preliminary research has shown that these individuals discount less steeply than healthy controls this pattern would most likely not be seen using a food scale. While choosing the larger delayed amount of food would be the self-controlled choice I hypothesize that due to restricting behaviors individuals with anorexia nervosa would be more likely to select smaller amounts of food, making the impulsive choice. With this in mind future research into eating disorders and delay discounting should involve the development or revision of a more accurate food scale as this may yield more accurate and applicable results with eating disorders.

Conclusion

The existing literature on delay discounting and eating disorders provides us with promising results suggesting the importance of discounting behaviors in these disorders. The current literature shows that binge eating disorder and bulimia nervosa follow the standard delay discounting paradigm seen in other behavioral maladies while anorexia nervosa presents an anomaly in the discounting literature. However, with so few studies it becomes an impossible task to make concrete evidence based conclusions. Despite there being a minimal number of studies conducted in this field there have been numerous studies conducted in related fields that provide evidence and support as to why this research is important and needs to be continued. Impulsivity, adolescence, obesity, and comorbid disorders have all been shown to have important connections with delay discounting and eating disorders. These connections such as elevated

impulsivity seen in those who use purging behaviors as well as the elevated discounting rates and eating disorder prevalence seen in adolescents provides evidence to support the significance of discounting behaviors in eating disorders. Through continuing to research these connections and find significant relationships it will allow us to begin to develop new treatment techniques that may help us to reduce the mortality rate of eating disorders and better serve those who are suffering. It is imperative that we continue to conduct this research and gear more time and funding towards its cause as it will further our understanding of delay discounting mechanisms as well as eating disorders and possibly many other behavioral maladies.

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