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An Investigation into Weight Mediated Conditions as Risk Factors for the Development of Autism Spectrum Disorder in Offspring and the Application of Applied Behavior Analysis to Pre-pregnancy Weight Behavior

Meghan M. Brahm, M.A., BCBA

B.A. Psychology, BCaBA
M.A. Special Education, Autism Spectrum Disorders, Applied Behavior Analysis, BCBA

Thesis submitted to the National University of Ireland, Galway in fulfilment of the requirements for the Degree of Doctor in Philosophy in Applied Behavior Analysis

School of Psychology,
National University of Ireland, Galway

April, 2018

Supervisor: Dr. Geraldine Leader
School of Psychology, National University of Ireland, Galway
Co-supervisor: Dr. Fidelma Dunne
University College Hospital, Galway
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Declaration and Statements

DECLARATION

This work has not been previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed……………………………………………………………………(candidate)

Date………………………………………………………………………

STATEMENT 1

This thesis is the result of my own investigation, except where otherwise stated.

Other sources are acknowledged by explicit references. A bibliography is appended.

Signed……………………………………………………………………(candidate)

Date………………………………………………………………………

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organizations.

Signed……………………………………………………………………(candidate)

Date………………………………………………………………………
Acknowledgments
Firstly, thank you to my supervisor, Dr. Geraldine Leader. Your support, guidance and encouragement both through this thesis and beyond has been more appreciated than I can express. You have helped me to grow as a researcher, behavior analysis and teacher, for which I will always be thankful. Thank you for all of your time, patience and support through our years together.

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To Mark, thank you for your unwavering support through this process. You are my biggest support for which I will always thank you for and will someday find a way to repay you.

My fellow PhD. student and “The occupants of G050 from 2013-2017” (Gunning, 2017) for always being there to lean on, laugh with and cry with. You are all more than I could have asked for in fellow Ph.D. comrades.

Finally, I would like to say thank you to each person who participated in this research. Without your help, this thesis would not have been possible. Thank you for taking the time to participate and in helping me learn more about yourselves and your children.
Publications and Conference Presentations Resulting from this Thesis
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Summary of Thesis

Obesity (OB) has been identified as one of the greatest health concerns of the present time, due to the universally increasing rates (WHO, 2016). It has been found that a large proportion of the rise of OB is among women of child-bearing age (Berghöfer et al., 2008). Excessive weight pre-pregnancy has been shown to contribute to a significant number of maternal and offspring complications (American College of Obstetricians and Gynecologists, 2013). Among those recently studied complications is offspring risk of Autism Spectrum Disorder (ASD) where OB and co-morbid conditions were present in pregnancy. OB and its related effects on pregnancy have been identified as requiring additional research and a central opportunity to limit controllable risk factors for the development of ASD in offspring (Xu et al., 2014). However, a barrier to investigating these outcomes is the lack of effective interventions to manage OB (O’Neill et al., 2012). In parallel with the increase in ASD rates, OB presents a significant health concern for both mother and child and is in need of further investigation regarding both the effects of the conditions and in the development of efficacious interventions (Nevison, 2014). This thesis aimed to evaluate maternal weight mediated conditions as risk factors for the development of ASD in offspring, to review the current approaches to weight management among women of child-bearing age, and to evaluate a functional assessment and function-matched intervention for the management of weight pre-pregnancy.

The study of environmental risk factors is an important and emerging area in understanding the etiology of ASD. Maternal weight related health factors which impact offspring risk of ASD is a novel, yet important area of investigation. Chapter 1 was a review into maternal conditions surrounding pregnancy which impact offspring ASD risk. Chapter 1 identified weight mediated conditions as emerging risk factors for
childhood ASD diagnosis, and highlights the need for additional and varied research in the area.

Chapter 2 evaluated diabetes mellitus (DM) and OB in pregnancy as risks for the development of ASD in offspring. The results from Chapter 2 support previous findings in literature which suggest that there is a significantly increased risk of a child being diagnosed with an ASD, when DM and OW/OB are present in pregnancy. Furthermore, Chapters 2 found that children were at a risk for additional diagnosis requiring special education services where OW and OB were present.

Chapter 3 evaluated the current standards of weight management programs from a behavior analytic perspective, to identify gaps where applied behavior analysis (ABA) can impact the treatment of weight related behavior patterns. Findings show a lack of assessment with regard to function of behavior in the current literature. Chapter 3 discussed that due to the absence of functional assessment, there is a persistent gap in the ability to identify and decrease variables which maintain problematic eating behavior.

Chapter 4 modified components of previously established measures to create an assessment package for the identification and functional assessment of eating behaviors in women of child-bearing age, outside of clinical eating disorders and binge eating. FBA results highlight the individual nature of eating behavior across participants and the need for individualized, function matched intervention to focus on behaviors related to weight.

A single-subject, individualized and function matched intervention was then implemented in Chapter 5 with the aim of decreasing problematic eating behaviors and increasing health of women pre-pregnancy. Results suggested that the information collected within the FBA lead to a matched intervention which was successful in
removing maintaining variables, decreasing the engagement in target behaviors and increasing the engagement in alternative and functionally equivalent behaviors for each participant’s unique needs.

This thesis found that pre-pregnancy OB among women of child bearing age is a significant risk factor for ASD and other disabilities in the offspring of those pregnancies. The current options for weight supports to decrease BMI before becoming pregnant are significantly lacking, while OB grows globally. ABA provides an evidence-based direction for the assessment and matched treatment of weight related behavior patterns which can aid in decreasing this global health epidemic. Research needs to focus on the mitigation of controllable risks for ASD and other condition. This thesis opens the discussion to ABA as a key factor in decreasing these controllable risks and improving the quality of life for mothers and their children.
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<td>ABA</td>
<td>Applied Behavior Analysis</td>
</tr>
<tr>
<td>ACOG</td>
<td>American College of Obstetricians and Gynecologists</td>
</tr>
<tr>
<td>ASD</td>
<td>Autism Spectrum Disorder</td>
</tr>
<tr>
<td>ADIR</td>
<td>Autism Diagnostic Interview- Revised</td>
</tr>
<tr>
<td>ADOS</td>
<td>Autism Diagnostic Observation Schedule</td>
</tr>
<tr>
<td>AGA</td>
<td>Average for Gestational Age</td>
</tr>
<tr>
<td>BED</td>
<td>Binge Eating Disorder</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>BN</td>
<td>Bulimia Nervosa</td>
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<td>CM</td>
<td>Contingency Management</td>
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<td>DV</td>
<td>Dependent Variable</td>
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<td>DD</td>
<td>Delay Discounting</td>
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<td>DD</td>
<td>Developmental Disability</td>
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<tr>
<td>DM</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>DIP</td>
<td>Diabetes in Pregnancy</td>
</tr>
<tr>
<td>DSM</td>
<td>Diagnostic and Statistical Manual for Mental Disorders</td>
</tr>
<tr>
<td>DR</td>
<td>Differential Reinforcement</td>
</tr>
<tr>
<td>DRA</td>
<td>Differential Reinforcement of Alternative Behavior</td>
</tr>
<tr>
<td>DRH</td>
<td>Differential Reinforcement of Higher Rates of Behavior</td>
</tr>
<tr>
<td>DRI</td>
<td>Differential Reinforcement of Incompatible Behavior</td>
</tr>
<tr>
<td>DRO</td>
<td>Differential Reinforcement of Other Behavior</td>
</tr>
<tr>
<td>DRL</td>
<td>Differential Reinforcement of Lower Rates of Behavior</td>
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<tr>
<td>S\textsuperscript{d}</td>
<td>Discriminative Stimulus</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>EO</td>
<td>Establishing Operation</td>
</tr>
<tr>
<td>EWG</td>
<td>Excessive Gestational Weight Gain</td>
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<tr>
<td>FBA</td>
<td>Functional Behavior Assessment</td>
</tr>
<tr>
<td>GDM</td>
<td>Gestational Diabetes Mellitus</td>
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<tr>
<td>GH</td>
<td>Gestational Hypertension</td>
</tr>
<tr>
<td>HY</td>
<td>Hypertension</td>
</tr>
<tr>
<td>IGT</td>
<td>Impaired Glucose Intolerance</td>
</tr>
<tr>
<td>ID</td>
<td>Intellectual Disability</td>
</tr>
<tr>
<td>IV</td>
<td>Independent Variable</td>
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<tr>
<td>IOA</td>
<td>Inter Observer Agreement</td>
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<td>IOM</td>
<td>Institute of Medicine</td>
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<td>IRT</td>
<td>Inter Response Time</td>
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<td>MC</td>
<td>Metabolic Conditions</td>
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<tr>
<td>MO</td>
<td>Motivating Operation</td>
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<td>OR</td>
<td>Odds Ratio</td>
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<tr>
<td>PDD</td>
<td>Pervasive Developmental Disorder</td>
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<td>LGA</td>
<td>Large for Gestational Age</td>
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<tr>
<td>Lbs.</td>
<td>Pounds</td>
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<td>PE</td>
<td>Preeclampsia</td>
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<td>T1DM</td>
<td>Type 1 Diabetes</td>
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<tr>
<td>T2DM</td>
<td>Type 2 Diabetes</td>
</tr>
<tr>
<td>SGA</td>
<td>Small for Gestational Age</td>
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<td>SPSS</td>
<td>S Package for the Statistical Sciences</td>
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<td>SSRI</td>
<td>S Serotine Receptor Inhibitor</td>
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<tr>
<td>SCQ</td>
<td>Social Communication Questionnaire</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Chapter 1

Maternal Health Conditions as Potential Risk Factors for Offspring Autism Spectrum Disorder: A Literature Review and Directions for Future Research

Components of this chapter have been accepted for publication: Brahm, M., Mannion, A., & Leader, G. (2018). Review Journal of Autism and Developmental Disability
Maternal Health Conditions as Potential Risk Factors for Offspring Autism Spectrum Disorder: A Literature Review and Directions for Future Research

Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by the early life presence of social, communicative and behavioral impairments (CDC, 2014; DSM-V, 2013; Harris, 2016). ASD was identified by Leo Kanner, in 1943 while evaluating a group of children who presented with similar impairments in early lack of social skills and language development and the presence of odd or repetitive patterns of behavior, yet individual differences in the degree to which they were impaired (Kanner, 1943).

Evolution of Diagnosis

Since initial identification, the definition and diagnostic criteria for ASD has been considerably refined. In the first edition of American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (DSM-I), released in 1952, ASD was contained within the schizophrenia classification and manifestations were described as “schizophrenic reaction, childhood type” (Matson & Sturmey, 2011, p.6). Classification was due to the belief at the time that ASD behavior manifestations were associated with adult schizophrenia and that symptoms in children were early displays of the adulthood schizophrenia to come (Matson & Sturmey, 2011).

It was not until the 1980 publication of the DSM-III that the first standardized diagnostic criteria and categorization of ASD was established (Volkmar & McPartland, 2014). “Infantile autism” was a condition listed within the new category of Pervasive Developmental Disorders (PDD) in the DSM-III (Maenner et al., 2014). The establishment of PDD as a separate diagnostic category highlighted the extent of impairments through the lifetime and across a variety of areas of functioning, which
was not previously recognized (Matson & Sturmey, 2011).

Infantile autism consisted of 6 diagnostic criteria; “(a) onset before 30 months of age (b) pervasive lack of responsiveness to other people (c) gross deficits in language development (d) if speech is present, peculiar speech patterns such as immediate and delayed echolalia, metaphorical language, and pronominal reversal (e) bizarre responses to various aspects of the environment (e.g. resistance to change, peculiar interest in or attachments to animate or inanimate objects) and (f) absence of delusions, hallucinations, loosening of association, and incoherence as in schizophrenia” (Matson & Sturmey, 2011, p.7).

In 1988, the *DSM-III-R*, changed the diagnostic criteria for ASD significantly (Volkmar & McPartland, 2014). Infantile autism was renamed autistic disorder and expanded to include a broader diagnostic criterion than the *DSM-III* (Maenner et al., 2014; Volkmar & McPartland, 2014). Criteria were realigned into a triad of impairment domains, namely, “(1) qualitative impairments in reciprocal social interactions (2) qualitative impairments in verbal and nonverbal communication and in imaginative activity and (3) markedly restricted repertoire of activities and interests and an onset during infancy or early childhood” (Matson & Sturmey, 2011, p.7; Volkmar & McPartland, 2014).

Each of the three domains included various related impairments, totaling 16 possible impairments to functioning (Volkmar & McPartland, 2014). Individuals met diagnostic criteria for autistic disorder if they presented with at least 8 of the cumulative 16 impairments (Volkmar & McPartland, 2014). Specifically, individuals must have presented with at least two impairments from the social domain and one from both the communication and repetitive/restricted behavior domains (Maenner et al., 2014). Importantly, the changes in the *DSM-III-R* highlighted the developmental aspect of the
disorder and did not restrict the diagnosis to young individuals, as in infantile autism (Volkmar & McPartland, 2014).

In 1994, the DSM-IV was revised again, to contain several subtypes within the PDD category (Maenner et al., 2014). Diagnostic subtypes included autistic disorder, Asperger disorder, Rett disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS; Matson & Sturmey, 2011). These revisions and subtype identification altered ASD to become viewed as a spectrum disorder (Matson & Sturmey, 2011).

Additionally, in the DSM-IV, autistic disorder impairments were reduced from 16 to 12 impairments and criteria for diagnosis required individuals to present with 6 impairments rather than 8, across the same social, communication and behavior domains (Volkmar & McPartland, 2014). Furthermore, criteria for the new subtypes were like that of autistic disorder but required that an individual present with fewer than 6 impairments, or that their manifestations totaled a different composition of categories than required for autistic disorder (Maenner et al., 2014).

In the most recent version of the DSM-V (DSM-V, 2013) diagnostic criteria have been refined further again, firstly by the removal of ASD subtypes which have been compressed into the collapsed PDD class (Volkmar & McPartland, 2014; Maenner et al., 2014; Vijayakumar & Judy, 2016). As well, the PDD class now including both an ASD diagnosis and the novel social communication disorder diagnosis (Volkmar & McPartland, 2014; Maenner et al., 2014; Vijayakumar & Judy, 2016).

In addition, no longer is there a triad of impairments, instead the DSM-V specifies a dyad of impairment where the social and communicative domains have been merged into one; social communication impairments. The presence of restricted or repetitive patterns of behavior, interests or activities remains and now includes the
presence of sensory difficulties as well (Maenner et al., 2014; Volkmar & McPartland, 2014). The DSM-V was released in 2013 and remains the standard criteria for the classification of ASD and other mental disorders (Volkmar & McPartland, 2014).

**Prevalence Debate**

Prevalence is defined as the number of persons who present with a disorder at any point in time, across the population (Matson & Sturmey, 2011). Prevalence rates of ASD have increased significantly since Kanner’s initial identification (Matson & Sturmey, 2011) rising from 2–4 per 10,000 children in Kanner’s estimate, to 1:68 in 2016 (CDC, 2016). At current, it is estimated that ASD impacts anywhere from 1%-2.5% of the general population (Randall et al., 2016; Vijayakumar & Judy, 2016) and is diagnosed in males at a rate four times greater than females, 1:42 and 1:189, respectively (CDC, 2014; Vijayakumar & Judy, 2016). In 2015, it was estimated that ASD affects 70 million people, globally (Autism Speaks, 2015).

As rates rise, debate in the field persists with respect to explaining the increase (Kim et al., 2011). Researchers agree that a component of the rise is attributable to better diagnostic practices having been developed due to the evolution of the DSM (Matson & Sturmey, 2011). Researchers also agree that the increased awareness of ASD has impacted rates of diagnosis, but suggest there is a large portion of the prevalence increase which is likely due to other factors (CDC, 2011; Hallmayer et al., 2011).

**Case Definition and Substitution**

Changes to the diagnostic criteria throughout the years have had mixed results in terms of impact on diagnosis rates and have led to disagreement regarding the increased reported prevalence of ASD (Kim et al., 2011; King & Bearman, 2009; Maenner et al., 2014; Polyak, Kubina & Girirajan, 2015; Vijayakumar & Judy, 2016). Difficulties with
comparing prevalence rates over time and across diagnostic criteria arise due to the concept of case definition; or the inability to compare previous rates to current, due to diagnostic definitions being incomparable (Matson & Sturmey, 2011).

Furthermore, ASD having been changed to include a spectrum in the DSM-IV, is said to limit the ability to compare those prevalence rates to the more restricted criteria previously and currently employed (Matson & Sturmey, 2011). The proposed limitations in the ability to compare rates across time due to case definition, is further complicated by diagnostic substitution (Matson & Sturmey, 2011).

Diagnostic substitution refers to the process, where an individual is diagnosed with one disorder at one point in time, then later their diagnosis is substituted due to impairments being better attributed for by new diagnostic criteria (Matson & Sturmey, 2011). Diagnostic substitution is said to have a high occurrence between intellectual disabilities (ID) and ASD. Meaning, individuals who were once diagnosed with ID are changed to ASD, and new diagnosis that may have been ID previously are now meeting ASD criteria (Polyak, Kubina & Girirajan, 2015). Researchers argue that diagnostic substitution impacts the ability to compare prevalence rates of ASD over time (Matson & Sturmey, 2011).

**Awareness and Access to Services**

ASD awareness has experienced significant momentum in the last decade (Autism Speaks, 2015). Organizations such as Autism Speaks©, whose mission is in part to increase awareness of ASD, now function across 70 countries (Autism Speaks, 2015). Evidence of expanding ASD awareness can be seen through efforts such as Autism Speaks© “Light it UP BLUE” campaign. This is a global campaign established with the specific mission of advancing ASD awareness through a month dedicated to awareness events (Autism Speaks, 2015). During this campaign, on “Autism
Awareness day” in 2015, over 18,600 buildings, in 142 countries lit the exterior of their buildings blue to raise ASD awareness (Autism Speaks, 2015). The universal exposure ASD has received over the last number of years has undoubtedly increased the awareness of ASD, which has led to more individuals being aware of red flags for ASD and consequently increased case identification (Matson & Sturmey, 2011).

Awareness has led to increased case identification, by advancing access to and funding for services, like diagnostic assessments, which may have not been previously available (Matson & Sturmey, 2011). The increase in access to diagnostic services is viewed as an additional explanation for the prevalence rate increase (Matson & Sturmey, 2011). However, further investigation is necessary to determine the impact of increased diagnosis access and case ascertainment on the prevalence rates of ASD (Matson & Sturmey, 2011).

**Epidemiology**

Despite the argument surrounding prevalence, researchers agree that ASD continues to be a global concern with a significant number of individuals affected and that the reason for the incidences, or the epidemiology, requires substantial additional research (Matson & Sturmey, 2011). As the number of individuals diagnosed with an ASD increases, emphasis on understanding the etiology becomes increasingly important, particularly when considering that, at present, the etiology of ASD is largely unknown (Lyall et al., 2016). Importantly, research suggests that understanding modifiable factors for ASD etiology can alter the growing trend (Klug et al, 2003; Lyall et al., 2016).

Through decades of research there is an emerging understanding of genetic heritability and environmental risk factors for the development of ASD however a great deal of work is still needed to fully understand the etiology of ASD and its increasing
rates (Lyall et al., 2016).

**Genetics in ASD**

Research has identified a variety of genetic variants, which may contribute to the incidents of ASD, though the exact effect is yet to be established (CDC, 2011). Vijayakumar and Judy (2016) report that in the last 10 years, there have been hundreds of susceptibility genes identified. Genetic understanding is complicated by multiple factors but particularly by the genomic profile likely being different from individual to individual and further complicated by the individual severities seen which suggests differing manifestations of phenotype (Vijayakumar & Judy, 2016).

To understand the underlying genetics of ASD, research has focused on familial studies for many years and has shown strong heritability where ASD is present in families (Sandin et al, 2014). Studies have suggested that the siblings of children with ASD have a 2-8% reoccurrence rate of PDD (Muhle, Trentacoste & Rapin, 2004) and that percentages increase to 12-20% when factoring in the sibling’s manifestation of the diagnostics domains for ASD, but not reaching criteria for a diagnosis (Chaste & Leboyer, 2012).

Early twin studies suggested heritability rates as high as 90% among monozygotic pairs (Steffenburg et al., 1989) which lead to a view that ASD may be primarily explained by genetics (Chaste & Leboyer, 2012). However, results from more recent twin research have suggested heritability to be about 37%, and suggest as much as 58% of the risk of ASD development among the pairs is attributable to the shared prenatal environmental conditions (Hallmayer et al., 2011).

**Gene-Environment Interaction**

Even though research has supported identification, diagnosis and genetics as components in the growth of ASD, these variables do not account for all the increase
Rather, researchers suggest the combination of environmental risk factors and genetics, work in conjunction to influence the majority of the increased rate of ASD (Hallmayer et al., 2011). This gene-environment interaction model lends itself to a broadly supported school of thought in the explanation of ASD (Chaste & Leboyer, 2012) where environmental insults are believed to transform the developing functions and composition of fetal brains while in utero (Roberts et al., 2007).

Chaste and Leboyer (2012) highlighted Galsson et al. (2004) finding’s as clearly representing the gene-environment association. Authors reported that individuals with ASD had greater prenatal and perinatal complications than their neurotypical siblings (Glasson et al., 2004). Additionally, those neurotypical siblings has more prenatal and perinatal complications than control subjects, with no familial history of ASD (Glasson et al., 2004). These results are said to suggest individuals with ASD may have different reactions to environmental conditions than their neurotypical siblings and may be more sensitive to prenatal conditions (Chaste & Leboyer, 2012).

While the field of genetics has greatly increased our understanding of the disorder and the genetic impact, disagreements within the field regarding heritability and the prevalence of ASD have clarified the need for greater research on environmental factors (Chaste & Leboyer, 2012). Though the prevalence debate remains, there is a consensus on the need to continue to search for understanding on environmental factors likely leading to the diagnosis of ASD (Chaste & Leboyer, 2012).

**Environmental Risks**

With regards to environmental risk factors, research has identified several factors occurring around pregnancy which increase the risk of offspring ASD. These risks include increasing maternal age at conception, maternal infection during pregnancy,
maternal medication use during pregnancy, maternal psychiatric history and maternal vitamin deficiencies during pregnancy (Gardner, Spiegelman, & Buka, 2009).

Most recently, research has suggested a relationship between maternal metabolic and/or nutritional states during pregnancy and developmental outcomes in offspring (Brahm, Mannion & Leader, 2018 in press; Krakowiak et al, 2012). Studies show less optimal nutritional states to be associated with higher rates of ASD and identify weight and weight mediated conditions as an emerging avenue in risk factor research (Bilder et al, 2013; Brahm, Mannion & Leader, 2018a, in press; Gardner et al., 2015; Krakowiak et al., 2012).

**Need for Further Research**

As research surrounding the etiology of ASD continues to grow, it becomes increasingly important to expand the identification of risk factors. The identification of risks, some of which may be preventable, has the potential to alter the trend in ASD diagnosis and treatment (Klug et al, 2003). The Interagency Autism Coordinating Committee Strategic Plan for Autism Research (2012), a US federal advisory committee, has specifically identified environmental risk factors as an important gap in the understanding of the etiology of ASD. The Committee reported that the area of environmental risk factor research is understudied, given insufficient attention, and should be a priority of research. However, conditions which have been identified as potential risk factors need additional research, to synthesize and clarify research results, before the conditions of interested should be implicated as validated a risk factor for ASD (Brahm, et al., 2018(a) in press).

This chapter will review the recent body of literature regarding maternal health factors that impact pregnancy and their relation to a child being diagnosed with ASD, extending previous research done in the area to include recent findings. Additionally,
this chapter will serve as an updated report on novel risk factor research as a means to expand the knowledge of health related environmental risk factors for ASD.

**Maternal Health Pre-Conception**

A number of studies have evaluated the way, if any, maternal health pre-pregnancy affect outcomes for both mother and child (Dodds et al., 2011). Results have largely varied, and suggest numerous limitations (Atladóttir et al., 2009). Recently, Dodds et al. (2011) report health conditions, including pulmonary disease, heart disease, renal disease and anemia to be significantly related to ASD diagnosis in offspring. Recent studies have focused on the areas of autoimmune diseases, allergies, asthma and epilepsy.

**Autoimmune Diseases, Allergies, Asthma and Epilepsy.** The immune system of mothers during pregnancy has been highly researched for a potential role in the development of ASD. Research has provided an understanding that the proper functioning of maternal autoimmune systems is imperative for fetal neurodevelopment (Hallmayer et al., 2011). Mouridsen et al. (2007) and Atladóttir et al. (2009) both utilized the Danish National health registry, to evaluate the risk for offspring ASD among participants when autoimmune diseases were present. Mouridsen et al. (2007) found that ulcerative colitis among mothers and Type 1 diabetes among fathers of ASD participants occurred significantly more frequently, when compared to neuro-typical controls. Authors discuss the need for replication and extension in their findings. The evaluation by Atladóttir et al. (2009) confirmed an association between ASD and familial Type 1 diabetes and rheumatoid arthritis in mothers, displayed in Mouridsen et al. (2007). This study also established an association between ASD and celiac disease among case mothers. Results suggest the association between ASD and celiac disease
was confined to women who were diagnosed within pregnancy, while children of women diagnosed prior to pregnancy did not show an increased risk of ASD. These results support the need for treatment of celiac disease; however as this is the first study to assess an association between ASD and celiac diseases, results require replication and extension (Atladóttir et al. 2009). These studies discuss the inconsistencies among previous research regarding family autoimmune history and ASD, and detail the need for further studies utilizing larger sample sizes, incorporating suitable comparisons groups, and the need for validated health history data rather than self-report, as required to determine if there is a true association between ASD and familial autoimmunity.

Croen, Grether, Yoshida, Odouli & Van de Water (2005) evaluated the risk between maternal allergies, asthma and autoimmune diseases in and around the time of pregnancy among a case-controlled cohort within a health care organization in northern California. Authors found maternal asthma and allergy diagnoses during the second trimester resulted in greater rate of offspring ASD. However, psoriasis was the only autoimmune disease to reach a statistically significant association with offspring ASD. Authors suggest interpretations of their findings as warranting caution until replication in additional large populations can occur.

As the study of co-morbid ASD and epilepsy continues to rise, it becomes increasingly important to investigate the development course of the two disorders (Mannion & Leader, 2014). Leonard, de Klerk, Bourke, and Bower (2006) studied results from a large-scale population assessment in Western Australia, showing mothers with epilepsy had a nearly fivefold increased risk (OR, 4.57; CI, 1.69–12.31) of having a child with ASD and ID, as compared to children with ID only, and typically developing children. However, authors report a limitation in the lack of data on medication use for this population and that it is not possible for them to differentiate if
the increased risk is because of seizure medication or the genetic conditions involving epilepsy.

Additional research found that maternal use of valproate, a drug used to treat epilepsy, while pregnant was associated with significant increased risk of ASD in offspring (Christensen et al., 2013). Christensen et al. (2013) explain that valproate is used in the treatment of epilepsy as well as certain bipolar episodes and prophylaxis of migraine headaches. Further evaluation showed an increased risk of ASD in relation to valproate remained when assessing both groups of mothers with and without epilepsy, but all of whom had taken the drug. Authors conclude with the need to clarify the relationship as well as determine how to balance the benefits of valproate against the reported risk of offspring ASD development.
Table 1.
*Summary of literature which assessed maternal pre-pregnancy health as risk factors for offspring ASD.*

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Factors Assessed</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atladóttir, et al. (2009)</td>
<td>Familial autoimmune disorders</td>
<td>689,196 Controls 3,325 ASD</td>
<td>Increased risk between rheumatoid arthritis, celiac disease and ASD.</td>
</tr>
<tr>
<td>Christensen, et al. (2013)</td>
<td>Exposure to valproate</td>
<td>655,615 Controls 5,437 ASD</td>
<td>Significantly increased risk of ASD for offspring, even when maternal epilepsy was controlled for.</td>
</tr>
<tr>
<td>Croen, et al. (2005)</td>
<td>Maternal autoimmune diseases, allergies and asthma</td>
<td>2095 Controls 407 ASD</td>
<td>Asthma during 2nd trimester, and allergy during 2nd trimester were significantly associated with ASD diagnoses. Psoriasis occurred more frequently in cases than controls, but no other autoimmune disease.</td>
</tr>
</tbody>
</table>
Maternal Mental Health

Studies have been conducted for many years, on the prevalence of psychiatric disorders among relatives of persons with ASD (Smalley, McCracken, & Tanguay, 1995). The results of early studies suggested a high prevalence of anxiety and bipolar disorder within groups of parents of children with ASD. More recently, studies have evaluated further psychiatric disorders and their effects on ASD diagnosis, finding noteworthy risk when maternal mental health concerns were present (Totsika, Hastings, Emerson, Lancaster & Berridge 2011).

Psychiatric Disorders, Major Mood Disorders and Medication. Lauritsen, Pedersen and Mortensen (2005) and Daniels et al., (2008) both assessed large registers within their respective countries, finding rates of mothers who had a history of psychiatric disorders or had been hospitalized for a mental health disorder, particularly depression and personality disorders, were significantly higher in ASD case mothers than in controls. Daniels et al. (2008) suggest that there are two potential variables associated with the increase. Firstly, the presence of a psychiatric condition might influence the parents in having their child assessed for conditions, resulting in increased ASD diagnosis. Secondly, a child being diagnosed with ASD could lead to a greater manifestation of parental psychiatric symptoms increasing the likelihood of an association between the diagnoses. Further research is needed to differentiate these two effects.

Beversdorf et al. (2005) were concerned with timing of maternal mental health, particularly maternal prenatal stress, and subsequent diagnosis of ASD in offspring. Authors report that changes in the cerebellum of children with ASD related to an event triggering maternal stress which occurred before 30-32 weeks’ gestation. Specifically, within their cohort the authors found an increased number of maternal stress events
occurring between 21-23 weeks’ gestation to be significantly related to a diagnosis of offspring ASD (p = 0.0007), with the highest stress association occurring between 25-28 weeks’ gestation. Authors conclude by saying that it is not yet clear if prenatal stressors can be considered an independent risk factor for ASD or if these variables may aid in the development of ASD in genetically susceptible individuals and that more research is needed in the area.

Rai et al. (2013) evaluated a large sample of offspring with ASD and matched controls in Sweden, finding maternal psychiatric disorders were associated with a significantly increased risk of ASD. Data available on a subgroup of mothers with medication use suggested the risk of ASD was confined to women who reported using antidepressants during their pregnancy. Reportedly, it is unclear if the association seen is casual in the development of ASD or is attributable to the presence of severe gestational depression, requiring further research.

Similar data from a Finnish health registry assessed 4713 births from 1987-2005 with a diagnosis of and ASD as compared to matched controls, finding parental schizophrenia and affective disorder was associated with an increased risk of ASD (Jokiranta et al., 2013). Specifically, PDD- Not Otherwise Specified was associated with all assessed categories namely, schizophrenia and other non-affective psychoses, affective disorders, neurotic and personality disorders and other nonpsychotic disorders, alcohol and drug addiction/abuse, disorders usually diagnosed in childhood or in adolescence. Authors report that results can only be defined as speculative in terms of the association because of the lack of research outside of their study in the area.

Croen, Grether, Yoshida, Odouli, and Hendrick (2011) and Harrington, Lee, Crum, Zimmerman, and Hertz-Picciotto (2014) evaluated data on prenatal exposure to antidepressant medications, or selective serotonin reuptake inhibitors (SSRI). Croen et
al. (2011) found women who were taking at least one antidepressant within the year prior to delivery had two times the risk of having a child with ASD. Harrington et al. (2014) also found males with ASD were 3 times as likely to have been exposed to SSRI’s in utero as compared to typically developing males, with the greatest risk seen in exposure during the first trimester. Both studies report the need for understanding this increased risk in association with the benefits of the medication use for mothers during pregnancy as needing further evaluation and that the risk-benefit knowledge is not strong enough to elevate one scenario over the other (Harrington et al. (2014).

Similarly, Maimburg and Væth (2006) evaluated medication use by mothers during pregnancy and association with offspring ASD. Specifically, the authors evaluated antiepileptic, psychoactive, antihypertensive, cardiovascular drugs, tocolytic medicine and steroids throughout pregnancy and during birth. Results showed an increase in the risk of infantile autism when medicine had been used during pregnancy, most notably, the use of psychoactive drugs, but no risk associated with tocolytic medicine and steroids. Again, the differentiation of genetic pre-disposition or fetal exposure to drug influences on the development of ASD is unknown.

A meta-analysis conducted by Gardner et al. (2009) exhibited a 46% association between diagnosis of ASD and maternal medication use during pregnancy. Specifically, researchers reported 60-68% increased risk of ASD when mothers were taking psychoactive drugs in pregnancy. The authors reported a need for further research to determine if medication findings are causal or suggest an association between ASD and severe gestational depression.
Table 2: Summary of literature which assessed maternal mental health as risk factors for offspring ASD.

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Factors Assessed</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beversdorf, et al. (2005)</td>
<td>Timing of prenatal stressors</td>
<td>212 Controls 188 ASD</td>
<td>Higher rates of stress at 21-28 weeks gestation were found in ASD cases.</td>
</tr>
<tr>
<td>Croen, et al. (2011)</td>
<td>Antidepressant use during pregnancy</td>
<td>1507 Controls 298 ASD</td>
<td>2 times ASD risk when antidepressants were used within the year before pregnancy.</td>
</tr>
<tr>
<td>Daniels et al. (2008)</td>
<td>Parental Psychiatric Disorders</td>
<td>30693 Controls 1227 ASD</td>
<td>Depression, neurotic and personality disorder and non-psychotic personality disorders increased risk of ASD.</td>
</tr>
<tr>
<td>Harrington et al. (2014)</td>
<td>SSRI</td>
<td>320 Typically developing mother-child pairs 154 developmental disability mother-child pairs</td>
<td>Males with ASD had a 3 times higher rate of SSRI exposure during pregnancy.</td>
</tr>
<tr>
<td>Jokiranta et al. (2013)</td>
<td>Parental psychiatric disorders</td>
<td>492 ASD mother-child pairs</td>
<td>Higher risk of ASD where schizophrenia and affective disorders were present. PDD-</td>
</tr>
<tr>
<td>Study</td>
<td>Condition</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------</td>
<td></td>
</tr>
<tr>
<td>Lauritsen, et al. (2005)</td>
<td>General Psychiatric disorders</td>
<td>NOS associated with all conditions assessed.</td>
<td></td>
</tr>
<tr>
<td>Larsson, et al. (2005)</td>
<td>Parental Psychiatric history</td>
<td>Double the risk of ASD if mother had been diagnosed with a psychiatric disorder. Maternal schizophrenia-like psychosis, affective disorder were significantly associated with ASD.</td>
<td></td>
</tr>
<tr>
<td>Maimburg &amp; Vaeth (2006)</td>
<td>Drug use in pregnancy and labor</td>
<td>Psychoactive medicine use in pregnancy was found to be a risk for infantile autism.</td>
<td></td>
</tr>
<tr>
<td>Rai, et al. (2013)</td>
<td>Parental depression and maternal antidepressant use</td>
<td>Maternal use of antidepressants during pregnancy increased offspring ASD risk.</td>
<td></td>
</tr>
</tbody>
</table>
Health in Pregnancy

Maternal health complications have been evaluated in several studies and have been shown to create a negative impact on the development of offspring in-utero (Hallmayer et al., 2011; Zerbo et al., 2013). Of particular interest has been mother’s health associated with illness and infections during pregnancy and the risks associated with offspring development of ASD (Atladottir et al., 2010).

Specific infections reported to be risk factors for ASD in early studies included congenital rubella (Gregg, 1941; Desmond, Wilson, Verniaud, Melnick & Rawls, 1970; Chess, 1971) prenatal measles, mumps and rubella (Deykin & MacMahon, 1979) herpes simplex (Ghaziuddin, Tsai, Eilers, & Ghaziuddin, 1992; Greer, Lyons-Crews, Mauldin & Brown, 1989) cytomegalovirus (Ciaranello & Ciaranello, 1995; Yamashita, Fujimoto, Nakajima, Isagai & Matsuishi, 2003) and maternal influenza (Deykin & MacMahon, 1979). In recent research, results have suggested infections and bleeding during pregnancy to be a significant risk for ASD development (Gardner et al., 2009; Patterson, 2011; Zerbo et al., 2013).

Infections During Pregnancy

Brimacombe, Ming and Lamendola (2007) evaluated a cohort of 164 case mothers as compared to the National and State of New Jersey averages on pregnancy, labor and delivery and history of the child and mother. Authors found significantly higher rates of vaginal bleeding among ASD mothers as compared to rates within both the National and New Jersey populations. Results suggest many significant differences between the cohorts requiring evaluations in additional populations (Brimacombe et al., 2007).

Lee et al. (2015) found nearly 30% increase in the risk of offspring ASD (OR = 1.37, 95% CI: 1.28, 1.47) to be associated with any inpatient maternal infection
during pregnancy, among 24,414 ASD cases as compared to 2,371,403 controls in a Swedish population sample. Increased risk was present across a variety of infections including bacterial and viral infections and across all trimesters. Still, the authors suggest that a clear distinction between the genetic variants which may make mother’s more susceptible to infections, and the potential interaction with those genes in the development of ASD is necessary, limiting the understanding of infections as a valid risk until additional research is conducted. Recently, Zerbo et al. (2013) found mothers who had a fever during pregnancy were at an increased risk for having a child with ASD as compared to control mothers. Particularly, those mothers who experienced fever but took no medication to control the fever had a higher risk for offspring ASD than those mothers who had a fever and took medication.

Atladottir et al. (2010) assessed data, via the Danish national register, of all children born in Denmark from 1980 to 2005 concluding viral infection in the first trimester and maternal bacterial infection in the second trimester to be associated with higher rates of ASD diagnosis, adjusted hazard ratio = 2.98 (CI: 1.29–7.15) and 1.42 (CI: 1.08–1.87), respectively. Authors emphasized the timing of intrauterine insults might be of importance in relation to risk odds, suggesting the need for further evaluation, and that their findings support an increasing hypothesis in regard to early pregnancy infection increasing ASD risk.

**Bleeding During Pregnancy**

Bleeding during pregnancy has been reported as a risk factor in several studies (Brimacombe et al., 2007; Kolevzon, Gross & Reichenberg, 2007). Results from a large-scale meta-analysis conducted by Gardner et al. (2009) confirmed previous findings. Meta-analysis data exhibited an 81% increased risk of offspring ASD where maternal bleeding during pregnancy was present. Extended research is necessary to
determine the conditions leading to bleeding in pregnancy and how those influence potential risk for ASD.
Table 3.
 Summary of papers which assessed maternal infections and bleeding during pregnancy as risk factors for offspring ASD.

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Issue Assessed</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atladóttir, et al. (2010)</td>
<td>All infections during total pregnancy duration. Secondly, type of and trimester where infection developed</td>
<td>1,612,342 controls, 10,133 ASD</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; trimester viral infection, 2&lt;sup&gt;nd&lt;/sup&gt; trimester bacterial infection increase risk for ASD.</td>
</tr>
<tr>
<td>Brimacombe, Ming &amp; Lamendola, (2007)</td>
<td>Pregnancy, labor &amp; delivery and new-born history complications</td>
<td>National and Jew Jersey year 2000 birth records, 164 ASD</td>
<td>Vaginal bleeding was statistically significantly related to risk of ASD in both control populations.</td>
</tr>
<tr>
<td>Gardener, Spiegelman &amp; Buka, (2009)</td>
<td>Bleeding during pregnancy</td>
<td>Meta-analysis</td>
<td>81% increase risk when bleeding is present in pregnancy.</td>
</tr>
<tr>
<td>Lee et al. (2015)</td>
<td>Maternal hospitalization with infection, type of infection and timing of infection during pregnancy</td>
<td>2,371,403, 24,414 ASD</td>
<td>ASD rates increased by nearly 30% with any inpatient hospitalization</td>
</tr>
</tbody>
</table>
Weight Mediated Conditions

Obesity (OB) has been identified as one of the most important, current health threats in the world (Guelinckx, Devlieger, Beckers, & Vanstant, 2008). A central concern is the 30% increase in OB among women of child bearing age (Berghöfer et al., 2008). Research has found a large contributor of this increase to be excessive weight gain during pregnancy (Vesco et al., 2014). As rates of OB continue to rise, paralleled with rates of ASD, research has begun to focus on weight mediated pregnancy conditions and their influence on offspring ASD risk.

Maternal Weight

Dodds et al. (2011) evaluated 129,733 children, 924 of which had a diagnosis of ASD. Authors determined high maternal pre-pregnancy weight (90 kg or more) and, for the first time, high gestational weight gain (18 kg or more) as each being independently and statistically significant risk factors for ASD. Supplementary research has repeatedly confirmed Dodds et al. (2011) results regarding maternal weight and weight gain in pregnancy (Bilder et al., 2013; Gardner et al., 2015; Krakowiak et al., 2012).

Krakowiak et al. (2012) reported OB mothers, with and without co-morbid hypertension, pre-eclampsia, and diabetes, had an increased risk of offspring ASD. Findings show less optimal perinatal conditions to be associated with higher rates of ASD and developmental delays in offspring and that perinatal conditions deteriorate with increasing weight gain. Specifically, authors report there was an increased association between ASD and diabetes as well as ASD and hypertension, however neither association reached statistical significance. There was a statistically significant increased risk between OB and ASD (OR: 1.67 [95% CI: 1.10–2.56]) as well as a greater prevalence of OB among case mothers (>20%) as compared to control mothers.
(14.3%).

Bilder et al. (2013) found the risk of ASD diagnoses in offspring was significantly associated with maternal excessive gestational weight gain. Moreover, the risk of ASD increased further with each 5-pound increment weight gain, above recommended guidelines (Bilder et al., 2013). In the largest study to date assessing maternal weight and ASD, Gardner et al. (2015) determined a strong and direct link between gestational weight gain and ASD risk. Specifically, results show that both too little and too much weight gain in pregnancy were related to offspring ASD development. Author’s results also suggest a further risk for every 5-pound increase, just as Bilder et al. (2013) found.

Studies evaluating maternal weight pre-pregnancy have found similar results as excessive gestational weight gain. Lyall, Pauls, Santangelo, Spiegelman and Ascherio (2011) evaluated maternal age at menarche, the characteristics of mother’s menstrual cycle pre-pregnancy, mothers use of oral contraceptives, body shape and body mass index (BMI) for risk of subsequent offspring ASD. Results indicated increased offspring diagnoses of ASD among mothers with early menarche, particularly <11 years of age, and mothers with a high BMI at age 18. Similarly, Reynolds, Inder, Neill, Pineda and Rogers (2014) evaluated a cohort of 62 mothers and infants, finding mothers with obese BMI classification pre-pregnancy had a significantly higher rate of offspring failing ASD screening measures as compared to non-obese mothers.

**Diabetes**

Diabetes Mellitus (DM) has been shown to be the most prevalent chronic medical condition among pregnant women (Rosenberg, Garbers, Lipkind & Chiasson, 2005). Research has established a relationship between increased maternal weight and
the development of gestational diabetes mellitus (GDM); however, research evaluating offspring outcomes of those pregnancies is lacking (Iafusco et al., 2006).

Overall results from a meta-analysis conducted by Gardner et al. (2009) showed a two-fold increase in risk of ASD among offspring when GDM was present, however results from individual studies are inconsistent. Results from a large Western Australian population, and an American based population study found that both pre-pregnancy DM and GDM was associated with increased risk of offspring ASD diagnosis (Brimacombe et al., 2007; Leonard et al., 2006). Likewise, Atladóttir et al. (2009) evaluated register data from Danish children, finding a significantly increased rate of type 1 diabetes (T1DM) among mothers of children with infantile ASD.

Recently, Lyall, Pauls, Spiegelman, Acherio and Santangelo (2012) assessed data from a large cohort of births, spanning 3 decades, also showing GDM was associated with a statistically significant increased risk of ASD (OR in primary analysis = 1.76, 95% CI 1.34, 2.32). Moreover, Xiang et al. (2015) conducted research on the risk of ASD associated with intrauterine exposure to type 2 diabetes (T2DM) and GDM. Importantly, this was the first study to examine the significance of the timing of GDM diagnosis and timing of intrauterine exposure to hyperglycaemia in accordance with gestational age, as playing a role in the risk of ASD development.

Researchers found pre-existing T2DM was not significantly associated with an increased risk of ASD but that GDM diagnoses at 26 weeks or earlier was a significant risk. Research regarding diabetes and ASD risk consistently recommend additional assessment into the different types of diabetes on ASD risk as well as timing of the condition, particularly because of the strength of associations found (Lyall et al., 2012; Xiang et al., 2015)

**Hypertension / Preeclampsia**
Langridge et al. (2013) evaluated pregnancy hypertension (HY; preeclampsia PE or essential HY) and a possible association with an increased risk of mild-moderate ID and ASD with co-morbid ID. Results suggested no maternal conditions or perinatal factors being associated with increased risk of ASD in the absence of ID. However, an increase in risk for children with ASD and co-morbid ID was found in mothers with gestational HY, suggesting a need for better understanding of the association between conditions.

In one of the largest population based studies to date, Burstyn, Sithole, and Zwaigenbaum (2010) evaluated singleton births in the province of Alberta, Canada occurring between 1998 and 2004 for ante- and perinatal risk factors for ASD, showing an increased risk for ASD when pre-pregnancy DM was present in mothers. Authors also found an increased risk of ASD in offspring where pre-eclampsia was present in pregnancy.

Buchmayer et al., (2009) examined a large matched control population, residing in Sweden, to determine if the risk of ASD among preterm birth individuals was attributable to pregnancy complications. Findings suggest preeclampsia was associated with a 50% increased risk of preterm birth offspring being diagnosed with ASD. However, as findings in HY and preeclampsia are inconsistent, authors suggest a need for further research to determine risk significance (Buchmayer et al., 2009).
<table>
<thead>
<tr>
<th>Study</th>
<th>Health Issues Assessed</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilder et al., 2013</td>
<td>Pre-pregnancy BMI and pregnancy weight gain</td>
<td>Population-based cohort-10,920 Controls 128 ASD Research-based cohort 288 ASD 493 Unaffected siblings</td>
<td>ASD risk significantly associated with pregnancy weight gain in both cohorts and increased with each 5lbs. increase.</td>
</tr>
<tr>
<td>Brimaxcombe, Ming &amp; Lamendola. (2007)</td>
<td>Pregnancy, labor &amp; delivery and newborn history complications</td>
<td>National and Jew Jersey year 2000 birth records 164 ASD 6080 Controls 1216 ASD</td>
<td>Diabetes was significantly higher in the sample population as compared to the national sample.</td>
</tr>
<tr>
<td>Buchmayer, et al. (2009)</td>
<td>Maternal, pregnancy-related and neonatal factors identified in previous research</td>
<td>6080 Controls 1216 ASD</td>
<td>Increased risk of ASD when preeclampsia was present in pregnancy.</td>
</tr>
<tr>
<td>Burstyn et al. (2010)</td>
<td>Pre-pregnancy diabetes, gestational diabetes, pre-eclampsia</td>
<td>169,372 Controls 931 ASD</td>
<td>Pre-pregnancy diabetes and pre-eclampsia increased the risk of ASD in offspring.</td>
</tr>
<tr>
<td>Dodds, et al., 2011</td>
<td>Prenatal, obstetric and neonatal factors while controlling for genetic susceptibility</td>
<td>129,733 Controls 924 ASD</td>
<td>Maternal pre-pregnancy weight of 90 kg or more and gestational weight gain of 18 kg or more were both statistically significant risk factors.</td>
</tr>
<tr>
<td>Gardener et al. (2015)</td>
<td>Gestational weight gain</td>
<td>333,057 Control 6420 ASD</td>
<td>Gaining both too little and too much weight increased risk of ASD.</td>
</tr>
<tr>
<td>Krakowiak et al. (2012)</td>
<td>Metabolic conditions during pregnancy</td>
<td>315 Controls 172 DD</td>
<td>Diabetes, hypertension and OB were higher among case mothers than controls.</td>
</tr>
<tr>
<td>Study</td>
<td>Maternal Conditions and Outcomes</td>
<td>Number of Participants</td>
<td>Results</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Langridge, et al., (2013)</td>
<td>Maternal conditions, sociodemographic factors, labor and deliver characteristics and neonatal outcomes</td>
<td>517 ASD 383,153 Controls 1,179 ASD</td>
<td>Increase in risk for children with both ASD and co-morbid ID was found in mothers with gestational hypertension.</td>
</tr>
<tr>
<td>Leonard, et al., (2006)</td>
<td>Diabetes (all forms)</td>
<td>236,964 Controls 191 ASD 2462 ID</td>
<td>Mothers with any form of diabetes present in pregnancy had an increased risk of having a child with ASD.</td>
</tr>
<tr>
<td>Lyall, et al. (2011)</td>
<td>Maternal hormonal levels</td>
<td>61,596 Controls 734 ASD</td>
<td>Menarche &lt;11, BMI greater than ≥30 at 18 were significantly associated with increased ASD risk.</td>
</tr>
</tbody>
</table>


Discussion

In summary, there is a great deal of work to be done in replicating, extending and validating potential risk factors for ASD. Clarification of the way by which environmental risks and genetic variants interact to influence ASD in offspring is an important next step for risk research (Guinchat et al., 2012).

This chapter reports on an updated sample of maternal health based, environmental risk factor research, which relate to the increasing ASD incidence rates, including and extending beyond the meta-analysis by Gardner et al., (2009). Findings from this literature review suggest similar risk identification namely, maternal general health history, maternal mental health, stress in pregnancy, medication use in pregnancy, infections and sickness during pregnancy, and bleeding during pregnancy as risk factors for offspring development of ASD.

Importantly, this review highlights critically modifiable health considerations as being emerging risks for ASD, namely the areas of weight and weight mediated risk factors. Specifically, research has begun evaluating pre-pregnancy OB, excessive gestational weight gain (EGWG), DM and HY in relation to ASD risk. Preliminary findings throughout the database suggest a need for replication and extension (Bilder et al., 2013) while reporting a continuously increasing prevalence in these conditions among women of child-bearing age, paralleled with increasing ASD incidence.

It is particularly noted that OB and EGWG should be examined further in regard to risk of ASD in offspring, as each have been found to be independent risk factors, the risk increases when they are combined, they are commonly co-occurring, OB and EGWG are mediating factors to other risks (i.e. GDM) and are highly controllable (Bilder et al., 2013; Gardner et al., 2015). Additionally, OB and EGWG should be independently evaluated for their role in the development of GDM, as the implications
of weight with respect to ASD risk associated with GDM is under-researched and unclear.

As research surrounding the etiology of ASD continues to grow, it becomes increasingly important to expand the identification of risk factors. The identification of risks, some of which may be preventable, has the potential to alter the trend in ASD diagnosis and treatment (Klug et al, 2003). Although research has determined a number of risks, clarification of the relationship between risks, genetic variants and the development of ASD is lacking, suggesting a need for further research (Guinchat et al., 2012).

To date, the body of data evaluating ASD risks has largely been confined to specific countries, despite it being reported that comparing prevalence across countries and identifying how community exposures to environmental conditions affect the risk of ASD are some of the most important variables in identifying risks (Rosanoff, 2014). At present, the majority of environmental risk factor research and prevalence data comes from a small set of countries and regions which have access to public health registries, allowing for substantial data sets. While the population cohorts are robust and the methodologies are rigorous, a limitation remains in the lack of geographical variation within the research pool. This highlights the need for research to be conducted in additional and varied regions, as the development of universally relevant risk factors may further advance the diagnosis and treatment of ASD.
Chapter 2

Maternal Diabetes, Hypertension/Preeclampsia and Obesity in Pregnancy and the Risk of Autism Spectrum Disorder in Offspring
Study 1: Maternal Diabetes and Hypertension/Preeclampsia in Pregnancy and the Risk of Autism Spectrum Disorder in Offspring

Justification for Study

As established in Chapter 1, weight mediated conditions in pregnancy are a developing avenue in the identification of risk factors for ASD and in understanding the etiology of the disorder. Chapter 1 highlighted DM, HT/PE and OB as having an emerging body of evidence to suggest increased risk of offspring ASD when these conditions were present within pregnancy, and outlined the need for further research (Brahm, et al., 2018a, in press; Koivusalo et al., 2016; Magee, Abalos, von Dadelszen, Sibai, Easterling & Walkinshaw, 2011). Specifically, Chapter 1 discussed DM, HY and OB needing further investigation before these conditions can be validated as risks for ASD, and presented the need for risk factor research to be conducted within novel and extended populations.

Chapter 2 will add to this literature base by investigating maternal DM, HY/PE, and/or OW in pregnancy as risk factors for ASD. Additionally, as risk factor research has not been conducted in the country of Ireland, this study aims to increase the understanding of risk factors among novel populations and to extend the current body of risk literature regarding maternal weight mediated conditions.

Diabetes Mellitus

DM is a chronic disorder where individuals have problems metabolising carbohydrates, fats and proteins due to a deficit of insulin secretion and/or action (Alberti & Zimmet, 1998). DM emerges when an individual’s blood sugar, or blood glucose, is higher than optimal (CDC, 2014). Insulin, a hormone produced in the pancreas, aids in the energy from glucose being transferred from food, into blood glucose to be used by the body (CDC, 2014). Individuals with DM body may not make
enough insulin, may not make insulin at all, or may not use insulin efficiently (CDC, 2014).

DM is one of the most universally common diseases and is significantly increasing in prevalence (Shaw, Sicree & Zimmet, 2010). In 2010, DM was estimated to impact 6.4% of adults, globally (Shaw, Sicree & Zimmet, 2010). It is estimated that by 2030, DM will impact 7.7% of adults (Shaw, Sicree & Zimmet, 2010). DM can lead to a number of further medical complications including blindness, renal failure, foot ulcers/amputation, joint problems, sexual dysfunction, cardiovascular disease and if left untreated can be fatal (Alberti & Zimmet, 1998). Additionally, pregnancies complicated by DM have increased risk of preeclampsia (high blood pressure), macrosomia (significantly larger than average birth weight), shoulder dystocia (obstructed delivery and/or failure to deliver shoulders), intrauterine foetal demise (stillbirth), foetal growth restriction, cardiac malformations, renal malformations and preterm delivery (McIntyre, Thomas, Wong, Idris & Callaway, 2009; Vargas, Repke & Ural, 2010). While there is no ‘cure’ for DM, there are many identified steps for successful management and possible prevention of certain types of DM and related complications (CDC, 2014).

**Types of Diabetes Mellitus**

There are three categories which DM is subdivided into, namely (a) insulin requiring for survival, (b) insulin requiring for control of disease and (c) diabetes but no insulin required to control disease (Alberti & Zimmet, 1998). These sub-divisions correspond with the most commonly referred diagnostics labels of T1DM and T2DM (Alberti & Zimmet, 1998).

**Type 1 Diabetes Mellitus.** T1DM, insulin required for survival DM, is characterized by an autoimmune process which causes the destruction of the cells the
pancreas produces to make insulin (CDC, 2014; Alberti & Zimmet, 1998). It has been hypothesized that T1DM is caused by both genetics and/or environmental influences, like certain viruses which lead to the disease becoming active (CDC, 2014). While T1DM is a significant health concern, only 5% of individuals with DM have T1DM (American Diabetes Association, 2017).

**Type 2 Diabetes Mellitus.** T2DM is the most common type of DM and develops through a number of risk factors working in conjunction (CDC, 2014). Risk factors are grouped as non-modifiable like genes, age and ethnicity as well as modifiable, such as weight, physical activity and eating patterns (CDC, 2014). The risk of developing T2DM can be lessened by increasing physical activity, decreasing calorie consumption and losing weight (Diabetes Prevention Program, 2015). Additionally, women who have had GDM are at an increased risk for developing T2DM later in life, which underscores the prevention of GDM as critical (Diabetes Prevention Program, 2015).

**Gestational Diabetes Mellitus.** GDM refers to glucose tolerance impairments with first onset, or which is first detected, during pregnancy (Ehrlich et al., 2016; Kerner & Brückel, 2014). Within GDM, expectant women’s bodies are unable to create enough insulin to control blood glucose levels (CDC, 2014). GDM significantly increases the chances for additional pregnancy complications such as cesarean delivery, neonatal hypoglycemia, infant macrosomia, offspring development of DM later in life, and a significantly higher risk of the mother developing T2DM within 5-10 years postpartum (DeSisto, Kim & Sharma, 2014).

GDM has been shown to be the most prevalent chronic medical condition among pregnant women, with as many as 9.2% American pregnancies and 2-18% of
pregnancies globally, impacted by GDM (DeSisto, Kim & Sharma, 2014; Koivusalo et al., 2016; Rosenberg, Garbers, Lipkind & Chiasson, 2005).

Risk factors for the development of GDM include being OW or OB pre-pregnancy, EGWG, previous GDM pregnancies, family history of T2DM, having higher than normal blood glucose rates pre-pregnancy (prediabetes), ethnicity and having polycystic ovary syndrome (CDC, 2014). GDM and OB are well known to be associated and research has suggested that 50% of the cases of GDM could be prevented if OW and OB were diminished prior to women becoming pregnant (Torloni et al., 2009; Kim et al., 2012).

**Hypertension**

In addition to diabetes impacting high rates of pregnancies, medical literature suggests that as many as 7-9% of UK pregnancies are complicated by HT (Magee, Abalos, von Dadelszen, Sibai, Easterling & Walkinshaw, 2011) and many of those pregnancies are complicated by the more serious pre-eclampsia (PE). GH and PE are new onset disorders occurring specifically in pregnancy, after mid-gestation (Mannisto et al., 2014). The risk of developing PE and GH increases with maternal age, OB, and other metabolic syndromes (Bramham, Parnell, Nelson-Piercy, Seed, Poston & Chappell, 2014).

GH is defined as diastolic blood pressure (dBP) $\geq 90$ mmHg and/or systolic BP (sBP) of $\geq 140$ mmHg. PE is seen when HT is caused by pregnancy and occurs after 20 weeks’ gestation. In addition, HT is classified as severe (BP of $\geq 160$-$170/110$ mmHg) or non-severe (BP of 140-159/109 mmHg; Magee, et al., 2011).

It has been found that sustained, severe GH is a significant risk for maternal and fetal complications such as maternal and perinatal mortality, increased morbidity post-pregnancy, stroke, pulmonary edema, preterm delivery, fetal death and results in
required medicinal treatment where severe HT is present (Magee et al., 2011).

**Relationship of DM and HT/PE to ASD**

As rates of both GDM and HT rise it becomes increasingly important to understand the role these conditions play in child development. Research has established the nutritional states of the mother during pregnancy as being one of the most significant impacts and predictors for sub-optimal maternal and child outcomes and suggest that the mothers nutritional state is a critical component in the development of these conditions (Xiang et al., 2015).

Studies have evaluated T1DM, T2DM and GDM as potential risk factors for ASD, but have yielded varied results (Brahm, et al., 2018a, in press). Results have suggested that GDM has the most stable reporting of increased risk and that results for T1DM and T2DM are more variable (Brahm, et al., 2018a, in press). Furthermore, there is emerging evidence to suggest that the gestational age of intrauterine exposure to hyperglycaemic conditions, could play a role in the risk of ASD development (Xiang et al., 2015). Therefore, HT and PE have been identified as a risk factor for ASD in some previous research but require further investigation (Brahm, et al., 2018a, in press).

**Obesity**

OB is a disease where excess body fat accumulates in the body, to an extent that health is adversely affected (WHO, 1998). OB develops when there is a disproportionate intake and expulsion of energy. Or, OB occurs when there is higher energy consumed than energy expelled through activity (WHO, 1998).

**Obesity Classification**

Body Mass Index (BMI) is the most standardly used measure for the classification of weight categories, universally (WHO, 2016). BMI is defined as a person’s weight in kilograms divided by the square of their height in meters (kg/m²).
BMI is said to provide the most useful population-level measure of OW and OB, yet it should be considered as a guide as it might not correspond to the same degree of OB in different people (WHO, 2016). Table 5 displays BMI classifications as recommended by the WHO.

Table 5: 
*World Health Organization’s BMI classification cut off scores.*

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principal cut-off points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.49</td>
</tr>
<tr>
<td>Normal range</td>
<td>18.50 - 24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.00 - 29.99</td>
</tr>
<tr>
<td>Obese class I</td>
<td>30.00 - 34.99</td>
</tr>
<tr>
<td>Obese class II</td>
<td>35.00 - 39.99</td>
</tr>
<tr>
<td>Obese class III</td>
<td>≥40.00</td>
</tr>
</tbody>
</table>

**Obesity Prevalence**

OB has become a serious global health threat, reaching epidemic proportions (WHO, 2014). The WHO reports that between 1980 and 2014, the worldwide rates of OB more than doubled. In 2014, more than 1.9 billion individuals over the age of 18, 39% of the world population, were OW and an additional 600 million, 13% of the world’s population, were OB (WHO, 2016). Furthermore, 41 million children under the age of 5 were either OW or OB, globally. Because of these universally increasing prevalence rates, the WHO has designated OB as one of the most critical health threats of our time.

**Obesity in Ireland**
OB and OW has become a growing epidemic in Ireland specifically (Boylan, McNulty, Walton, Flynn, Nugent, & Gibney, 2014). Between 1990 and 2011 the rates of OB, rose from 11% to 23% of the Irish population (Boylan et al., 2014). At present, 60% of Irish adults are OW or OB, with the trends in OB increasing (Dee et al., 2015). The most significant and concerning increase in OB prevalence is among women of child-bearing age (18-35), where 54% of women now show an increased risk of cardiovascular disease due to weight (Boylan et al., 2014).

**Obesity in Pregnancy**

**Pre-pregnancy Obesity.** A large component of the increase in OB globally, is the rise of OB in women of child-bearing age (ACOG, 2013). Research has shown that OB is the most common medical complication in women of child-bearing age (Caralano & Shankar, 2017). Data from the United States show more than 30% of women of child-bearing age are OB, more than 20% of pregnant women are OB and 8% of women of child bearding age are classified as extremely OB (ACOG, 2013) with rates continuing to rise.

**Maternal Complications.** OB at the time of pregnancy and conception increases the risk for complications and has been said to cause detrimental health effects for mother and baby (Sarwer, Allison, Gibbons, Markowitz, & Nelson, 2006; ACOG, 2013). The risks of developing complications such as GDM, PE/HT, toxemia, urinary infections spontaneous abortion, venous thromboembolism, labor induction, premature delivery and emergency C-section delivery are all significantly higher in women of OW and OB BMI classifications as compared to those of normal BMI (Kristensen, Vestergaard, Wisborg, Kesmodel, & Secher, 2005; Sarwer, Allison, Gibbons, Markowitz, & Nelson, 2006; ACOG, 2013).
**Child Outcomes.** Furthermore, the effects of maternal OB on fetal development has significant negative effects as well. Sub-optimal outcomes such as a more than doubled risk of neonatal death and stillbirth, neural tube defects, abdominal wall defects, heart defects, multiple congenital anomaly syndromes, orofacial clefts, hydrocephaly, anal atresia, hypospadias, cystic kidney, pes equinovarus, omphalocele and diaphragmatic hernia (Blomberg & Kallen, 2010; Kristensen et al. 2005; Watkins, Rasmussen, Honein, Botto & Moore, 2003), premature birth, stillbirth, congenital abnormalities, macrosomia, as well as a higher chance of T2DM and child and adolescence OB later in life, are all more prevalent in children of OW/OB mothers, as compared to their normal weight peers (ACOG, 2013).

**Excessive Gestational Weight Gain (EGWG)**

Gestational weight gain above the recommended limits have been shown to increase fetal complications beyond those associated with pre-pregnancy OB and lead to an increase in further weight retention after pregnancy (Guelinckx, Devlieger, Beckers & Vansant, 2008; Polly, Wing & Sims, 2002; Vesco et al., 2009). Increased weight has also been associated with greater risks of mothers developing additional metabolic conditions during pregnancy, particularly, GDM diabetes and PE (Vesco et al., 2014).

In 1990 the Institute of Medicine created initial guidelines for prenatal weight gain as a means to encourage appropriate maternal gestational weight gain and decrease sub-optimal outcomes (Committee on Nutritional Status During Pregnancy and Lactation, 1990). In 2009, the guidelines were updates and now specify a total pregnancy weight gain of 5-9 kg in women of obese BMI classification (Weight Gain During Pregnancy, 2009).
Table 6. *WHO’s Gestational Weight Gain Recommendations in pounds according to BMI classification, per trimester.*

<table>
<thead>
<tr>
<th>Pre-pregnancy BMI Category</th>
<th>Body Mass Index</th>
<th>Recommended Range of Total Weight Gain (Lbs.)</th>
<th>Recommended Rates of Weight Gain in Second and Third Trimesters (Mean Range p/week, Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Less than 18.5</td>
<td>28–40</td>
<td>1 (1–1.3)</td>
</tr>
<tr>
<td>Normal Weight</td>
<td>18.5–24.9</td>
<td>25–35</td>
<td>1 (0.8–1)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25–29.9</td>
<td>15–25</td>
<td>0.6 (0.5–0.7)</td>
</tr>
<tr>
<td>Obese (includes all classes)</td>
<td>30 and greater</td>
<td>11–20</td>
<td>0.5 (0.4–0.6)</td>
</tr>
</tbody>
</table>

Although these guidelines have been adopted in many areas, they have not been universally recognized (Muktabhant et al., 2012), even though research shows an adherence to the guidelines is associated with optimal maternal and child outcomes (Abrams, 2000). Studies from both the United States and Europe suggest that 20%-40% of women are gaining more than the recommendations per their BMI classification and that the numbers continue to grow (Thangaratinamet al., 2012; Cedergren 2006; IMO, 2009).

Excessive gestational weight gain has been associated with adverse infant outcomes such as a low five-minute Apgar score, seizures, hypoglycemia (low blood sugar), polycythemia (high red blood cell count), meconium aspiration syndrome (fecal matter in lungs), forced C-section and large-for-gestational age when compared to women who remain in their recommended weight gain guidelines (Hedderson 2006; Stotland 2006) and children of mothers who exceeded WHO recommendations are more likely to be large for gestational age and OB by 3 years of age (Olson,
Strawserman & Dennison, 2009). Importantly, research has shown that increased BMI and EGWG lead to a long-term increased risk of disease and complications later in life for both mother and child, suggesting a transmission of conditions from mothers to their infants during pregnancy (Shaikh, Robinson & Teoh, 2010; Sen et al., 2010; Yu et al., 2011). Conversely, it has been shown that among OB women, low-gestational weight gain has decreased the risk of several undesirable outcomes including PE, caesarean section, instrumental delivery, and large-for-gestational-age births (Cedergren 2006). However, successful interventions are lacking yet needed to alter weight behaviors pre-pregnancy to decrease this global problem (Brahm et al., 2018a in press).

**Maternal Conditions, Autism Spectrum Disorder and Other Special Needs**

Chapter 1 clearly outlined the emerging evidence establishing maternal weight as a key variable in the risk for ASD (Brahm et al., 2018a, in press). Importantly, pre-pregnancy weight and EGWG has been suggested as the mediating factor among several potential ASD risk factors, such as DM and PE (Brahm et al., 2018a, in press). Therefore, controlling OB pre-pregnancy and limiting weight gain within pregnancy, could provide avenues in the prevention of additional risks.

**Childhood Cognitive Outcomes**

The effects of maternal OB with respect to childhood cognitive and developmental outcomes are a new area of study as well. Maternal OB in pregnancy has been found to be associated with impaired brain development in offspring, decreased executive functioning and lower intelligence levels (Pugh et al., 2015). Findings of previous research suggest that maternal pre-pregnancy OB has a more significant effect on offspring neural development than gestational weight gain alone (Pugh et al., 2015; Razaz et al., 2017). This also provides an important health strategy
in potentially preventing the development of these complications and disorders, yet require significant additional research (Pugh et al., 2015; Razaz et al., 2017).

As stated in Chapter 1, as rates of OB and ASD continue to rise, research has begun to focus on pregnancy complications influenced by weight and their effect on offspring ASD. Yet, research on OB and its risk in ASD development is still emerging and has been defined as one of the crucial areas for research and intervention (Artal, Lockwood & Brown, 2010; Brahm et al., 2018a, in press).

**Atlantic Diabetes in Pregnancy**

The Atlantic Diabetes in Pregnancy (DIP) study (Dennedy & Dunne, 2010) was a five-year study conducted in Ireland, which established a research network between hospitals with maternity facilities along the Irish seaboard. The study examined pregnancy outcomes of 5,670 women screened for GDM, HT and OB. Of the women screened, 2,433 developed the conditions of interest during their pregnancies. Researchers found less optimal offspring outcomes, such as congenital malformations and offspring being large for gestational age, for those children whose mothers presented with gestational metabolic conditions. Participants in this study were recruited through the Atlantic DIP database (see Methods).

**Current Study**

This study evaluated the risk of a child being diagnosed with an ASD when there is a presence of DM, HY/PE and/or OB during pregnancy, as compared to offspring of mothers with none of the conditions of interest. This study identified participants from the Atlantic DIP study whose offspring were diagnosed with ASD by an independent diagnostician and validated their diagnosis using the Social Communication Questionnaire (SCQ). Additionally, this study screened all participants for potential markers of ASD using the SCQ to identify children at risk for ASD but not
diagnosed. This study was the first large-scale population-based epidemiologic investigation into maternal health factors and their relationship to offspring development conducted in Ireland.

**Methods**

**Participants**

Participants were mothers ($N=447$) of children born between the years of 2005-2010 who participated in the Atlantic DIP study. Mean maternal age at child birth was 33.6 ($SD=\pm 5.0$) ranging from 17.7 to 47.7 years. 57.5% ($n=242$) of offspring were male and 42.5% ($n=205$) percent were female. Six percent ($n=27$) of all respondents’ offspring had an ASD diagnosis, given outside of the study team.

**Measures**

**Self-Designed Data Collection Survey**

A self-constructed, 5-part questionnaire (see Appendix A) provided information on the previously identified risk factors for ASD outlined in Chapter 1.

Section 1 contained demographic questions relating to marital status, household size, income, race/ethnicity and country of birth. Questions were adapted from the Irish National Census, 2016.

Section 2 asked about factors occurring within pregnancy, specifically first week of antenatal care, infections/sickness/health conditions during pregnancy, vitamin intake, smoking, drinking or illicit drug use in pregnancy, medication use during pregnancy, employment status and type during pregnancy.

Section 3 evaluated the presence of both maternal and paternal mental health and general health factors. Questions were asked regarding parental age at offspring birth, presence of or history of a diagnosed mental health concern, the presence of
general health complications such as autoimmune diseases or cancer, and genetic abnormalities such as Fragile X Syndrome.

Section 4 provided information on the presence or absence of an ASD diagnosis in relation the child being reported on. Questions were also asked with regard to any other diagnosis the child might have as well as diagnosis of ASD or other disabilities in offspring not followed by the Atlantic DIP study.

**Social Communication Questionnaire.** Section 5, the SCQ (formerly the Autism Screening Questionnaire) screening measure, was used to identify children who may show some indication of a developmental delay and thus would befit from additional assessment for ASD (Lee, David, Rusyniak, Landa & Newschaffer, 2007). There are two versions of the SCQ namely, the current form for use before age 4, and the lifetime form. As participants were children were born from 2005-2010, it was appropriate to administer the lifetime version.

The tool consists of 40 yes or no questions and takes between 5 and 10 minutes to complete. The screening tool was validated using a sample of 200 children, ages 4 and above with a variety of developmental disabilities including ASD. The tool discriminates between likely ASD and non-ASD outcomes using a 15-point cut off score with sensitivity=0.85 (true positive screens) and specificity=0.75 (true negative screens; Berument, Rutter, Lord, Pickles & Bailey, 1999).

**Diamond Data Base System**

The Diamond Data Base of pregnancy health information is an electronic record system used in the Atlantic DIP study to record and track women’s health information as it relates to pregnancy. Doctors enter health information during and after women’s antenatal appointments and data is kept in an electronic form for post review. The Diamond Data base provided information on pregnancy characteristics, birth
characteristics, and postpartum period information. Data was extracted from the
Diamond Database for all respondents with regards to:

1. Pre-pregnancy weight, defined as a valid (i.e. Doctor’s recorded weight) within
   the 3 months prior to pregnancy or no greater than 8-week gestation.
2. Presence of DM in pregnancy
3. Type of DM and date of diagnosis
4. Use of insulin during pregnancy
5. Presence of HT or PE in pregnancy
6. Fertility treatments leading to current pregnancy
7. Gravida
8. Previous Miscarriages
9. Multiple birth outcome of current pregnancy
10. Week gestation at delivery
11. Type of delivery
   a. Reason for cesarean delivery, if applicable (i.e. emergency or elective).
12. Type of baby feeding

**Participant Recruitment**

Participants were recruited through the Atlantic DIP study database. This study
was approved by the University College Hospital, Galway’s Ethics Review Committee
in September, 2014 and informed consent was obtained from all participants prior to
being accepted into the study’s cohort.

Participants where DM was present in pregnancy were contacted via post mail
with a recruitment package consisting of a letter of invitation, participant information
sheet, consent form and survey to complete. If no packet was returned within 2-4
weeks of initial contact, women were then contacted via phone to inquire on interest in participation and to answer any questions that they had.

Due to post mail communication difficulties, non-DM participants were contacted via phone call and introduced to the study, then invited to take part. Interested participants were sent the same recruitment packet as the DM, via post mail or email. If the survey was not returned within four weeks, participants were contacted again by the studies researcher in the same manner as the DM group.

**Data Coding and Stratification**

Returned survey responses were entered into the Statistical Package for Social Sciences (SPSS, 23.0). Continuous variables were re-coded during data entry, into categorical values for the purpose of analysis. Pre-pregnancy BMI was coded using the WHO, Institute of Medicine (WHO-IOM) guidelines for BMI calculation of weight in kilograms divided by the square of their height in meters (kg/m$^2$): Table 7. The number resulting from the equation was then translated into BMI classification as recommended by the WHO (Table 7). OB was categorized into three different classes; (a) class I (BMI of 30–34.9), (b) class II (BMI of 35–39.9), and (c) class III (BMI of 40 or greater). For example, a woman weighing 150 pounds and 5’6” tall would equate to; 150 lbs. x 703/66 = BMI 24.21, normal. SCQ’s were also scored, according to the measure’s manual and numerical outcomes were entered into SPSS.

**Table 7. BMI Classifications Adapted from WHO 2004.**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principal cut-off points</th>
<th>Additional cut-off points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.50</td>
<td>&lt;18.50</td>
</tr>
<tr>
<td>Severe thinness</td>
<td>&lt;16.00</td>
<td>&lt;16.00</td>
</tr>
<tr>
<td>Moderate thinness</td>
<td>16.00 - 16.99</td>
<td>16.00 - 16.99</td>
</tr>
<tr>
<td>Mild thinness</td>
<td>17.00 - 18.49</td>
<td>17.00 - 18.49</td>
</tr>
</tbody>
</table>
Normal range 18.50 - 24.99 18.50 - 22.99
Overweight ≥25.00 ≥25.00
Pre-obese 25.00 - 29.99 25.00 - 27.49
Obese ≥30.00 ≥30.00
Obese class I 30.00 - 34.99 30.00 - 32.49
Obese class II 35.00 - 39.99 35.00 - 37.49
Obese class III ≥40.00 ≥40.00

**Study Sample**

Initial recruitment consisted of \(N=3,538\) individual women, both with and without the condition of interest who completed participation in the Atlantic DIP Study. Of those, \(N=3538\) surveys, 339 (32%) of DM and 1,239 (51%) of non-DM were returned to the study center as undeliverable and/or were un-contactable via phone call attempts, resulting in \(N=447\) (23%) contacted successfully and returned completed surveys, with consent. Conditions of interest and data stratification for analysis among respondents are shown in Figure 1.

Figure 1. *Recruitments Response Rates and Stratification for Analysis*
Study Variables

*Independent Variables (IV)*-

Initial analysis reviewed pre-and-perinatal conditions present surrounding pregnancy and delivery which were established in Chapter 1 of this thesis as IVs.

- Maternal and paternal age
- Amount of schooling
- Maternal and paternal race
- Maternal and paternal country of birth
- Household income and size
- Marital status
- Employment status and type
- Vitamin use during pregnancy
- Medication use and type during pregnancy
- Smoking, drinking and/or illicit drug use in pregnancy
- Health conditions in pregnancy other than DM/HT
- Pre-pregnancy weight
- Presence of DM in pregnancy, type of DM and date of diagnosis
- Use of insulin during pregnancy
- Presence of HT or PE in pregnancy
- Fertility treatments leading to current pregnancy
- Parity, gravida, and/or previous miscarriages
- Multiple birth outcome of current pregnancy
- Week gestation at delivery
- Type of delivery, reason for cesarean delivery if applicable
- Type of baby feeding
- Child gender
- APGAR 1 and 5 minute score
- Birth weight
- Head circumference at birth
- SCQ score
- Sibling presence of ASD or other special need

IVs included in the regression analysis were identified through the Chi-Square test (explained below) and included the maternal metabolic conditions impacting pregnancy above. Only significantly associated IVs from Chi-square test of association were then included into the regression analysis (explained below).
Dependent Variable (DV)-

The dichotomous DV in this study was the presence or absence of ASD in offspring.

Analysis

General descriptive results provided prevalence of ASD diagnosis among offspring as well as presence information about maternal DM, HY, OW and OB among questionnaire respondents. A Chi-Square test for associations was used to determine associations between IV’s and ASD in offspring. IV’s which were significantly associated with ASD were then used as the predictors for a binominal logistic regression.

Binominal logistic regression was used to predict the probability that the dichotomous DV (ASD yes, no) will fall into one of two categories when given one or more IV. Binominal logistic regression was employed to analyze DM, HY, OW and OB as risk factors for offspring ASD diagnosis. Binomial logistic regressions operate on seven assumptions for which these data were tested to fit (Box & Tidwell, 1962).

General Descriptive Results and Chi-Square Analysis of Variables Associated with Autism Spectrum Disorders

Table 8 shows the general descriptive statistics results of ASD prevalence rates across all respondents, as well as subset prevalence rates within each DM population (T1DM, T2DM, GDM) and each BMI classification (underweight, normal, OW, OB). 11.9% of DM and 2.8% of non-DM offspring were reported as having a diagnosis of ASD and were confirmed through the SCQ. HY and PE did not occur at a high enough rate in this data set to be assessed. Therefore, it has been determined that HY and PE were not risks for ASD within this data set. Offspring ASD prevalence rates among normal weight mothers was 1.8% and 8.6% among women of OW/OB BMI categories.
Table 9 represents the cross-tabulation outcomes of each DM category and the number and percent of individuals within each BMI category per-DM type.

Table 8.
*ASD diagnosis according to BMI and DM type.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>ASD</th>
<th>No ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Full cohort</td>
<td>27 (6%)</td>
<td>420 (94%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BMI Code</th>
<th>ASD</th>
<th>No ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Underweight</td>
<td>1 (0.2%)</td>
<td>7 (1.6%)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>2 (0.4%)</td>
<td>159 (35.6%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>13 (2.9%)</td>
<td>148 (33.1%)</td>
</tr>
<tr>
<td>Obese 1</td>
<td>7 (1.6%)</td>
<td>56 (12.5%)</td>
</tr>
<tr>
<td>Obese 2</td>
<td>3 (0.7%)</td>
<td>31 (6.9%)</td>
</tr>
<tr>
<td>Obese 3</td>
<td>1 (0.2%)</td>
<td>19 (4.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diabetes</th>
<th>ASD</th>
<th>No ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>None</td>
<td>8 (1.8%)</td>
<td>280 (62.8%)</td>
</tr>
<tr>
<td>T1DM</td>
<td>2 (0.4%)</td>
<td>20 (4.5%)</td>
</tr>
<tr>
<td>T2DM</td>
<td>2 (0.4%)</td>
<td>4 (0.9%)</td>
</tr>
<tr>
<td>GDM</td>
<td>10 (2.2%)</td>
<td>81 (18.2%)</td>
</tr>
<tr>
<td>Impaired glucose tolerance</td>
<td>5 (1.1%)</td>
<td>35 (7.8%)</td>
</tr>
</tbody>
</table>

Table 9.
*Cross-tabulation of DM category, BMI and ASD.*

<table>
<thead>
<tr>
<th>BMI Code</th>
<th>T1DM</th>
<th>T2DM</th>
<th>GDM</th>
<th>IGT</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Under total</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>8 (1.8%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>Normal total</td>
<td>8 (1.7%)</td>
<td>0 (0%)</td>
<td>21 (4.7%)</td>
<td>12 (2.6%)</td>
<td>120 (26.9%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (0.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>OW total</td>
<td>8 (1.7%)</td>
<td>0 (0%)</td>
<td>31 (7%)</td>
<td>8 (1.7%)</td>
<td>112 (25.5%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>2 (0.4%)</td>
<td>0 (0%)</td>
<td>5 (1%)</td>
<td>3 (0.6%)</td>
<td>3 (0.6%)</td>
</tr>
<tr>
<td>OBI total</td>
<td>10 (2.2%)</td>
<td>1 (0.2%)</td>
<td>18 (4%)</td>
<td>12 (2.6%)</td>
<td>28 (6%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>0 (0%)</td>
<td>2 (0.4%)</td>
<td>1 (0.2%)</td>
<td>1 (0.2%)</td>
<td>3 (0.6%)</td>
</tr>
<tr>
<td>OBII</td>
<td>3 (0.6%)</td>
<td>4 (0.9%)</td>
<td>12 (2.6%)</td>
<td>5 (1%)</td>
<td>12 (2.6%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (0.4%)</td>
<td>0 (0%)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>OBIII</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>9 (2%)</td>
<td>3 (0.6%)</td>
<td>7 (1.5%)</td>
</tr>
<tr>
<td>With ASD</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (0.2%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
Table 10 and 11 summarize the maternal, paternal, and household demographic characteristics for all group as well as results of cross tabulation with a chi-square test of association for variables associated with ASD. No variable was significantly associated with ASD. Mothers of children with ASD were slightly younger in this cohort as compared to mothers with neurotypical children ($M=33.5$, $SD=5.19$, $M=33.2$, $SD=5.02$). Fathers of neurotypical children were slightly higher than those with ASD, $M (37.49)$ $SD (6.82)$ as compared to $M (33.2)$ $SD (6.53)$. Fathers of children with ASD were more likely to be White/Irish as compared to any other race or ethnicity. The household income of children with ASD diagnoses was slightly less than those of neurotypical children ($M=€27,000$, $M=€40,000$). While there were slight difference between groups, a Chi-square cross tabulation tests of association found no demographic variable to be significantly associated with a diagnosis of ASD in offspring.

Table 10.
Mother’s and Household Demographic at Time of Pregnancy and Association with ASD.

<table>
<thead>
<tr>
<th>Variables</th>
<th>ASD</th>
<th>Non-ASD</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>$\chi^2$ p</td>
</tr>
<tr>
<td>Age</td>
<td>$M (33.2)$ $SD (5.02)$</td>
<td>$M (33.5)$ $SD (5.19)$</td>
<td>.998</td>
</tr>
<tr>
<td>Household size</td>
<td>$M (4.5)$ $SD (1.1)$</td>
<td>$M (4.5)$ $SD (1.12)$</td>
<td>.656</td>
</tr>
<tr>
<td>Household Income</td>
<td>$M (€27,000)$ $SD$ ($€13,000$)</td>
<td>$M (€40,000)$ $SD$ ($€10,000$)</td>
<td>.970</td>
</tr>
<tr>
<td>Education Level</td>
<td></td>
<td></td>
<td>.583</td>
</tr>
<tr>
<td>Primary</td>
<td>0 (0%)</td>
<td>4 (1%)</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>7 (25.9%)</td>
<td>87 (20.7%)</td>
<td></td>
</tr>
<tr>
<td>Third level</td>
<td>20 (74.1%)</td>
<td>329 (78.3%)</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td>.371</td>
</tr>
<tr>
<td>Single</td>
<td>1 (3.7%)</td>
<td>20 (4.8%)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>21 (77.8%)</td>
<td>354 (84.3%)</td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>2 (7.4%)</td>
<td>16 (3.8%)</td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>0 (0%)</td>
<td>3 (.7%)</td>
<td></td>
</tr>
<tr>
<td>Partnership</td>
<td>2 (7.4%)</td>
<td>26 (6.2%)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (3.7%)</td>
<td>1 (.2%)</td>
<td></td>
</tr>
<tr>
<td>Employment Status</td>
<td></td>
<td></td>
<td>.612</td>
</tr>
</tbody>
</table>
Table 11. *p<.05 **p<.01

**Paternal Demographics at Time of Pregnancy**

<table>
<thead>
<tr>
<th>Variables</th>
<th>ASD n (%)</th>
<th>Non-ASD n (%)</th>
<th>Chi-square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>M (33.2) SD (6.53)</td>
<td>M (37.49) SD (6.82)</td>
<td>0.117</td>
<td></td>
</tr>
<tr>
<td>Paternal Race</td>
<td></td>
<td></td>
<td>.665</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>0 (0%)</td>
<td>9 (2.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0 (0%)</td>
<td>4 (1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irish</td>
<td>24 (88.9%)</td>
<td>368 (87.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irish Traveler</td>
<td>0 (0%)</td>
<td>3 (0.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other White</td>
<td>2 (7.4%)</td>
<td>29 (6.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
<td>1 (0.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paternal Country of Birth</td>
<td></td>
<td></td>
<td>.895</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>21 (77.8%)</td>
<td>348 (82.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>3 (11.1%)</td>
<td>39 (9.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (7.4%)</td>
<td>26 (6.2%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12 summarizes the conditions surrounding pregnancy, including the conditions prior to pregnancy for all participants, with significantly correlated outcomes from a cross tabulation with chi-square test for associations identified. Variables found to be statistically significantly associated with a diagnosis of ASD among all mothers included: any sickness or infection during pregnancy \(\chi^2(1) = 4.066, p = .044\), the presence of DM in pregnancy, \(\chi^2(1) = 15.185, p = .001\), pre-pregnancy weight \(\chi^2(1) = 10.566, p = .001\), and multiple birth pregnancy \(\chi^2(1) = 6.847, p = .009\).

Table 12. *p<.05 **p<.01

**Maternal Health Status and Health Conditions Surrounding Pregnancy.**
<table>
<thead>
<tr>
<th>Pregnancy Condition</th>
<th>ASD</th>
<th>Non-ASD</th>
<th>Chi-Square</th>
<th>( \chi^2 )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin use</td>
<td></td>
<td></td>
<td></td>
<td>.841</td>
<td></td>
</tr>
<tr>
<td>Prenatal Vitamins</td>
<td></td>
<td></td>
<td></td>
<td>.314</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12 (44.4%)</td>
<td>195 (46.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15 (55.6%)</td>
<td>225 (53.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folic Acid</td>
<td></td>
<td></td>
<td></td>
<td>.568</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24 (88.9%)</td>
<td>394 (93.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (11.1%)</td>
<td>26 (6.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td></td>
<td></td>
<td></td>
<td>.568</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6 (22.2%)</td>
<td>75 (17.9%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>21 (77.8%)</td>
<td>345 (82.1%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication Use</td>
<td></td>
<td></td>
<td></td>
<td>.118</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>14 (51.9%)</td>
<td>164 (39%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>13 (48.1%)</td>
<td>256 (61%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarette Smoking</td>
<td></td>
<td></td>
<td></td>
<td>.831</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2 (7.4%)</td>
<td>1 (.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>25 (92.6%)</td>
<td>419 (99.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol Consumption</td>
<td></td>
<td></td>
<td></td>
<td>.248</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3 (11.1%)</td>
<td>85 (20%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>24 (88.9%)</td>
<td>335 (80%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illicit Drugs Use</td>
<td></td>
<td></td>
<td></td>
<td>.800</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>1 (.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27 (100%)</td>
<td>287 (99.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition other than DM</td>
<td></td>
<td></td>
<td></td>
<td>.044*</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18 (66.7%)</td>
<td>196 (46.7%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>9 (33.3%)</td>
<td>224 (53.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes in Pregnancy</td>
<td></td>
<td></td>
<td></td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19 (70.4%)</td>
<td>140 (33.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>8 (29.6%)</td>
<td>280 (66.7%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin Use During Pregnancy</td>
<td></td>
<td></td>
<td></td>
<td>.085</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8 (29.6%)</td>
<td>70 (16.7%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>19 (70.4%)</td>
<td>350 (83.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight pre-pregnancy</td>
<td></td>
<td></td>
<td></td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24 (88.9%)</td>
<td>254 (60.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (11.1%)</td>
<td>166 (39.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility Treatment</td>
<td></td>
<td></td>
<td></td>
<td>.143</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31 (7.4%)</td>
<td>389 (92.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27 (100%)</td>
<td>389 (92.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnancy Number</td>
<td></td>
<td></td>
<td></td>
<td>.079</td>
<td></td>
</tr>
<tr>
<td>( M ) (3.18) ( SD ) (2.7)</td>
<td>3.61 (1.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td>.476</td>
<td></td>
</tr>
<tr>
<td>( M ) (1.11) ( SD ) (1.45)</td>
<td>1.02 (1.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravida</td>
<td></td>
<td></td>
<td></td>
<td>.86</td>
<td></td>
</tr>
<tr>
<td>( M ) (2.66) ( SD ) (2.63)</td>
<td>2.46 (1.52)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous Miscarriage</td>
<td></td>
<td></td>
<td></td>
<td>.009**</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3 (11.1%)</td>
<td>10 (2.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>24 (88.9%)</td>
<td>410 (97.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\* \( p < .05 \) \* \( ** p < .01 \)
Table 13 summarizes the outcome of pregnancy, delivery characteristics and the perinatal factors assessed. Child gender $\chi^2(1) = 7.548, p = .006$, child’s birth weight (average, large, or small for gestational age; AGA, LGA, SGA) $\chi^2(2) = 9.406, p = .009$, feeding type $\chi^2(2) = 6.426, p = .040$, were all significantly associated with child’s diagnosis of ASD.

Table 13.

**Delivery information, child outcome and child demographics.**

<table>
<thead>
<tr>
<th>Child Outcome</th>
<th>ASD (n) (%)</th>
<th>Non-ASD (n) (%)</th>
<th>Chi Square $\chi^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21 (77.8%)</td>
<td>221 (52.6%)</td>
<td>.006*</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6 (22.2%)</td>
<td>199 (47.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week Gestation at Birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (38.74) SD (3.4)</td>
<td>M (39.47) SD (1.76)</td>
<td></td>
<td>.400</td>
<td></td>
</tr>
<tr>
<td>Type of Delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaginal</td>
<td>16 (59.3%)</td>
<td>282 (67.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-section</td>
<td>11 (40.7%)</td>
<td>138 (32.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGA</td>
<td>19 (70.4%)</td>
<td>321 (76.4%)</td>
<td>.009**</td>
<td></td>
</tr>
<tr>
<td>LGA</td>
<td>3 (11.1%)</td>
<td>47 (18.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGA</td>
<td>5 (18.5%)</td>
<td>20 (4.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Circumference at Birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (34.6) SD (2.05)</td>
<td>M (34.93) SD (3.24)</td>
<td></td>
<td>.040*</td>
<td></td>
</tr>
<tr>
<td>APGAR score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 minute</td>
<td>M (8.69) SD (1.1)</td>
<td>M (8.69) SD (9.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 minutes</td>
<td>M (9.34) SD (.67)</td>
<td>M (9.51) SD (.60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeding Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottle</td>
<td>19 (70.4%)</td>
<td>193 (46%)</td>
<td>.001*</td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td>6 (22.2%)</td>
<td>139 (33%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>2 (7.4%)</td>
<td>88 (21%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASD Diagnosis</td>
<td>27 (100%)</td>
<td>0 (0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCQ Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal 0-11</td>
<td>1 (3.7%)</td>
<td>394 (93.8%)</td>
<td>.001*</td>
<td></td>
</tr>
<tr>
<td>Moderate 12-14</td>
<td>3 (11.1%)</td>
<td>20 (4.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High 15+</td>
<td>23 (85.2%)</td>
<td>6 (1.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Diagnosis</td>
<td>13 (48.1%)</td>
<td>42 (10%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Sibling ASD Diagnosis</td>
<td>11 (40.7%)</td>
<td>11 (2.6%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Sibling other diagnosis</td>
<td>8 (29.6%)</td>
<td>38 (9%)</td>
<td>.001**</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05 **p<.01

As weight was found to be a significant risk factor for ASD and a known risk factor for the development of DM in pregnancy, further investigation into OW/OB
outcomes of this data was warranted. Table 14 and 15 provide descriptive statistics and variables associated with pre-pregnancy weight above normal classifications. Table 15 summarizes the rates of BMI categorization between women of children with an ASD diagnosis, those children who have any other diagnosis requiring special education services and those whose children do not have any special needs diagnosis. Results show that mothers of children with any special need were more likely to have OW or higher BMI classification pre-pregnancy.

Table 14.
Mean BMI Classification and Child Diagnosis Outcomes

<table>
<thead>
<tr>
<th>Measures Assessed</th>
<th>ASD n (%)</th>
<th>Non-ASD n (%)</th>
<th>Any Special Need n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total BMI</td>
<td>27</td>
<td>418</td>
<td>67</td>
</tr>
<tr>
<td>Underweight</td>
<td>1 (3.7%)</td>
<td>7 (1.7%)</td>
<td>1 (1.5%)</td>
</tr>
<tr>
<td>Normal</td>
<td>2 (7.4%)</td>
<td>159 (37.9%)</td>
<td>11 (16.4%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>13 (48.1%)</td>
<td>148 (35.2%)</td>
<td>30 (44.8%)</td>
</tr>
<tr>
<td>Obese I</td>
<td>7 (25.9%)</td>
<td>56 (13.3%)</td>
<td>15 (22.4%)</td>
</tr>
<tr>
<td>Obese II</td>
<td>3 (11.1%)</td>
<td>31 (7.4%)</td>
<td>6 (9%)</td>
</tr>
<tr>
<td>Obese III</td>
<td>1 (3.7%)</td>
<td>19 (4.5%)</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>Total Overweight</td>
<td>27 (88.9%)</td>
<td>251 (60.4%)</td>
<td>55 (82.1%)</td>
</tr>
</tbody>
</table>

Table 15 results also showed that as weight increased, the frequency of above normal offspring SCQ increased, suggesting higher ASD symptomology as weight increased.

Table 15:
Offspring SCQ Category by Maternal BMI Classification

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>Normal range (0-11)</th>
<th>Moderate (12-14)</th>
<th>High Range (≥15)</th>
<th>Total 12-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under</td>
<td>7 (87.5%)</td>
<td>0</td>
<td>1 (12.5%)</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>Normal</td>
<td>150 (93.2%)</td>
<td>7 (4.3%)</td>
<td>4 (2.5%)</td>
<td>11 (6.8%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>141 (87.6%)</td>
<td>8 (5%)</td>
<td>12 (7.5%)</td>
<td>20 (12.5%)</td>
</tr>
<tr>
<td>Obese I</td>
<td>51 (81%)</td>
<td>3 (5%)</td>
<td>9 (14%)</td>
<td>12 (19%)</td>
</tr>
<tr>
<td>Obese II</td>
<td>28 (82.4%)</td>
<td>4 (11.8%)</td>
<td>2 (5.9%)</td>
<td>6 (17.7%)</td>
</tr>
<tr>
<td>Obese III</td>
<td>18 (90%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
<td>1 (10%)</td>
</tr>
</tbody>
</table>
Due to the high rate of OW/OB present in this sample and increased rates of suboptimal offspring outcomes present, a second Chi-Square test for associations was used to determine relationships between IV’s and maternal OW/OB. Variables which were significantly related to increasing maternal weight can be found in Table 16. Multiple health conditions, DM and insulin use during pregnancy all occurred at a higher rate among mothers who were OW/OB as compared to those of normal weight. Additionally, having had more than one pregnancy, delivering via cesarean, having an emergency cesarean delivery and bottle feeding were all more likely among OW/OB mothers as compared to those of normal weight. Total weight gain in pregnancy was collected for a subset of the total study population. Total weight gain exceeding WHO recommendations was also found to be more likely among OW/OB mothers.

Table 16: 
Conditions significantly associated with overweight/obesity.

<table>
<thead>
<tr>
<th>Pregnancy Condition</th>
<th>Overweight/Obese</th>
<th>Normal</th>
<th>Chi-Square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education- School</td>
<td>74 (26.6%)</td>
<td>23 (13.6%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>204 (73.4%)</td>
<td>146 (86.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>191 (68.7%)</td>
<td>138 (81.7%)</td>
<td>.002**</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>87 (31.3%)</td>
<td>31 (18.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health condition present other than</td>
<td></td>
<td></td>
<td>.000**</td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>92 (20%)</td>
<td>141 (51%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total weight gain</td>
<td></td>
<td></td>
<td>.000**</td>
<td></td>
</tr>
<tr>
<td>Over</td>
<td>42 (31.8%)</td>
<td>62 (64%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>90 (68.2%)</td>
<td>35 (36%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offspring ASD</td>
<td>24 (5.4%)</td>
<td>2 (.04%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Child’s additional diagnosis</td>
<td>45 (10.1%)</td>
<td>10 (2.2%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Child with any special need</td>
<td>224 (50.2%)</td>
<td>156 (35.0%)</td>
<td>.000**</td>
<td></td>
</tr>
<tr>
<td>Siblings ASD diagnosis</td>
<td>16 (3.6%)</td>
<td>5 (1.1%)</td>
<td>.024*</td>
<td></td>
</tr>
<tr>
<td>SCQ Category (medium/high)</td>
<td>41 (92%)</td>
<td>11 (2.5%)</td>
<td>.015*</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>119 (26.7%)</td>
<td>40 (9.0%)</td>
<td>.001**</td>
<td></td>
</tr>
<tr>
<td>Insulin during pregnancy</td>
<td>59 (13.2%)</td>
<td>19 (4.3%)</td>
<td>.008*</td>
<td></td>
</tr>
<tr>
<td>Pregnancy Number (≥1)</td>
<td>225 (68%)</td>
<td>106 (23.9%)</td>
<td>.000**</td>
<td></td>
</tr>
</tbody>
</table>
Risk of Autism Spectrum Disorder. Statistically significant chi-square variables were included into a Binomial regression analysis to determine the risk of ASD when conditions were present in pregnancy. Table 17 displays the outcomes of regression analysis to determine the risk of ASD in offspring. Results suggest four variables as being significantly associated with increased ASD risk in offspring. Specifically, offspring feeding type and child gender were each found to significantly increase the likelihood that a child would be diagnosed with an ASD, $\beta = .042$, $p<.05$ and $\beta = .032$, $p<.05$, respectively. Maternal DM in pregnancy was found to increase the risk of a child being diagnosed with an ASD 4-fold. When adjusted for the additional significantly correlated variables, DM in pregnancy remained significantly associated with an increased risk of ASD. Pre-pregnancy OW/OB was also found to be a significant risk for ASD development when additional correlated risk factors were incorporated into regression models. Maternal OB was found to increase the risk of ASD 5-fold fold, even when controlling for the influence of maternal DM.

Table 17.  
Binomial regression of correlated variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>p</th>
<th>Exp. (B)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes in Pregnancy</td>
<td>.003**</td>
<td>4.114</td>
<td>1.610</td>
<td>10.517</td>
</tr>
<tr>
<td>Pre-pregnancy Obesity</td>
<td>.031*</td>
<td>5.272</td>
<td>1.162</td>
<td>23.922</td>
</tr>
<tr>
<td>Sickness other than DM</td>
<td>.056</td>
<td>.412</td>
<td>.166</td>
<td>1.025</td>
</tr>
<tr>
<td>Multiple Birth Pregnancy</td>
<td>.260</td>
<td>2.719</td>
<td>.478</td>
<td>15.477</td>
</tr>
<tr>
<td>Child Birthweight</td>
<td>.364</td>
<td>1.374</td>
<td>.692</td>
<td>2.727</td>
</tr>
<tr>
<td>Child Gender</td>
<td>.032*</td>
<td>.316</td>
<td>.110</td>
<td>.905</td>
</tr>
<tr>
<td>Feeding Type</td>
<td>.042*</td>
<td>.506</td>
<td>.263</td>
<td>.974</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

Discussion

This study found that pre-pregnancy OB and DM are significant risk factors for offspring development of ASD. This study found that OB increases a child’s risk of
being diagnosed with an ASD 5-fold and DM increases by 4-fold. Results of this study are consistent with previous research and suggest that the risk of offspring ASD diagnoses are significantly impacted by the presence of DM and/or OB in pregnancy. Additionally, this study found that being male was significantly associated with offspring ASD diagnosis, which is in line with previous research and current prevalence rates (CDC, 2014).

Mothers of children with ASD were slightly younger in this cohort as compared to mothers with neurotypical children ($M=33.5, SD=5.19$, $M=33.2, SD=5.02$). Fathers of neurotypical children were slightly older than those with ASD, $M (37.49) SD (6.82)$ as compared to $M (33.2) SD (6.53)$. Fathers of children with ASD were more likely to be White/Irish as compared to any other race or ethnicity. The household income of children with ASD diagnoses was slightly less than those of neurotypical children $M=€27,000$, $M=€40,000$). While there were slight difference between groups, a Chi-square cross tabulation tests of association found no demographic variable to be significantly associated with a diagnosis of ASD in offspring. Results suggest three variables related to pregnancy and perinatal time periods as being significantly associated with increased ASD risk in offspring. Specifically, offspring feeding type was found to increase the likelihood that a child would be diagnosed with an ASD by half-a-fold. Maternal DM in pregnancy was found to increase the risk of a child being diagnosed with an ASD by 4-fold. When adjusted for the additional significantly correlated variables, DM in pregnancy remained significantly associated with an increased risk of ASD. Pre-pregnancy OW/OB was also found to be a significant risk for ASD development when additional correlated risk factors were incorporated into regression models. Maternal OB was found to increase the risk of ASD by 5-fold, even when controlling for the influence of maternal DM.
Diabetes in Pregnancy

DM affecting pregnancy was not only a risk factor for ASD but was also significantly related to a number of other previously identified risks. It was found that 74% of women who had DM in pregnancy were of an OW or OB BMI classification pre-pregnancy as compared to 55.3% of the non-DM group. 87% of women in the DM group presented with DM which had first onset within pregnancy (GDM and IGT). GDM and IGT are both related to pre-pregnancy weight, suggesting that weight could be the factor which is leading to increased DM in pregnancy. Additionally, DM was associated with having been pregnant more than one time, occurring in 98% of DM women as compared to 61.5% of non-DM women. This should be considered with regard to the propensity for women to be of increased weight pre-pregnancy after having been pregnant at least once previously. There is an identified need for women to decrease weight pre-pregnancy and a request for increased support for women to meet this goal (American College of Obstetricians and Gynecologists, 2013). The results of this study support the identification of pre-pregnancy weight loss and weight control supports for women to be in need.

It was found that where ASD, DM and/or OB was present, there was also an association towards co-morbid diagnosis in offspring. Co-morbidities in this data set consisted of conditions such as Fragile X Syndrome, dyslexia and apraxia. Future research should evaluate the potential impact that DM/OB has on additional diagnosis as co-morbidity occurs at high rates with unclear epidemiology (Mannion, Brahm & Leader, 2014). Furthermore, while it was expected that SCQ scores and co-morbid diagnosis would be significantly associated with ASD, sibling diagnosis of ASD as well as other special needs diagnosis were also found to be significantly associated to ASD within this data set. Future research should aim to evaluate sibling diagnosis where DM
and OB were present in other pregnancies as well as determine if those conditions
impacted multiple pregnancies for one woman and lead to additional children having
sub-optimal outcomes. As remains a need for additional data to determine the
relationship between the gene environment impact on ASD diagnosis, this information
becomes increasingly important.

Weight

This study highlights the impact pre-pregnancy weight has on the development
of additional conditions which have been found to be risks for sub-optimal offspring
outcome. Specifically, this Study found that OB was a risk factor for maternal DM,
emergency cesarean delivery, and a child being bottle fed. Being bottle fed was found
to be a significant risk factor for offspring ASD development as well although the
reasoning is unclear. Future research should aim to evaluate this finding. OB, like DM
was found to occur most predictably among women who had at least one previous
pregnancy further supporting the need for women to lose initial pregnancy weight
before successive pregnancies. The decrease of weight before becoming pregnant again
has the potential to impact subsequent offspring outcomes although future research is
needed to determine this impact.

Decreasing Modifiable Risks. OB has been identified as the most controllable
factor within pregnancy (American College of Obstetricians, 2013; Bilder et al., 2015;
Xiang et al., 2015). Furthermore, OB has also been shown to lead to the most
significant sub-optimal outcomes for both mother and children (Brahm et al., 2018a, in
press). HY and DM have been identified as the two most common medical risks in
pregnancy and research has found OB to be the major contributing factor in
development of these complications (Rosenberg, Garbers, Lipkind & Chiasson, 2005).
It has been established that if women’s weight could be controlled pre-pregnancy,
nearly 50% of the cases of DM could be eliminated (ACOG, 2013; DeSisto, Kim & Sharma, 2014).

Due to this emerging research, it has been strongly recommended that women of child bearing age receive specific counseling regarding the risks associated with increased weight pre-pregnancy for both mother and child (ACOG, 2013). The CDC (2006) and the ACOG (2005) recommend that women be screened and treated for OW and OB before becoming pregnant, yet state that there is a significant lack of support in this area and lack of efficacy in the current supports available.

In addition to screening and counseling on the risks associated with OW and OB pregnancies, it has been recommended that women of childbearing age have access to individual nutrition consultation and exercise programs, to decrease body weight before becoming pregnant (American College of Obstetricians and Gynecologists, 2013). Women maintaining a healthy weight within the childbearing years has become a substantial health concern and an area in need of improvement, particularly when considering research shows nearly half of the pregnancies in the USA alone are unplanned. The control of these modifiable factors is fundamental in limiting risks associated with in-utero nutritional and metabolic states for children.

The present study showed, 62% of women within this cohort entered into their pregnancy with either OW or OB BMI classifications. This number is in-line with previous research which found 68% of women were entering into their pregnancy OW and as many as 55.8% of women of child-bearing age were OB (Catalano & Shankar, 2017). Importantly this Study showed that 75% of women who were in the DM cohort were entering into their pregnancy OW and that 83% of those women developed DM with first onset in pregnancy. These numbers represent the need to decrease weight
pre-pregnancy with regard to the extent of the OW/OB population and subsequent GDM development.

Further complicating weight risk is the rate of EGWG in women who are already OW/OB entering pregnancy. Research has shown that 37% of normal-weight women, 64% of OW and 46% of OB women gain in excess of their recommended weight gain in pregnancy (Johnson et al., 2015; Phelan, 2010). The outcomes of this Study support those previous finding. Research also continues to show that EGWG is related to a two-to-three-fold increase in the risk of women becoming OW after birth and increased long-term weight retention (Gunderson, 2000). Additionally, EGWG has continuously been associated with offspring being at an increased risk for being OW in childhood (Oken, 2007). This highlights the need to decrease unhealthy weight and weight related behaviors pre-pregnancy as a means to decrease weight gain in pregnancy and to establish healthy behaviors for the future of bother mother and child.

**Need for Intervention.** As the rates of OB continue to rise globally, it becomes increasingly important to provide women with the knowledge and skills to limit this modifiable risk. Weight control interventions in and around the time of pregnancy are reported to be unsuccessful, under-researched and under developed (Vesco et al., 2014). Wadden, Webb, Moran and Bailer (2012), report that behavioral weight control interventions have had limited success with OW and OB adults, helping them to lose weight and alter their health behaviors. Research shows interventions for women attempting to lose weight before becoming pregnant is even further necessary but lacking (Wadden et al., 2012). In the Unites States, 60% of OW and 70% of OB women sampled reported trying to lose weight before pregnancy, but found weight loss and weight loss management uncommon (Bish et al., 2005). Research shows a marked need for successful interventions to manage weight pre-pregnancy and translate healthy
behaviors through the pregnancy period (Brahm, Mannion & Leader, 2018b, in press). Developing a successful intervention to change in this manageable risk has the potential to make a meaningful difference yet is currently lacking.

Bilder et al (2015) discuss the management of modifiable variables for ASD risk as being an important outcome of their findings. Authors suggest that factors which are controllable and pose a risk to offspring should be more meaningfully monitored in the clinical settings. This progression can be seen in Xiang et al. (2015) recommendation of early screening for ASD in offspring of mothers who had GDM, based on the results of their study. The results of the current study support these findings and recommendations. However, research is necessary to determine how to decrease these risks considering the limited success of current intervention protocols (Brahm, et al., 2018b, in press).

**Conclusion**

In conclusion, as the prevalence rates of OB and DM continue to grow, it becomes increasingly important to understand the impact these conditions have on mothers and particularly on the development of offspring resulting from those pregnancies. Chapters 1 and 2 of this thesis show that pre-pregnancy OB is a significant risk factor for the development of ASD as well as a variable influencing the development of additional risks for ASD such as DM. OB is a growing epidemic across the globe and requires evaluation and consideration in being controlled for to mitigate the risk of ASD. The results of this research highlights the need to assess the current standard of weight supports to women of child bearing age, determine gaps in supports, and intervene with women of child bearing years more successfully to increase their healthy weight through more efficacious supports.
Part 2: Application of Applied Behavior Analysis to Pre-pregnancy Weight Behaviors
Part Two Introduction

Behavior Analysis

The field of behavior analysis was established over 100 years ago by the work of John B. Watson (Cooper, Heron & Heward, 2007). At the time of Watson’s research, psychology was focused on topics like states of mind and internal mentalistic processes (Cooper et al., 2007). Yet, Watson argued that psychology should be more concerned with observable behaviors and their interaction with the environment (Cooper et al., 2007). In 1913 Watson wrote “Psychology as the Behaviorist Views It”, which discussed the newly established field of behavior analysis, and the new focus on his concept of stimulus-response (S-R), or environment-behavior psychology. Since Watson’s seminal paper, the field of behavior analysis has expanded significantly.

A large portion of growth is attributable to the work of B. F. Skinner (Cooper et al., 2007). Considered the ‘father of behavior analysis’ Skinner advanced the field of behavior analysis beginning in 1938 by publishing his research titled The Behavior of Organisms (Skinner, 1938). This publication established three distinct, yet related branches of behavior analysis which the field has remained organized by. Namely, behaviorism, experimental analysis of behavior (EAB) and applied behavior analysis (ABA; Presti, Cau & Moderato, 2012; Cooper et al., 2007).

Behaviorism

Behaviorism, is the branch of behavior analysis concerned with the philosophy of the science of behavior, rather than behavior itself (Cooper et al., 2007). Also called radical behaviorism, this branch is different from other areas of psychology which study behavior, by its subject matter being observable and measurable components of behavior, rather than focusing the mentalistic ideas of inner thoughts and feelings controlling behavior (Cooper et al., 2007).
Skinner argued that these inner thoughts, also called ‘private events’, held three main components; “(A) private events such as thoughts and feelings are behavior; (b) behavior that takes place within the skin is distinguished from other (“public”) behavior only by its inaccessibility; and (c) private behavior is influenced by (i.e., is a function of) the same kinds of variables as publicly accessible behavior” (Cooper et al., 2007, pp. 13). Therefore, the aim of radical behaviorism is to explain all behaviors, even those private events.

**Experimental Analysis of Behavior**

Skinner’s *The Behavior of Organisms* summarized his laboratory work which established a greater understanding of behavior itself (Cooper et al., 2007) and identified two different types of behaviors. Specifically, respondent behavior and operant behavior (Cooper et al., 2007). Skinner defined respondent behavior similar to Watson’s stimulus-response view, in that respondent behaviors are elicited by environmental stimuli which occur immediately before the behavior. However, Skinner noted that not all behavior could be explained within stimulus-response relationships (Cooper et al., 2007).

Instead, Skinner argued that most behaviors are more influenced by the events which immediately follow them, rather than what comes before. Behaviors which are influenced by the events following their occurrence are termed operant behaviors (Cooper et al., 2007). Skinner agreed preceding stimuli are important, but rather determined that the consequences which follow behavior are what decrease or increase the likelihood of its future occurrence (Cooper et al., 2007).

This stimulus-response-stimulus paradigm is now known in behavior analysis as the three-term contingency and is the unit of analysis with which the field evaluates
operant behaviors (Cooper et al., 2007). Therefore, operant behavior is conceptualized into three consecutive components. Namely, the antecedents which occur before, the behavior itself and the consequences which follow the behavior. Through decades of research, Skinner developed EAB which focused on utilizing scientific methods to analyze operant behavior and its relationship to environmental variables within the three-term contingency (Cooper et al., 2007).

EAB consists of five identifying concepts; “1. Rate of response is the most common dependent variable, 2. Repeated or continuous measurements is made of carefully defined response classes, 3. With-in subject experimental comparisons are used instead of designs comparing the behavior of experimental and control groups, 4. The visual analysis of graphed data is preferred over statistical inference, 5. A description of functional relations is valued over formal theory testing” (Cooper et al., 2007, pp. 23).

**Applied Behavior Analysis**

Lastly, in 1953 Skinner published *Science and Human Behavior*, where he discussed the extension of experimental analysis of behavior, to the behavior of humans within complex settings (Cooper et al., 2007). Through the 1950s and 1960s the experimental analysis of operant behavior conducted in laboratory settings, began to be replicated with in human participants in settings such as government and education (Cooper et al., 2007). This generalization to humans in complex settings expanded the field from experimental to applied behavior analysis (ABA). ABA is now known as the science of human behavior which focuses on the analysis and improvement of socially significant behaviors (Baer, Wolff & Risley, 1968; Cooper et al., 2007). An important distinction between ABA and other sciences which evaluate behavior was made by Carr
(1993), where he described ABA being focused on the function, or purpose, of behavior rather than behavior itself.

In 1968, Baer, Wolf and Risley produced one of the foundational articles in the field of ABA. Within their article the authors identified the seven dimensions of ABA which guide applied treatments of behavior. It was specified that treatments, which do not feature all seven dimensions, are incomplete and potentially compromised in effectiveness (Baer et al., 1968). These seven dimensions remain the guiding principle for ABA interventions.

**Seven dimensions of Applied Behavior Analysis** (Baer et al., 1968)

1. Applied: Investigates socially significant behaviors important to the individual and those close to the individual.
2. Behavioral: Focus is on observable and measurable behavior.
3. Analytic: Demonstrated functional relationships between behavior and the environment.
4. Technological: The procedures used are written such that the study could be completely and accurately replicated.
5. Conceptually systematic: Interventions are derived from the principles of behavior.
6. Effective: Behavior changes significantly enough to create meaningful and practical results for individuals.
7. Generality: Behavior change maintains overtime, across environments and generalizes to other related behaviors.

Over decades of research the field of ABA has expanded the study of behavior established by Watson, Skinner and other early researchers, to a wide array of human
and animal behavior. The expansion from early research has established a comprehensive application of ABA into evidence-based practice for behavior change processes, and has aided our understanding of complex behavior to allow for the development of effective interventions.

**Functions of Behavior**

As stated, the foundational difference between behavior analysis and other areas of psychology is the focus on functions of behavior. Behavior analysis has been successful in the assessment and treatment of behavior due to the understanding of maintaining variables and the ability to alter consequences of behaviors. Carr (1977) discussed the evaluation of reasons, or maintaining outcomes, for self-injurious behavior in individuals, as being more important than evaluating the motivation for the behavior. Carr (1977) rationalized his identification of reason over motivation as a response to the lack of success in treatments of the time and stressed the concept that individual’s behaviors likely have different functions which need to be identified before a successful treatment can be developed. In this review, Carr (1977) established the preliminary identification of the functions of challenging behavior. Through years of research, it is now understood, within the field of ABA, that many operant behaviors, not just self-injurious ones, are maintained by 4 possible functions (Cooper et al., 2007).

Specifically, the four functions under which all behavior is reinforced and therefore persists; access to attention, access to tangible stimuli, escape/avoidance unwanted stimuli, and/or automatic reinforcement. When utilizing ABA to intervene on any behavior, one must first evaluate and establish the function of the behavior of concern (Miltenberger, 2008).
Functional Assessment

Functional assessment (FA) is the method of investigation which provides information on, and determines the function of, target behavior as well as the relationships between the environment and said behavior (Cooper et al., 2007). Iwata, Dorsey, Slifer, Bauman and Richman (1982) introduced the first standardized methodology for assessing and identifying operant functions of aberrant behavior in FA. The authors used this methodology initially in the analysis of self-injurious behavior, however, the standard was quickly adapted to analyze environment-behavior interactions that maintain operant behaviors (Mace, 1994). Throughout decades of research, functional based strategies have been supported as the most successful approach for evaluating operant behavior (Cooper et al., 2007; Horner, 1994).

The FA process identifies the contingencies which maintain behavior, the antecedents and consequences, and allows for the development of individualized, function based interventions to decrease aberrant behavior and increase appropriate behavior (Cooper et al., 2007). An FA evaluates problem behavior through measures such as interviews, rating scales, direct observation, and experimental analysis (O’Neill, Horner, Albin,. Sprague, Storey & Newton, 1997).

In addition to the antecedents, behaviors and consequences identified in the FA process, setting events, or factors which may alter the strength of a consequence at the moment and increase the likelihood of behavior occurring, can be assessed as well (Ingram, Lewis-Palmer & Sugai, 2005). It has been established that, behavior likely functions in the order of; setting event-antecedent-behavior-consequence, and therefore should be assessed in this respect (Ingram, Lewis-Palmer & Sugai, 2005).
O’Neil et al. (1997, pg. 3) define the five primary outcomes of a functional assessment process as being:

1. A clear description of the problem behavior, including classes or sequences of behavior that frequently occur together.
2. Identification of the events, times and situations that predict when the problem behaviors will and will not occur across the full range of typical daily routines.
3. Identification of the consequences that maintain the problem behaviors (that is, what functions the behaviors appear to serve for the person).
4. Development of one or more summary statements or hypotheses that describe specific behaviors, a specific type of situation in which they occur and the outcomes or reinforces maintaining them in that situation.
5. Collection of direct observation data that support the summary statements that have been developed.

**Design of Interventions Following Functional Assessment**

Function based interventions refer to the process of using the information collected within FA’s to develop plans which teach an alternative response(s) or tasks (s), that match the determined function of behavior or makes the target behavior less reinforcing than the alternative (Cooper et al., 2007). Simply, function based interventions target the reason problem behavior is occurring and provide alternative behavior in its place (Horner, 1994).

As stated in O’Neil et al. (1997, p. 2) behavior support is comprehensive in that it focuses on the consequences for appropriate and inappropriate behavior, alters antecedents which precede problem behavior and importantly teaches new skills for an
individual that allow them to be more successful with novel more appropriate behavior and make problem behavior less likely to occur. Important components of successful interventions include assessment of the functions of behaviors, assessment and intervention on the antecedents which precede behavior and the extinction of target behaviors with replacement of functionally equivalent behaviors (Umbreit & Ferro, 2015).

The design of function based interventions has been developing for decades (Carr, 1977; Umbreit & Ferro, 2015). Previous research has evaluated the efficacy of interventions which are function and non-function based to determine the efficacy of this approach. Through decades of research, it has been shown that function based methodologies to altering behavior are associated with the most significant improvement in behavior (Ingram, Lewis-Palmer, Sugai 2005). Therefore, function based interventions have been shown to be the most efficacious treatment approach (Beare, Severtson & Brandt, 2004; Iwata, Dorsey, Slifer, Bauman & Richman, 1982/1984; Petscher, Rey & Bailey, 2009).

**Conclusion**

Years of ABA research show that behavior analysis is an empirically validated, scientific based framework for interventions which lead to socially significant and meaningful outcomes across a range of behaviors (Meredith et al., 2014). The second part of this thesis will utilize the science of ABA, to evaluate the current themes in OB literature, assess individual eating behavior and create individualized behavior change interventions to increase healthy repertoires of eating behavior among women of child bearing age.
Chapter 3

Towards a Functional Perspective of Eating Behavior in Response to the Obesity Epidemic
Towards a Functional perspective of Eating Behavior in Response to the Obesity Epidemic

Justification for Current Study

As stated in Chapter 2, OB and OW are significant concerns, globally. The percentage of individuals who meet the criteria for being OB has drastically risen across the last 30 years (Washington, Banna & Gibson, 2014). From 1980 to 2013 the percentage of adult OB increased from 10% to 35.7% in the United States alone (Centers for Disease Control and Prevention, 2013). The increase in the rates of OW and OB individuals has drawn attention to the need for a better understanding of the factors leading to this escalation, on both a societal and individual level (Hearon, Utschig, Smits, Moshier, & Otto 2013). The gaps in understanding have contributed to a lack of effective, applied interventions to aid individuals in preventing and, or reversing this health problem (Guelinckx et al., 2008). Existing interventions have been reported as being largely ineffective in aiding OB individuals with losing weight, maintaining weight loss over time and suggest a variety of limitations which require further investigation (O’Neill et al., 2012).

Early research suggested that identifying the antecedents and consequences, which are functionally related to eating behavior, is necessary for the understanding of behavior and for the development of individual interventions (Lee & Miltenberger, 1997). Previous studies have shown that maladaptive eating behaviors and patterns serve different functions for different individuals, therefore the identification and treatment of behavior according to function is imperative (Stickney & Miltenberger, 1998; Stickney, Miltenberger & Wolff, 1999). However, decades later, the lack of functional assessment remains a gap in treatment efficacy.
Importantly, research has highlighted that the use of a “one size fits all” approach to intervention, contributes to the lack of treatment efficacy (O’Neill et al., 2012). As such, an individualized management protocol has been recommended in the treatment of OB, which includes the analysis of individual behaviors that contribute to increased weight gain (O’Neill et al., 2012). In particular need, are individualized interventions and counseling for women of childbearing age, to decrease body weight before becoming pregnant (ACOG, 2013). This is particularly important considering Chapter 2 found 62% of women were entering their pregnancies at least OW and the OW and OB are a significant risk factors for numerous maternal and fetal suboptimal outcomes.

This chapter will evaluate the current standard of assessment and treatment in OB and related eating patterns from a behavior analytic perspective, to determine possible avenues for increase efficacy in treatment and prevention of the health effects caused by OB.

**Obesity Treatment**

Due to the number of OB individuals and the high co-morbid medical risks, the WHO has designated OB as one of the most critical health threats of our time. Yet the most noteworthy factor with regard to this epidemic is that OB is preventable (WHO, 2016).

The increase in the rates of OW and OB displays a need for a better understanding of the factors leading to this escalation, on both a societal and individual level (Hearon, Utschig, Smits, Moshier, & Otto 2013). These gaps in understanding have contributed to a lack of effective interventions to aid individuals in preventing and, or reversing this health problem (Guelinckx et al., 2008). Research reports a variety of limitations which require further investigation (O’Neill et al., 2012).
Health problems are attributable to individual behavior (Bouton, 2014; Roane, Ringdhal, & Falcomata, 2015). That is, health concerns such as OB are caused by the behaviors that individuals reliably engage in and abstain from, for example, too much eating behavior and too little physical activity. At the most basic level, health behaviors are a result of the choices made every day. Additionally, as it has been established that eating behaviors are applicable to individuals rather than generalizable across groups such as healthy versus OB, the current “one size fits all” intervention style is a major limitations in treatment (Zijlstra et al., 2011). These choices and individual behaviors have been identified as the central opportunity for health improvement (Schroeder, 2007) and a task for the behavioral sciences, specifically for ABA (Roane et al., 2015).

Behaviorally based weight control interventions have been developed over several years (Vesco et al., 2014). Interventions lie within a variety of behavioral sciences and have shown some success in the immediate decrease of weight (Butryn, Webb, & Wadden, 2011). However, limitations are consistently reported in the amount of initial weight loss and lack of maintenance over time (Butryn et al., 2011). Current interventions related to OB specifically show similar limitations, have little or no individualization and lack comprehensive assessment of the variables surrounding eating behavior.

ABA has been successful in the identification, assessment and treatment of individual operant behavior for a number of decades (Michael, 1982). As eating has been established as an operant behavior (Lee & Miltenberger, 1997) it is likely that ABA has the potential to increase success in the treatment of maladaptive eating. ABA has been shown to be effective in many interventions targeting eating behaviors such as food selectivity, food refusal, and rapid eating in populations with disabilities (Presti, Cau, & Moderato, 2012). However, the current body of research shows a lack of
application to interventions among non-clinical populations. Specifically, current approaches lack identification of maintaining variables and function based treatment protocols. Rather, focus is placed on reducing antecedent conditions that elicit eating behavior (Leeher et al., 2015).

For example, the emotion regulation model of binge eating suggests that individuals with Binge Eating Disorder (BED) are more likely to binge eat when negative emotions are present. The model suggests that overeating negatively reinforces binge eating. Yet, interventions primarily focus on altering emotional states and fail to remove the maintaining variable or provide functional alternatives (Leehr et al., 2015). The body of research which has employed ABA to eating outside of individuals with disabilities has shown success in the assessment and treatment of Bulimia Nervosa (BN), Binge Eating Disorder (BED) and similar behavior patterns (Bosch et al., 2008; Giddings & Miltenberger, 2010; Johnson et al., 1995; Lee & Miltenberger, 1997; Loro & Orleans, 1981; McManus & Waller, 1995; Stickney & Miltenberger, 1999; Stickney, Miltenberger, & Wolff, 1999). These assessments and interventions show promising results and warrant investigation with additional populations (Bosch et al., 2015). These previous studies have shown that eating behaviors serve different functions for different individuals, therefore the identification of function is critical (Stickney & Miltenberger, 1998; Stickney et al., 1999). Research suggests that identifying the functionally related antecedents and consequences of eating behavior, is necessary for the development of effective interventions (Lee & Miltenberger, 1997).

Even with the understanding that rates of OB and OW are rapidly increasing, and individual behaviors are at its core, interventions largely focus on behaviors associated with eating disorders such as BED and BN. While these are important health
concerns and require intensive treatment, there is a significant lack of effective interventions for maladaptive eating in non-clinical populations (de Zwaan, 2001). This is a concern particularly when considering that binge eating or overeating can be key components to OB in non-clinical populations, and as many as 46% of OB individuals in treatment report engaging in compulsive eating or binge eating (de Zwaan, 2001; de Zwaan & Mitchell, 1992). To further highlight the importance of non-clinical interventions, individuals of a healthy weight report similar rates of binge eating as OB patients, leading to greater susceptibility in gaining excess weight over time (O’Neill et al., 2012).

Current reports call for low-cost and effective ways to manage OB and alter the growing trend in rates universally (Washington, Banna, & Gubson, 2014). It has been well established that behavioral treatment should be the first line of intervention for OW and OB individuals (Butryn et al., 2011). However, this is not always the case and there is a lack of trained personal to implement interventions respective to the number of people in need, leading to increased barriers in decreasing OB cost burdens (Butryn et al., 2011).

**Eating Behavior**

The definition of eating behaviors in research varies based on the field of analysis and treatment. Often, eating behaviors are defined as amount of food intake, eating rate, bite size, number of bites or meal duration (Zijlstra et al., 2011). Research and intervention also focuses on what are termed as eating behavior dimensions. Several eating behavior dimensions have been identified and include, food responsiveness, enjoyment of food, reinforcing value of food, satiety responsiveness, eating disinhibition, impulsivity and self-control (French et al., 2012). Research
reports these dimensions as occurring at higher rates among OW populations than in normal weight populations (French et al., 2012).

While these domains provide useful information to understand eating behavior, and are important in the evaluation of problematic behavior patterns, it is key to note that some dimensions focus on the antecedents to maladaptive eating, not why or what maintains it. Furthermore, from a behavior analytic perspective, these eating behavior dimensions could also serve as establishing operations (EO) and/or motivating operations (MO) leading to increased food intake, not as the determining factor in the behavioral persistence.

**Current Study**

This study will report on the current assessment of eating behaviors and describe avenues for functional assessment procedures to increase the understanding of the OB epidemic from an individual contingency perspective. Additionally, current interventions will be reviewed, conceptualized into behavior analytic principles, and a discussion will be offered regarding how ABA can support function matched interventions to increase effectiveness and decrease cost burdens. Lastly, a discussion regarding the application of ABA into evidence based eating and health interventions will be presented.

**Current Interventions**

The current protocol for weight interventions is a least-to-most, stepped-care approach. Patients are generally given a standard treatment predicated on their BMI, and the presence or absence of comorbid conditions such as DM (Wadden, Webb, Moran, & Bailier, 2012). Interventions are delivered on a trial and error basis, beginning with the least intrusive and costly lifestyle modification, extending to invasive, high risk medical procedures (Wadden et al., 2012).
Lifestyle Modification

Diet change. Life style modifications are the most commonly delivered, first tier approach used with individuals with high BMIs. Sometimes referred to as behavioral weight control, these interventions consist of diet change, exercise increase, and behavior therapy (Fabricatore & Wadden, 2003; Wadden et al., 2012). Lifestyle modifications have the goal of establishing changes to dietary and behavioral repertoires, which a person can implement independently to increase health (Fabricatore & Wadden, 2003).

Within lifestyle modifications, dietary interventions are frequently delivered and utilize either low-calorie or very-low-calorie diet programs to follow, based on BMI category and weight loss goal (Fabricatoire & Wadden, 2003). Research suggests that lifestyle modifications are most successful when behavior therapy is offered in conjunction with prescribed food plans and menus, as opposed to a self-selected diet (Fabricatore & Wadden, 2003).

Physical activity is an additional component of a lifestyle modification intervention. Physical activity is regularly targeted for change in the context of programmed activity, where an individual is intentionally engaging in specific workouts. Physical activity is also targeted by increasing movement within choice making, such as choosing to take the stairs rather than the elevator (Fabricatore & Wadden, 2003).

Behavioral Therapy. Behavioral therapy is the final standard component of lifestyle modification and commonly offered to individuals seeking weight loss assistance (Fabricatore & Wadden, 2003). Components of behavioral therapy consist of education on the negative outcomes of maladaptive eating behavior, specific goal setting, self-monitoring, contingency rewards for successful health behaviors and
motivational interviews (Johnson et al., 2015; Wadden et al., 2012). Behavior therapy is traditionally delivered in a non-individualized group setting for a specified number of weeks (Wadden et al., 2012). Examples of behavioral therapy techniques are discussed below.

**Goal setting.** Goal setting is foundational to any behavioral intervention (Wadden et al., 2012). The development of clear, objective and measurable goals allows for assessment of progress and easily identifiable standards each person can be held to (Wadden et al., 2012). In behavioral interventions for OB, goals are set for variables such as daily calorie intake and weekly minutes of physical activity (Butryn et al., 2011).

One concerning trend in goal setting is the significant discrepancies between the average 10% weight loss for non-surgical interventions and the 20%-35% patients consider to be their goal (Foster, Wadden, Vogt, & Brewer, 1997; Jeffery, Wing, & Randall, 1998; O'Neil, Smith, Foster, & Anderson, 2000; Wadden, Brownell, & Foster, 2002). The disagreement can be viewed as unsatisfactory by the individual and contribute to patients’ discontinuation of intervention plans, creating a barrier to weight loss achievement and maintenance (Wadden et al., 2002). These complications highlight the necessity for appropriate goal setting measures to keep participants motivated, reinforced and increase treatment fidelity.

**Self-monitoring.** Accessing feedback through self-monitoring of goals allows participants to determine if targeted behaviors are improving, deteriorating or being maintained (Butryn et al., 2011). The purpose of self-monitoring is to increase patient’s awareness of their behavioral engagement and the extent to which they are following their program or where improvements can be made (Berkel et al., 2005). Evidence suggests participants who have the highest rate of self-monitoring tend to have the
largest weight loss outcomes (Butryn et al., 2011). Careles et al. (2012) report that within a step-cared intervention, those who reliably engaged in self-monitoring were more successful and required less intensive interventions then those who did not self-monitor. Thus, self-monitoring is considered one of the most important components of behavior therapy (Berkel, Poston, Reeves, & Foreyt, 2005). However, self-monitoring of unsuccessful outcomes, like goals which are not being met, can be problematic and lead to discontinuation of plans by participants, particularly where reinforcement efficacy is a concern (Petry, 2000).

Washington et al. (2014) discuss how lack of access to reinforcers early in intervention protocols is associated with lack of engagement in treatment. When criteria are set too high for success to be achieved, participants are less likely to engage with treatment and to have positive outcomes (Wadden et al., 2012; Washington et al., 2014). This stresses the need for appropriate goal setting, reinforcers and self-monitoring (Wadden et al., 2012; Washington et al., 2014). Furthermore, Petry (2000) discussed the selection of reinforcers and their efficacy as an additional consideration in plan discontinuation. From a behavior analytic perspective, this lack of efficacy could be diminished in two ways. Firstly, by utilizing a preference assessment to determine items which may serve as reinforcers to individuals. Then collecting data on behavior to determine the efficacy of stimuli as reinforcers. Secondly, utilizing more systematic shaping procedures, creating small, successive and attainable goals which are likely to access reinforcement when achieved (Washington et al., 2014). While shaping is a commonly used tactic in behavioral literature (Bray & Bouchard, 2004) shaping towards a goal set too high or temporally expansive goals is likely to lead to ratio-strain and discontinuation.

**Contingency Management.** Contingency management is a tactic grounded
in behavior analysis. It is a commonly used strategy in lifestyle modification, which incorporates monitoring engagement in specific behaviors and providing reinforcement based on meeting set criteria (Washington et al., 2014). Contingency management and other incentive-based interventions have been developed and utilized in increasing frequency and are becoming standardly delivered in health and wellness promotion programs (Meredith et al., 2014).

Contingency management is most commonly used in the treatment of substance abuse (Davis et al. 2016; Petry, 2000) and has recently been applied to physical activity behaviors among OW populations and individuals with eating disorders (Washington et al. 2014; Wismiewski & Ben-Porath, 2015). To highlight the scope of incentive-based and contingency management usage, the American Affordable Health Care Act encourages employers to use incentivization to increase the likelihood that their employees will engage in healthy behaviors (Meredith et al., 2014).

The principles employed in contingency management suggest promising avenues for eating behavior interventions. However, there are considerations in its application. Contingency management procedures are predicated on the concept of food and inactivity being automatically reinforcing for individuals, and lacks assessment of the true maintaining variables. Therefore, when the contrived contingency management ends, behavior tends to increase back to problematic rates (Bouton, 2014; Hartlieb et al., 2015). Future research should evaluate the processes involved in behavioral components like extinction procedures, reinforcer fading, self-monitoring and stimulus control in relation to contingency management for problematic eating.

Additionally, when considering the discrepancies in goal setting and the resulting ratio strain, criteria within contingency management must be evaluated.
Criteria which are too low could inadvertently reinforce inappropriate rates of behavior and too strict criteria may lead to missed reinforcement (Holtyn, Knealing, Jarvis, Subramaniam, & Silverman, 2017).

**Replacement Behaviors.** A fundamental component of behavior change procedures is the acquisition of skills necessary to engage in alternative behavior. Interventions which focus on increasing functionally related replacement behaviors have greater outcomes than those which are not function based (Umbreit & Ferro, 2015).

While replacement behavior training is present in current interventions, functional replacement behaviors is an area for advancement (Bouton 2014). An example of the need for replacement behavior training is in the outcomes of binge eating in OB populations. Current intervention results suggest a decrease in rates of binge eating behavior after treatment; however there is little actual weight loss (Wadden et al., 2002). It has been hypothesized that interventions may reduce the rate of binging behavior, but neglect the possibility that people are compensating with increased eating outside of binges (Wadden et al., 2002). This might translate to patients lacking alternative behaviors which are functionally equivalent to binging, a fundamental factor from an ABA perspective.

A component of the ability to replace an unhealthy behavior with a healthy one is the concept of health literacy. Health literacy is defined as “….people’s knowledge, motivation and competences to access, understand, appraise and apply health information in order to make judgements and make decisions in everyday life concerning health care, disease preventions and health promotion to maintain or improve quality of life during the life course.” (Sørensen et al., 2012, p.3). Research has determined that nearly 50% of all Europeans have inadequate and/or problematic
health literacy skills (Sørensen et al., 2012). Increasing health literacy is an important aspect in creating a repertoire of replacement behaviors for maladaptive eating and is an avenue for future research (Sørensen et al., 2012).

Yet, increasing knowledge is not enough. Replacement behaviors require training procedures to increase the likelihood that an individual will identify opportunities for healthy decision making, engage in healthy alternatives when opportunities arise and are effective in functionally replacing the target behavior (Umbreit & Ferro, 2015). As stated by Michael (1993), for behavior to occur, the person must both want to engage and importantly, know how to engage in behavior. This underscores the importance of teaching procedures and ensuring replacement behaviors are motivating enough for the person to engage in. However, due to the lack of functional assessment within current treatment, competing replacement behaviors are not a focus.

**Group Interventions.** Behavioral weight control interventions within lifestyle modification are traditionally delivered in non-individualized group settings with the goal of modifying eating behaviors and activity rates (Burtryn et al., 2011). Butryn et al. (2011) report most group treatments of OB to occur on a weekly basis for an initial 4-6-week period. Sessions commonly include private weigh-ins, participants providing the group with an account of their success on goals through the week, and end with the teaching of a new weight management skill from a structured curriculum (Butryn et al., 2011).

Results of group behavioral treatments in OB have remained relatively stable over the last 15 years (Wadden et al., 2002). Participants in interventions of 20 weeks lost an average of 9% of their goal weight, regained an average of 30% of lost weight within one year of treatment succession, and continue to re-gain over time (Foreyt &
Goodrick, 1993; Wadden & Foster, 2000; Wilson, 1994; Wing, 2002). Research has begun focusing on increasing the amount of weight loss during group intervention and improving maintenance overtime, as a means of increasing outcomes (Wadden et al., 2002). Yet further research is necessary in the area of generalized and maintainable behavior change to aid in remediating these limitations.

**Pharmacology**

Pharmacological treatment is the next most invasive step in the current protocol. Pharmacological interventions are recommended when there is an increased disease risk or a very high BMI, typically greater than 30. Pharmacotherapy has shown greater success in the maintenance of weight loss as opposed to aiding in initial weight loss (Fabricatore & Wadden, 2003). This presents a two-tiered complication. Firstly, the need for individuals to lose initial weight remains a concern, with research showing initial weight loss to be problematic. Secondly, long term medication use can create financial burdens for patients and funding sources, and the side effects can lead to additional health concerns overtime (Fabricatore & Wadden, 2003).

**Surgery**

Surgical interventions are the top tier and most invasive treatment option for OB (Fabricatore & Wadden, 2003). Bariatric surgery is reserved for individuals within morbidly obese BMI categories and/or the presence of comorbid, weight related disease (Fabricatore & Wadden, 2003). Studies show surgical interventions lead to 25-30% of initial weight reduction and maintenance of 50% weight loss over time (Fabricatore & Wadden, 2003). These results suggest success among the most OW individuals, yet weight re-gain is a concern and prevalent occurrence, post-surgery (Mitchell et al., 2014). One school of thought on the lack of efficacy is that weight change does not maintain over time because problematic eating behaviors present pre-surgery remain
post-surgery (Mitchell et al., 2014). This shows that the need to alter behavior patterns is substantial even where invasive procedures are concerned (Mitchell et al., 2014).

**Applied Behavior Analysis and Eating Behaviors**

**Functional Assessment of Eating Behavior**

In the context of eating behavior, there is a marked lack of function-based assessments and interventions. Much of the eating behavior interventions are based on the concept of stimulus-response psychology, or are concerned with stimuli which elicit maladaptive eating behavior and fail to address the maintaining variables. Nonetheless, there is a small but promising body of research evaluating the functional assessment process and functional treatment of binge eating behavior associated with BN and BED.

Lee and Miltenberger (1997) provided a review of the functional assessment literature on binge eating finding failures in the examination of functions of binging. Rather, much of the literature examined focused on the antecedents to binge eating and dimensions of the behavior such as frequency, severity, and duration, but fail to address the consequences maintaining the behavior. This review reported similar findings as the current body of literature, where eating is viewed as the consequence of the eliciting stimuli rather than eating being viewed as the behavior.

Lee and Miltenberger (1997) discuss numerous avenues for further research on binge eating, focusing on the systematic assessment of the antecedents and consequences related to the behavior. The development of procedures targeting the functional assessment of binge eating, like indirect and direct assessment methodologies is presented as a priority. Authors also discuss the necessity to develop assessment methodologies for specific populations such as non-clinical binge eaters. This would provide information on the eating behaviors of individuals and aid the development of interventions.
Stickney and Miltenberger (1999) and Stickney et al. (1999) evaluated direct and indirect measures for the functional assessment of binge eating as recommended by Lee and Miltenberger (1997). Stickney and Miltenberger (1999) developed the Conditions Associated with Binge Eating (CABE) with the goal of identifying specific antecedents and consequences of binge eating within a retrospective self-report instrument. Authors also developed self-monitoring forms to assess the immediate covert antecedents to individual’s binge eating as well as an antecedent checklist to assess temporally remote antecedents. Results showed that participants responded similarly between the direct and indirect measures but that the retrospective report was slightly more intense. This suggests that the use of self-report direct and indirect measures such as the CABE could be utilized to evaluate the functional relationship in binge eating behavior but requires further investigation. Stickney and Miltenberger (1999) suggest future research should examine the temporally remote antecedents to binging, as well as highlight the need for a functional assessment interview procedure for binge eating.

Stickney et al. (1999) evaluated the use of an interview and questionnaire to assess retrospective information on the antecedents and consequences of binge eating episodes. The Binge Eating Interview (BEI) and Binge Eating Questionnaire (BEQ, a self-completed version) was administered among 16 undergraduate females who reported engaging in binge eating at least twice per week. Findings suggested both real-time and retrospective assessment of the antecedents and consequences of binge eating should be utilized for a valid and complete assessment of behavior.

More recently, Redlin, Miltenberger, Crosby, Wolff, and Stickney (2002) extended the work of Stickney and Miltenberger (1999) and Stickney et al. (1999) by utilizing those established measures among OB individuals with BED. Measures were
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extended to include variables temporally related to binge eating. Redlin et al. (2002) also evaluated the conditional probability of binge eating by collecting data on all days, not only days where binging occurred. The authors report the necessity for individualized assessment of antecedents and consequences to binge eating, stating it may not be possible to gather generalized variables of eating due to their individual nature.

**Function Based Treatment**

Functional treatments for binge eating behavior have shown success in decreasing the frequency of binge eating episodes (Bosch, Miltenberger, Gross, Knudson, & Brower-Breitwieser, 2008; Giddings & Miltenberger, 2010). Two studies have utilized extinction procedures to decrease binge eating maintained by automatic negative reinforcement (Bosch et al., 2008; Giddings & Miltenberger, 2010). Both studies employed the direct and indirect measures developed by Stickney and Miltenberger (1999) and Stickney et al. (1999) to identify the function of binge eating in individual participants and design a function based intervention. Both studies successfully decreased rates of binge eating utilizing extinction procedures on negatively reinforced behavior.

The research on functional assessment of binge eating shows promising results in the assessment of eating, and provides many avenues for further research. Yet, functional assessment research has primarily been conducted in the context of BED, and has had little application to eating behaviors outside of clinical populations (Bosch et al., 2008; Giddings & Miltenberger, 2010; Johnson et al., 1995; Loro & Orleans, 1981; McManus & Waller, 1995; Stickney & Miltenberger, 1999; Stickney et al., 1999). Future research should focus on applying the functional assessment protocols to
varied eating behaviors outside of eating disorder populations and the development of function matched treatment.

**Antecedents and Consequences**

Results from the research utilizing function based assessment and interventions on BED and BN populations almost universally, suggest a relationship between negative affect and over-eating (Hearon et al., 2013). In behavior analytic terms, the research has found binge eating behaviors to be either automatically negatively reinforced by providing momentary relief from aversive emotional responding or positively reinforced through access to a primary reinforcer (Bosch et al., 2008; Giddings & Miltenberger 2010; Leehr et al., 2015; Macht, Haupt, & Ellgring, 2005). Still, little has been done regarding consequences of eating outside of clinical populations even though OW/OB individuals have a higher population prevalence than BED and BN combined; 52%, compared to 0.7%-4%, 1%-3%, respectively (Bosch et al., 2008; CDC, 2010; WHO, 2016). Research shows that most OW/OB individuals engage in some form(s) of maladaptive eating, but do not meet the BED/BN criteria, creating barriers in understanding OB related behavior (Hearon et al., 2013).

In addition to the research on the consequences of eating, Stickney et al. (1999), Giddings and Miltenberger (2010), and Leehr et al. (2015) among others, synthesized a variety of antecedents to binge eating behavior. Authors report conditions such as negative affect, anxiety, anger, boredom, being alone, being in one’s home, incurring un-structured time, the presence of high-calorie foods and dietary restraint to occasion binge eating behavior. It is reported that over time these antecedents become discriminative stimuli ($S^d$) for binge eating and require specific modifications for change (Giddings & Miltenberger, 2010). Moreover, it has been suggested that
negative affect as antecedents to binge eating behavior is relevant for OB persons with BED, but not for OB individuals without comorbid eating disorders (Leehr et al., 2015).

It is important to note, authors found that behaviors like binge-eating, may increase a person’s feeling of internal antecedents such as guilt due to over eating. This subsequently leads to increased escape/avoidance, and serve as S^d for additional binge-eating behavior to avoid internal antecedents. This leads to a circular pattern of avoid-eat-avoid (McManus & Waller, 1995). In behavior analytic terms, this pattern is referred to as a behavior chain. The development of behavior chains may play an important role in the formation of maladaptive eating behaviors, particularly in non-clinical populations; however further research is necessary to evaluate the relationship of antecedent-consequence maintenance.

Establishing and Motivating Operations in Eating Behavior

Delay Discounting. Delay discounting (DD) can be defined as a person’s behavior as a response to immediate gratification as opposed to a willingness to wait for longer durations or Delay rewards of greater magnitude (Weller, Cook, Avsar, & Cox, 2008). DD occurs when a person selects a small and immediate reward over a larger but Delay reward (Rollins, Dearing, & Epstein, 2010). A DD assessment identifies the choice a person makes between two available rewards which are different in amount and immediacy of availability (Rollins, Dearing, & Epstein, 2010).

The use of ecological momentary assessments has suggested that the momentary relief from negative affect experienced in BED and/or BN populations could be related to a DD paradigm (Giddings & Miltenberger, 2010). This suggests that it is the relief in the moment that maintains behavior, irrespective of the negative social and health outcomes over time due to the behavior (Giddings & Miltenberger, 2010).
Research has suggested OB individuals have increased rates of DD and therefore are more likely to engage in impulsive behaviors related to eating while discounting the future problems associated with their behavior (Weller et al., 2008). Additionally, there is evidence that suggests a relationship between increasing BMI and stronger preference for immediate over delayed benefits (Smith, Bogin, & Bishai, 2005; Zhang & Rashad, 2008). One study found DD was confined to a sub-group of OB women as compared to non-OB women and OB/non-OB men (Weller et al., 2008), suggesting women are at a higher risk for DD behavior patterns.

Research in DD discusses training alternative behavior as an important component lacking in current interventions particularly among OB individuals (Weller et al., 2008). Intervention research would benefit from a design which assesses an individual’s history of reinforcement and the function associated with DD paradigms to create repertoires of alternative behaviors which target that history and are functionally equivalent.

**Dietary Restraint and Disinhibition.** Dietary restraint refers to a person’s intentional effort to eat less than they would prefer (Schaumberg, Anderson, Anderson, Reilly, & Gorrell, 2016). Dietary restraint can differ from dieting behaviors which are defined as following an explicit eating plan with the goal of achieving weight loss (Schaumberg, Anderson, Anderson, Reilly, & Gorrell, 2016). From an ABA perspective, restrained eating may limit a person’s access to the reinforcement associated with high-energy or highly preferred foods, resulting in access to those foods incurring a state of deprivation. Deprivation then serves to increase the reinforcing value of behaviors associated with obtaining food. In other words, when a person engages in food restraint they are creating a state of deprivation as it relates to targeted
foods, which in turn increases the reinforcing value of behavior to obtain those foods (Epstein, Leddy, Temple, & Faith, 2007).

Van den Bos and de Ridder (2006) highlighted that some of the identified antecedents to eating, such as negative affect, might impact a person’s ability to continue in a restrained eating paradigm. It has been found that failed restraint can serve as an antecedent for increased rates of eating behavior (Schaumberg, Anderson, Anderson, Reilly, & Gorrell, 2016). It was suggested that these antecedents may alter a balance between the reward system and self-control in restrained eaters (Van de Bos & Ridder, 2006). Yet, further research is necessary to determine the functional components of this paradigm and the development of interventions to target determined functions.

Disinhibition is discussed frequently in relation to eating behavior as well. Disinhibition can be defined as a tendency towards overeating in response to stimuli or situations (Weller et al., 2008). In behavior analytic terms, disinhibition is engagement in overeating behavior under stimulus control and occurs when certain stimuli elicit disinhibited eating patterns. When combined with dietary restraint, a pattern of overeating occurs where a state of deprivation is present, increasing the potency of foods under stimulus control. This is particularly true when considering that restrained eaters exhibit stronger automatic approach tendencies and greater wanting for high-fat foods (Roefs, Herman, MacLeod, Smulders, & Jansen, 2005; Veenstra & de Jong, 2010) leading to higher disinhibition in response to stimuli.

**Reinforcement and Relative Reinforcing Value.** Reinforcement is a fundamental aspect of behavior maintenance and is the process which influences the likelihood that a behavior will continue to occur in the future (Miltenberger, 2004). It has been found that OB individuals have a high instance of food cravings and report
that eating has a higher reinforcing value than non-OB individuals (Delahanty, Meigs, Hayden, Williamson, & Nathan, 2002; Rissanen et al., 2002; Saelens & Epstein, 1996). Studies have also shown that persons of OB BMI classifications report high-fat and high-sugar foods to be more enjoyable than non-OB persons report them to be (Stice, Spoor, Bohon, Veldhuizen, & Small, 2008).

When studying reinforcement associated with food intake, research has evaluated the difference between anticipatory rewards of food as compared to reinforcement from actual intake, in the context of calories consumed (Stice, Spoor, Bohon, Veldhuizen, & Small, 2008). One study evaluated the brain activity in OB versus lean adolescent girls, finding the OB group showed increased anticipation of the palatability of a food item. Importantly, this study highlighted the concept of conditioning in the context of anticipating food reward as an important component of a behavioral repertoire of OB needing to be examined.

Relative reinforcing value (RRV) refers to the extent to which a person will expend efforts to gain access to a stimulus in the context of progressive ratio schedules of reinforcement (Rollins, Dearing, & Epstein, 2010). Clark, Dewey, and Temple (2010) were interested in the RRV of high caloric foods between individuals with an OB BMI and those of normal BMIs. Researchers report women with lower BMIs exhibited low food reinforcement and women with OB BMI exhibit high food reinforcement, when the same foods and food quantities were delivered across a 14-day period. Additionally, both groups of women showed a decrease in reinforcement from foods which were low in calories. Authors highlight that OB women report less of a liking of the high caloric foods as time went on, yet continued to work for and select the high caloric foods as reinforcers.
Research has shown that having high RRV for food is associated with higher intake of calories and that OB persons have greater RRV for food reinforcement (Rollins et al., 2010). Both Franlen and Muris (2005) and Davis et al. (2007) suggest women who had an increase in sensitivity to rewards, had higher BMIs, self-reported a higher rate of food cravings and had a higher preference for sweet and fat foods, which also correlated with increased BMI.

Furthermore, many studies have evaluated the effect macronutrient composition of food has on intake (Epstein et al., 2007). It has been repeatedly shown that people choose foods which are considered tasteful to them, or more reinforcing based on taste, and fail to consider the nutrient composition of food (Levine, Kotz, & Gosnless, 2003). It is an important consideration when evaluating food intake, to determine the perceived, or reported, food preference and the actual intake of types of foods (Drewnowski, Kurth, Holden-Wiltse, & Saari, 1992). This is especially important in the case where sugar and fats are concerned, as cravings and high RRV for these two micronutrients are associated with OB (Drewnowski et al., 1992).

While a number of studies have contributed to the understanding of RRV and its presence in individuals, little has been done to assess and alter the contingencies in an applied setting. This is an important area of intervention as reinforcement is what maintains any operant behavior pattern, like eating. This area of eating behavior requires additional, applied research.

**Eating Behavior Patterns**

As stated, there are several maladaptive eating patterns which are developed through functional relationships, yet these relationships are lacking assessment and treatment. It has been noted that maladaptive eating patterns tend to be established early in life and have a long history of reinforcement by the time interventions are
employed. These established repertoires of eating require careful and precise assessment to identify and understand all of the contingencies relating to the behavioral maintenance. This is an additional area for future research to assess and intervene individually.

**Behavior Chains**

Behavior chains are defined as “a specific sequence of discrete responses, each associated with a particular stimulus condition” (Cooper, Heron, & Heward, 2007, p.435). Overtime the repeated presentation of stimuli, behaviors, and consequences, in sequence becomes associated to form a chain. An important component of this process, particularly as it relates to eating, is within the chain each response serves a dual function. That is, each response serves as a conditioned reinforcer for the response itself as well as an $S^d$ for the next component of the chain (Cooper et al., 2007). A hypothetical example of an avoidance maintained eating behavior chain is illustrated in Figure 2.

*Hypothetical avoidance maintained eating behavior chain.*

A number of behavior based therapies report using behavior chain analysis in the treatment of eating disorders, with some success in decreasing symptoms (Bankoff, Karpel, Forbes, & Pantalone, 2012). Specifically, Dialectical Behavior Therapy (DBT), utilizes chain analysis in the treatment of psychological disorders such as borderline
personality disorder, substance use disorders, treatment-resistant depression, and eating
disorders (Rizvi & Ritchel, 2014). The chain analysis used in DBT is adapted from the
principles of operant conditioning, classical conditioning, and functional analysis as
established in ABA and, has shown some success with eating disorders (Rizvi &
Ritchel, 2014).

The work done in DBT related to eating, supports chain analysis as a useful
intervention. That is, when the principles of ABA are applied to components of
behavior chains, it allows for systematic evaluation of and intervention with the
targeted behavior. This concept, a component of habit reversal, is useful in reducing
chained behavior by interrupting the chain and substituting behaviors incompatible with
the problem pattern (Cooper et al., 2007). Research on behavior chains and how to alter
their presence in eating behavior is limited outside of clinical populations, requiring
extension and further evaluation.

**Habit Reversal**

Habit reversal has long been used to successfully decrease a variety of
problematic behaviors using multi-component treatment packages (Cooper et al., 2007).
Azrin and Nunn (1973) described nervous habits originating as normal reactions to an
event, or an engagement in normal behavior which has increased in frequency and
changed topography. Authors described behavior becoming termed as a nervous habit
when it develops to abnormally high frequencies.

As stated, eating behaviors are viewed as individual behavior patterns, denoting
habit reversal as a potentially valuable intervention component. Habit reversal is
particularly useful as the parts of intervention such as, awareness training, competing
response training, and social supports can target the hypothesized maintaining
contingencies of maladaptive eating behaviors described previously (Miltenberger, Fuqua, & Woods, 1998).

When applied to behaviors symptomatic of tic disorders, habit disorders, or stuttering for example, habit reversal produces significant reductions in behavior (Bate, Malouff, Thorsteinsson, & Bhullar, 2011). Reductions extend beyond the period of delivered interventions, creating long lasting decreases in targeted behavior (Bate et al., 2011). Habit reversal has the potential to aid in effective long-term behavior reduction and potential to decrease the amount of weight re-gain seen within problematic eating behavior chains.

An important advantage in the use of habit reversal with respect to the OB epidemic is funding. There is a pronounced drive to decrease OB related health costs worldwide (Withrow & Alter, 2011). Habit reversal has been shown to be equally successful in decreasing behavior, both when therapist contact was a component of treatment and when there was an absence of therapist contact (Bate et al., 2011). Therefore, habit reversal could provide a cost-effective component in a comprehensive treatment package for maladaptive eating behaviors. This is particularly relevant when considering that, like tic disorders, eating behaviors may be primarily addressed by physicians rather than behavior analysts, therefore the validation and dissemination of this technique in varied context could prove useful (Miltenberger, Fuqua, & Woods, 1998).

However, it should be noted that habit reversal might be useful as one component of a larger, function based treatment package. Especially due to the limitations of habit reversal lacking attention to private events, such as emotional responding, one of the identified variables in some binge eating behavior repertoires (Bate et al., 2011). Alternative intervention tactics grounded in ABA for these
instances, such as response cost or differential reinforcement of alternative behaviors have been recommended for evaluation, denoting the individual nature of interventions (Miltenberger et al., 1998; Miltenberger, 2008). Nonetheless, the use of habit reversal is warranted in the investigation of eating behavior interventions.

**Stimulus Control**

Stimulus control can be explained as a person behaving one way in the presence of a previously reinforced stimulus and behaving a different way in the absence of said stimulus (Cooper et al., 2007). The use of stimulus control in relation to weight provides the ability to alter cues in the environment, which suggest to a person to engage in certain eating behaviors (Foster, 2006). In behavioral therapy of OB, participants are often taught to change the environments they come in contact with most often, such as home and work, to reduce exposure to preferred unhealthy foods (Butryn et al., 2011). Recent research has highlighted, what is termed as the “toxic environment”, in relation to food stimulus control, suggesting high calorie and desirable foods are constantly visible and available to consumers (Battle & Brownell, 1997; Brownell, 1994; Horgen & Brownell, 1998, 2002; Wadden et al., 2002). Authors define “toxic” as the increasing rate of contact, advertisement and availability of calorie dense foods which are also low in cost (Wadden et al., 2002). The IOM reported that because there has been essentially no change to the genetics of the generation impacted by OB, focus must be on the social and cultural variables which encourage high calorie diets and decreasing activity levels (IOM, 1995).

Stimulus control is a particular problem among restrained eaters (Papies & Hamstra, 2010). Papies and Hamstra (2010) synthesized a number of studies which suggest that environmental cues elicit strong motivation for eating behaviors. Restrained eaters create a state of deprivation to hedonic foods, environmental stimuli
increase in potency and are more likely to elicit eating behavior. Coupled with the toxic food environment, this eating behavior domain is increasingly susceptible to maladaptive patterns.

Behavioral reemergence due to stimulus control is an additional consideration in the lack of maintenance in weight loss over time by patients. Problematic eating behavior may reoccur when eliciting stimuli are present in different, temporally expansive or non-targeted contexts (Bouton, 2014). Consequently, stimulus control needs to be a component of intervention planning due to the renewal effect, reinstatement, rapid reacquisition or spontaneous recovery incurred within stimulus control paradigms (Bouton, 2014).

Stimulus control is an important component of a treatment package for maladaptive eating behaviors but requires further refinement. But, without assessment and individualization, stimulus control interventions could prove ineffective for those where discriminative stimuli require specific intervention. Additionally, without consideration and interventions on the maintaining variables, current approaches are incomplete in the view of stimulus control as a means of facilitating improved eating behavior (Butryn et al., 2011).

**Eating Behavior and Interventions in Pregnancy**

Results from interventions for women in and around the time of pregnancy show the same limitations as OB interventions (Shirazian, Raghavan 2009). That is, the lack of supports for women has highlighted the need to address weight gain in women of child bearing age, before they become pregnant (Shirazian, Raghavan 2009). Research has demonstrated that health care providers should focus on preventative measures to limit the growing number of OB pregnant women and that minimizing GWG in OB patients is imperative (Shirazian & Raghavan, 2009).
Even though the impact of pre-pregnancy OB and EGWG gain has been clearly outlined and disseminated, there remains a significant lack of successful interventions to prevent these health concerns (Vesco et al., 2014). The current weight control interventions within and around pregnancy are under-researched and under developed (Vesco et al., 2014). Wadden, Webb, Moran and Bailer (2012), report that behavioral weight control interventions research and implementation within pregnant women is critical but lacking (Wadden et al., 2012).

In 2012 Muktabhant, Lumbiganon, Ngamjarus and Dowswell conducted a meta-analysis of randomized control trial interventions for preventing EGWG. Authors evaluated 27 studies totaling 3,964 women to determine the efficacy of current interventions for EGWG. Results did not find a statistically significant difference between the weight gains of OB women in intervention groups as compared to controls. This demonstrated the lack of efficacy in the current intervention options. Likewise, Thangaratinam et al. (2012) evaluated intervention results by intervention type. The authors studied the effects of, physical activity only, diet only or a mixed approach with aspects of both. They assessed 34 studies, with 5,481 women, finding gestational weight gain was lower in the experimental groups as compared to the no intervention group, with largest effects in the dietary only intervention group. However, analysis did not control for pre-pregnancy BMI class, an established variable impacting outcome in previous research (Thangaratinam et al., 2012). Importantly though, the authors found an overall decreasing trend in rates of GDM, HT, PE, and other suboptimal fetal outcomes among mothers in intervention groups compared to controls.

One of the largest barriers to preventing health complications pre-pregnancy and limiting GWG is the large variability of interventions being used and lack of replication
for each (Muktabhant, et al., 2012). There is considerable variation in the components of intervention, persons delivering interventions, quality and intensity (Muktabhant, et al., 2012). This limitation is similar to those identified in eating interventions outside of pregnancy (Muktabhant, et al., 2012). The most significant results can been seen when interventions include some form of behavioral counseling (Muktabhant, et al., 2012). However, the research in reducing weight pre-pregnancy and reducing EGWG, like OB shows a marked lack of function based, individualized interventions. Promisingly, the overall theme of research in eating interventions shows a trend towards recommending more high-quality research to be conducted to determine the most effective intervention for the management of weight around pregnancy (Muktabhant, et al., 2012).

Discussion

While it is known that OB and weight are influenced by factors which are unrelated to behavior; such as genetics; increased weight is the direct result of an imbalance between energy in and energy out (Wadden et al., 2012). The influence behavior has on this imbalance is substantial. Due to this importance, the treatment of weight related behavior patterns must undergo a fundamental change (Roane, Ringdhal, & Falcomata, 2015). Considering the success of function based approaches with other behavior problems and binge eating behavior, functional assessment of eating patterns in OB is necessary (Bosch et al., 2008; Giddings & Miltenberger, 2010; Iwata, Pace, Cowdery & Miltenberger, 1994; Kearney & Silverman, 1990; Lee & Miltenberger, 1997; Stickney et al., 1999; Repp, Felce, & Barton, 1988).

As stated by Carels et al. (2011), it is not likely that all individuals will benefit from, and gain the tools necessary for weight change, using one treatment method. Consequently, the “one-size fits all” approach currently utilized must be improved upon (Carels et al., 2011). It has been established that interventions which follow a
functional assessment and are functionally based to address the maintaining consequences of target behavior, are most effective (Bosch et al., 2008; Giddings & Miltenberger, 2010; Iwata, Pace, Cowdery & Miltenberger, 1994; Johnson et al., 1995; Kearney & Silverman, 1990; Lee & Miltenberger, 1996; Loro & Orleans, 1981; McManus & Waller, 1995; Stickney & Miltenberger, 1998). Future research should focus on the extension of previously identified measures in the functional assessment of eating behavior to populations outside of clinical eating disorders (Stickney & Miltenberger, 1999; Stickney et al., 1999).

Likewise, the components of treatment packages discussed in the current review show some success in weight management interventions. However, a more individualized and function based delivery of components which match a person’s specific needs could increase success and decrease discontinuation and weight regain. Future research should evaluate the delivery of these interventions according to function and individual need.

Despite the need for a paradigm shift in weight interventions, a concerning theme is repeated among weight control research recommendations. Specifically, the development of more intensive treatment protocols to support the needs of individuals who are not meeting weight loss goals has been recommended, despite research establishing that when individuals fail to meet weight loss goals in the early phases of interventions, they are unlikely succeed even when intervention is increased and or expanded (Carels et al., 2012). Research has evaluated the effects of increasing treatment dosage in contexts like extending cognitive behavioral therapy (CBT) sessions from 12 to 24-week courses for the treatment of BED (Mitchell, Raymond, & Specker, 1993), finding this approach still left 33% of participants with BED symptoms at the end of treatment. This suggests that it is not the amount of intervention, but
rather the individualization of treatment which is critical (Mitchel et al., 1993; Redlin et al., 2001). Therefore, it is unlikely behavior will change based on the suggested, more intensive treatment, as opposed to an individualized approach. Coupled with the need to decrease the cost burdens associated with OB treatment, it would be more efficacious to increase the specificity of treatment, rather than implement supplementary protocols.

**Behavior as the Focus**

Interventions, at present, focus on weight change as a means of determining success and typically allows individuals 6-18 weeks to achieve initial weight loss (Carles et al., 2012). This poses a threat to treatment success when considering that behaviors need to change before weight will change (O’Neill et al., 2012). Focus should be on observable and measurable health behaviors rather than weight as a measurement of success and view weight as a terminal goal, after behavior change is established (Carles et al., 2003; O’Neill et al., 2012). Without focusing on changing the behaviors, which have long learning histories and influence weight, patients are not likely to be successful. This concept was discussed by Carels et al., (2003) and reoccurred recently by O’Neill et al. (2012) when recommending the use of tailored and appropriately personalized treatment plans to be developed for those seeking weight control interventions. O’Neill et al. (2012) specified including screening for precise behaviors associated with increased weight, and suggested treatment which focuses on those identified problematic behaviors.

Washington et al. (2014) support this concept in suggesting small and gradual behavior changes over time as preferable and more effective compared to immediate behavior cessation. Yet, little progress has been made towards changing the focus of interventions to treat behavior and rather continue to focus on weight change. Meredith et al. (2014) discussed treatment providers focusing on specific behaviors rather than
weight loss as an important consideration for incentive-based interventions due to ratio strain. If a person is engaging in physical activity and dieting behaviors for extended durations but does not see body weight decrease, the access to reinforcement could be limited increasing the likelihood of ratio strain (Meredith et al., 2014). This is similar to and likely interlinked with the discussion of treatment discontinuation when goal setting discrepancy is present, particularly when goals are not met (Wadden, Brownell, & Foster, 2002). The areas of shaping behavior change and reinforcement scheduling are areas in need of further research and implementation in the applied setting.

**Multi-Disciplinary Collaboration**

Research supports the importance of utilizing multiple behavior change interventions, yet there is a lack of interventions which target all problematic behaviors and the contingencies wherein they exist (Epstein, Salvy, Carr, Dearing, & Bickel, 2010). Currently, interventions treat multiple problematic behaviors when they fall within established treatment protocols and view each behavior as a separate mechanism (Epstein et al., 2010). An example of a more effective treatment would be teaching an appropriate alternative behavior to replace a variety of maladaptive behaviors within the same contingency frame or stimulus class (Epstein et al., 2010). This concept aligns with the literature supporting health literacy as a means to increase a repertoire of healthy behavior, over singular health behaviors. Nonetheless, an important component of increasing health literacy related to behavior change is knowing how to apply the information and when, which is currently lacking. Research states that “this area of multiple behavior change is new, but may prove to be very important as the simplest and most cost-effective approaches to treatment are identified” (Epstein et al., 2010, p.441). Yet, within the field of behavior analysis this concept is not new, but has been identified and used successfully in treatment for decades (Stokes & Baer, 1977). This
further highlights the need for collaboration between the health sciences to pool skills and expertise in creating an effective, evidence-based treatment protocol.

**Definition of Eating Behavior**

Defining problematic eating behaviors both operationally and functionally is an avenue in need of future research. Miltenberger, Fuqua, and Woods (1998) identified the topographical rather than functional definition of tic disorders and related behaviors, treated with habit reversal as a significant limitation (Miltenberger, Fuqua, & Woods, 1998). This limitation is clearly repeated within the eating behavior research, as evident in the literature on behavior dimensions and the definitions of eating mentioned previously (French et al., 2012; Zijlstra et al., 2011).

The recent shift in eating guidelines to focus on dietary patterns rather than specific foods in determining healthy eating creates an improved avenue for the identification of problematic eating. The US Department of Health and Human Services (HHS) and U.S. Department of Agriculture (USDA) discuss the patterns which individuals habitually eat and drink as potentially “more predictive of overall health status and disease risk, than individual foods or nutrients.” Fittingly, individual eating patterns have become the focus of the 2015-2020 Dietary Guidelines for Americans (HHS & USDA, 2010). This change towards individual behaviors highlights two avenues for future research. Firstly, there needs to be more of a focus on the pattern analysis and habitual eating patterns of individuals. Secondly, focus should begin to move away from viewing binge eating as the central concern among eating behaviors and begin to focus on problematic eating behavior determined in individual’s patterns.

Furthermore, evidence shows that healthy eating patterns are associated with decreased T2DM, OW, OB and a small body of evidence supports a relationship between healthy eating patterns and a decrease in neurocognitive disorders and
congenital abnormalities (ACOG, 2013). This is important to consider when OW and OB are attributable to eating patterns and are significant risks in the development of the neurodevelopmental disability of ASD and other cognitive deficits. Considering the potential interactions and relationship between eating behavior, metabolic states and brain function or development, significant evaluation in the betterment of weight interventions is crucial. As this need for accurate and individualized assessment of eating behaviors becomes increasingly clear, the investigation of the application of FBA procedures to problematic eating behavior in all populations is warranted (Guelinckx et al., 2008; McGuire, 2011; O’Neill, 2012; Hearon et al., 2013).

The outcome of Chapter 2 shows an increased risk of ASD when OB and weight related conditions occur in pregnancy, identifying the pre-pregnancy period as a modifiable risk. Research has outlined the time in and around pregnancy as one of the most valuable “teachable moments” for the development of health behaviors among women (Phelan, 2010). The period surrounding and during pregnancy presents itself with an important opportunity to create lasting change in the health of the mother and baby (Sagedal et al., 2013). Moreover, research suggests decreasing excess weight gain in pregnancy could alter the weight of mothers across time and potentially additional pregnancies (Sagedal et al., 2013). However, research has stressed this opportunity as significantly underutilized and in need of change before women become pregnant (Phelan, 2010).

Therefore, it is crucial for health care providers to be delivering preventative and corrective measures to limit the growing number of OB pregnant patients and to minimize gestation weight gain (Sagedal et al., 2013). Successful interventions have the ability to generalize effects to the family environment as a whole and increase the health of all individuals in that environment (Sagedal et al., 2013).
**Conclusion**

OB is a health epidemic of enormous proportions. It is important to recognize that OB and related conditions are firstly behavior patterns which overtime lead to health complications. Interventions have advanced and show some success, yet the persistent increase of this epidemic clearly shows the need for a change. The behavioral aspects of the OB epidemic is undoubtedly a job for behavioral science, particularly ABA. Yet, there is a significant gap in application of the science to eating outside of eating disorder populations. It is plausible that increasing the use of functional behavior assessment and individualized interventions based on function of operant eating behaviors has the ability to increase treatment efficacy in the current treatment protocol. Yet, research in the use and application of these methods is in needed.
Chapter 4

Self-Report Direct and Indirect Functional Assessment of Eating Behaviors in Overweight Women Pre-pregnancy
Chapter 4: Self-Report Direct and Indirect Functional Assessment of Eating Behaviors in Overweight Women Pre-pregnancy

Justification for Study

As found in Chapters 1 and 2, pre-pregnancy OB is a risk factor for numerous fetal complications, including the development of ASD and other DD’s (Brahm et al., 2018a, in press). Chapter 1 found that a high rate of mother and offspring health risks are attributable to environmental factors which are controllable (Brahm et al., 2018a, in press). Chapter 2 found risks which are attributable to OW and OB are significant risks in the development of ASD and other health problems. Chapter 2 also highlighted OB as an influential factor in the development of subsequent risks for ASD, such as GDM. Hence, OW and OB are warranted for investigations aimed towards decreasing modifiable risks factors (Artal, Lockwood & Brown, 2010; Brahm et al., 2018b, in press). However, the area of risk mitigation is significantly lacking in the ability to be assessed (Artal, Lockwood & Brown, 2010). The largest barrier to risk mitigation research, where OW and OB factors are concerned, is the lack of effective interventions as discussed in Chapter 3 (Artal, Lockwood & Brown, 2010; Brahm et al., 2018b, in press). Therefore, research on decreasing weight before women become pregnant, as a means for decreasing risk is required (Artal, Lockwood & Brown, 2010). Yet, the establishment of effective interventions to investigate this risk mitigation are necessary before outcomes can be assessed (Brahm et al., 2018b, in press).

Need for Assessment

OB is a socially significant problem of epidemic proportions (Brahm, Mannion & Leader, 2018, in press). As stated, the “one size fits all” approach to intervention is part of the lack of treatment efficacy (O’Neill et al. 2012; Brahm et al., 2018b, in press).
Thus, an individualized management protocol has been recommended in the treatment of OB, which includes the analysis of individual behaviors that lead to increased weight (O’Neill et al. 2012; Brahm et al., 2018b, in press).

It has been established that interventions which are functionally based and address the maintaining consequences of problem behavior are most effective (Bosch et al., 2008; Gidden & Miltenberger, 2010; Iwata, Pace, Cowdery, & Miltenberger, 1994; Johnson, Schlundt, Barclay, Carr-Nangle, & Engler, 1995; Kearney & Silverman, 1990; Lee & Miltenberger, 1996; Loro & Orleans, 1981; McManus & Waller, 1995; Repp, Felce & Barton, 1988; Stickney & Miltenberger, 1999). Studies have shown that maladaptive eating serves different functions for individuals. Therefore, the identification and treatment of eating behavior according to function is necessary for increased efficacy (Stickney & Miltenberger, 1998; Stickney, Miltenberger, Wolff, 1999; Brahm et al., 2018b, in press). However, there is a clear lack of functional assessment and matched interventions for individuals outside of clinical eating disorder populations as established in Chapter 3 (Brahm et al., 2018b, in press).

Previous research has developed a functional approach to the assessment of eating behaviors associated with BED and BN and suggests promising avenues for adaptation into generalized eating behavior (Brahm et al., 2018b, in press). Yet, the assessment of contingencies surrounding over eating and other problematic eating patterns in non-clinical populations is in need of further work (Brahm et al., 2018, in press). The promising results of previous, function based assessment and intervention literature, warrants extension outside of eating disorders and into eating behavior among non-clinical individuals. Particularly needed is the use of FBA procedures for individuals who are OW or OB (Brahm et al., 2018b, in press).

**Functional Behavior Assessment**
The introduction to Part 2 of this thesis presented the FBA process as an evidence based procedure for gathering information on events which surround behavior. Part 2 identified the FBA as the initial step in the behavior analytic approach to assessment and treatment of problematic behaviors (Giddings & Miltenberger, 2010). Research began developing functional assessment methods for binge eating behavior several years ago (Lee, & Miltenberger, 1997; Redlin, Miltenberger, Crosby, Wolff, & Stickney, 2001; Stickney, & Miltenberger, 1999) and has shown success in interventions matched to the function of behavior (Bosch et al., 2008; Giddings & Miltenberger 2010). Researchers have utilized measures to functionally assess binge eating, primarily in individuals with BED or BN (Bosch et al., 2008; Giddings & Miltenberger, 2010; Lee, & Miltenberger, 1997; Redlin, Miltenberger, Crosby, Wolff, & Stickney, 2001; Stickney & Miltenberger, 1999; Stickney, Miltenberger, & Wolff, 1999). Collectively, authors developed and utilized both direct (e.g., self-monitoring forms, checklists) and indirect measures (e.g., interviews and rating scales) to functionally assess binge eating in clinical populations successfully, but with little done outside of these populations (Lee, & Miltenberger, 1997; Stickney & Miltenberger, 1999; Stickney, Miltenberger & Wolff, 1999; Redlin, Miltenberger, Crosby, Wolff, & Stickney, 2001; Bosch et al., 2008; Giddings & Miltenberger, 2010).

**Direct and Indirect Assessment.** Indirect assessment methodologies include functional assessment interviews (FAI; Lee & Miltenberger, 1997). A commonly used version of FAI is the Functional Analysis Interview Form (O’Neill et al., 1990). The FAI form was designed to assess problematic behaviors exhibited by individuals with DD and is recommended to be modified or adapted to assess problem behaviors in alternative populations (O’Neill et al. 1990; O’Neill et al., 1997; Lee & Miltenberger 1999). Stickney, Miltenberger and Wolff (1999) developed the Binge Eating Interview
(BEI), a modified FAI, for the purpose of binge eating assessment. Authors evaluated the BEI among 16 undergraduate females who reported engaging in binge eating at least twice per-week. Findings show that both real-time and retrospective assessment, through interviews, of the antecedents and consequences of binge eating can be combined for valid evaluation of the maintaining contingencies.

Stickney and Miltenberger (1999) evaluated the use of direct and indirect measures for functionally assessing binge eating behaviors in subclinical individuals. Authors evaluated the CABE and self-administered antecedent check lists and monitoring forms among 22 college students. Results between direct and indirect measures in the identification of events related to binge eating were similar. Yet, results show a more intense report of symptoms retrospectively, suggesting symptoms appear more severe when using recollection to report. These results highlighted the need to combine direct and indirect measures when assessing the variables surrounding eating behavior and present an avenue for adaptation to non-clinical individuals.

**Establishing Operations and Discriminative Stimuli Assessment.** The assessment of S\textsuperscript{d} and EOs is also warranted for investigation with relation to eating behavior, as discussed in Chapter 3. In the context of BED and BN it was found that negative emotional arousal can serve as an EO which increases the reinforcing value of escape from that emotional response (Giddings & Miltenberger, 2010; Michael, 1982;). The opportunity to escape increases the likelihood of escape seeking behaviors to occur in the presences of environmental stimuli which over time have become S\textsuperscript{d} for an escape response class, such as overeating (Giddings & Miltenberger, 2010; Miltenberger, 2004). Additionally, behavior dimensions such as restraint and deprivation can serve as EO’s and, or S\textsuperscript{d} for an escape response (Brahm et al., 2018b, in press). The process of EO and S\textsuperscript{d} formation is present in most operant behavior
paradigms (Miltenberger, 2008) including eating behavior (Brahm et al., 2018b, in press). Therefore, the assessment of EO and Sdq surrounding eating behavior is warranted within a novel functional assessment for eating behavior.

Dietary Pattern Analysis

The USDA and HHS (2010) defines dietary patterns as “the quantities, proportions, variety, or combination of different foods, drinks, and nutrients (when available) in diets and the frequency with which they are habitually consumed” (USDA & HHS, 2010). The USDA and HHS identifies the patterns in which individuals habitually eat and drink as potentially “more predictive of overall health status and disease risk, than individual foods or nutrients” (USDA & HHS, 2010). Fittingly, individual eating patterns have become the focus of the 2015-2020 Dietary Guidelines for Americans (USDA & HHS, 2010).

As described by the USDA/HHS “U.S.-Style Eating Pattern is designed to meet the Recommended Dietary Allowances and Adequate Intakes for Essential Nutrients, as well as Acceptable Macronutrient Distribution ranges set by the Food and Nutrition Board of the IOM” (USDA & HHS, 2010). The limitations in eating pattern allowance within the new guidelines are designed to be generalizable across cultural and individual preferences to provide a universally applicable standard of eating patterns.

As discussed in Chapter 3, there is large variation in the definition of maladaptive eating behaviors. Some research considers eating dimensions (i.e. restrained eating) in the definition of eating behavior and others evaluate components such as duration of intake as definitions of maladaptive (Brahm et al., 2018b, in press). A universal operational definition of maladaptive eating behavior has traditionally been problematic due to the lack of defined eating behavior parameters. Combining the previously identified measures of eating behavior with the novel USDA/HHS
guidelines creates an opportunity to define healthy and maladaptive eating behavior more systematically. This also increases the ability to assess, observable and measurable behavior which leads to health or health problems.

The current shift in eating guidelines, to focus on dietary patterns, rather than specific foods, further highlights the importance of behavior in relation to health. As the need for accurate and individualized assessment of eating behaviors becomes increasingly clear, the investigation of FBA procedures to problematic eating behavior, in all populations, is further warranted (Guelinckx et al., 2008; Hearon, Utschig, Smits, Moshier, & Otto, 2013; O’Neill, 2012). Brahm et al. (2018b, in press) discussed the need to identify and evaluate problematic eating behaviors utilizing the dietary pattern analysis within a functional assessment procedure. However, research using these procedures has not yet been conducted.

**Current Study**

With evidence that eating behavior interventions are ineffective and lacking functional evaluation of individualized behaviors, this study aimed to address those gaps. This study used the USDA/HHS definition of dietary patterns in the assessment and analysis of eating behavior to determine individual maladaptive eating patterns. This study also utilized previously established behavior dimensions and measurements in the identification of eating EO’s, Sd, and patterns to create a measurable definition of eating behavior.

This study then went on to use and expand the FBA methodologies outline by Stickney and Miltenberger (1999), Stickney, Miltenberger & Wolff (1999) and Bosch et al. (2008) to assess the antecedents, behaviors and consequence contingencies of individual eating patterns among sub-clinical OW/OB women of child bearing age.

**Method**
Participants

Participants were three Caucasian women \((n=3)\), within the child bearing years of 24-35 \((M=29.3, \text{SD}=5.5)\). Participants were recruited through electronic postings. All individuals freely volunteered to participate in the study, which received ethical approval from the Research Ethics Committee at the National University of Ireland, Galway in September, 2015.

Women were provided with an informational form outlining the study and instructed to contact the researcher via phone or email if they were interested in participating. Women who contacted the research were given further information regarding what the study entailed and were screened for inclusion and exclusion criteria. If women chose to participate and met criteria for participation, informed consent was obtained, prior to their being accepted.

Inclusion and Exclusion Criteria. Inclusion criteria required women to be between the ages of 18 and 35, with no current or history of an eating disorder, no presence of T2DM or other medical conditions requiring specialized nutritional care.

Exclusion criteria included being under 18 years of age, over 36 years of age, having or previously having a diagnosed eating disorder or having a medical complication which impacted nutritional state or required specialized dietary care (e.g. T2DM, hyperthyroidism, etc.).

Participant One

Ava (all names are pseudonyms) was a 29-year-old Caucasian female who worked full time as a hairdresser. Ava had an intake BMI of 30.5 (Obese I; 5’4”, 178 lbs.) and no history of an eating disorder. Ava reported having engaged in 6 diet programs within the last five years such as Atkins© and Ideal Protein© but reported her weight had steadily increased since ending her last diet two years prior to intake. Ava
reported being unsuccessful with the diet programs because they were too restricting and had an all or nothing theme, where she could not consume any carbohydrates or sugar. Ava reported these diets as making her feel guilty if she broke the rules and that she felt confined within her available intake. Ava identified weekends as her most problematic eating time, explaining that she has been in a pattern of healthy eating during the week and very unhealthy over the weekend days, for two years. Ava reported that she felt “stuck” in this cycle and wanted help learning how to change this eating pattern.

**Participant Two**

Cathy was a 24-year-old Caucasian female graduate student and office worker. Cathy had an intake BMI of 28.4 (Overweight; 5’2”, 155 lbs.) and reported having attempted two diet programs, AdvoCare® and fat free, within the last five years. Cathy expressed concern with her sugar intake and identified herself as having a “sugar addiction”. At intake, Cathy engaged in less than 20 minutes of physical activity per day. Cathy reported her inactivity as a concern due to her job, which required long periods of sitting throughout the day. She discussed knowing inactivity was unhealthy and was looking for suggestions on altering this pattern. Furthermore, Cathy reported difficulties with her ability to engage in healthy eating during the week because of her schedule. Cathy reported having to eat in her car frequently and having very little spare time to eat regularly through the day because of how busy her schedule was.

**Participant Three**

Maeve was a 35-year-old Caucasian female working as a pharmacy lab technician in a hospital and mother of one 4-year-old daughter. Maeve had an intake BMI of 27.1 (Overweight; 5’4”, 158 lbs.). Maeve identified herself as being a “yoyo dieter” for most of her adult life. She reported going on diets to lose weight then
discontinuing her diet and gained back more than she had lost. Maeve identified her most significant concern as her emotional overeating and her feelings of guilt associated with breaking restrained eating patterns. Maeve did not engage in intentional physical activity during the FBA assessment although reported a history of intentional activity three times per week while dieting. During initial intake, Maeve repeatedly discussed counting calories and decreasing consumption of calories throughout her day as being important to her due to her belief that significantly restrained eating leads to weight loss and maintenance. Maeve presented with a great deal of knowledge on how to lose weight but lacked the ability to identify healthy patterns of weight management where restraint was not a theme.

Measures

Demographic Information Collection

A self-constructed questionnaire (Appendix J) provided demographic information on the participant’s age, socio economic status, medical history and history of dieting.

Indirect Assessment Measures

Functional Assessment Interview. The FAI is a 10-part structured interview that allows for detailed data collection on the events that influence problem behavior (O’Neill et al. 1990). An adapted version of the FAI (Appendix B; O’Neill et al. 1990, O’Neill et al., 1997) was used, in combination with the BEI, to assess the variables associated with eating behavior. Questions were asked regarding the behavior itself, potential ecological/setting events, immediate antecedents, temporal antecedents, consequences, the efficiency of the behavior, identification of functional alternative behaviors within individual repertories and history of behavior. The FAI form has been
used in numerous previous research studies and applied contexts and is the standard for FAI structuring (O'Neill, Albin, Storey, Horner & Sprague, 2014).

**Binge Eating Interview.** The BEI (Stickney et al., 1999) is a semi-structured interview, which allows assessment of the antecedents and consequences associated with episodes of binge eating. This 32-item interview identifies potential setting events, history of behavior and variables maintaining binge eating behavior. This scale has been utilized in previous research as an indirect measure for the functional assessment of binge eating behaviors and in the development of function based interventions for BED (Bosch et al., 2008; Giddings & Miltenberger, 2010; Redlin et al., 2001; Stickney & Miltenberger, 1999; Stickney et al., 1999). A slightly modified version of the BEI was utilized (Appendix B) in data collection to identify contingencies associated with intake episodes determined to be problematic. Modifications were made to the language surrounding binge eating in the BEI and change to describe the individual participant’s specific problematic eating behavior.

**Dutch Eating Behavior Questionnaire (DEBQ).** The DEBQ (Strien, Frijters, Bergers, & Defares, 1986) is a 33-item, self-report measure of eating styles which quantifies restrained eating, emotional eating and external eating. Participants answered each item on a 5-point Likert scale ranging from “never” to “very often”. Cronbach’s alpha coefficients and Pearson’s correlation coefficients indicate high internal consistency and factorial validity (Strien et al., 1986). This scale was used to identify the dimensions of behavior which may serve as EO or temporal antecedents to problematic eating behavior (Brahm et al., 2018b, in press).

**Self-report Direct Measures**

**Food Diary Form.** Combination ABC narrative and categorical data was collected through a food diary form, adapted from Bosch et al., 2008 (Appendix F).
The food diary form was a self-report, 7-item measure consisting of type of intake (e.g. meal or snack), internal antecedent’s pre-intake, external variables pre-intake, foods consumed, quantity consumed, internal antecedent’s post-intake and external variables post-intake. The food diary provided recording of the antecedent conditions, eating behaviors and consequences of eating episodes in real time. The form included data collection on previously identified setting events and EO’s related to specific eating instances such as start and stop times, location, social context, amount of food (portion size).

Participants completed the form by marking internal and external antecedents using the provided antecedent checklist, in real time. Variables in the checklist were 27 antecedents adapted from the CABE (Stickney & Miltenberger, 1999) and the Emotional Eating Scale (Arnow, Kenardy & Agras, 1995). Variables consisted of covert antecedents such as “worn out” and “excited” and provided participants with the option to label their own covert antecedent if different than what was provided as examples. Temporal covert antecedents such as “feeling tired” were tracked as well.

External antecedents consisted of environmental conditions such as setting of food intake and the type of food available. Consequence reporting was completed on internal consequences such as feelings of guilt after eating and the environmental consequences like leaving a friend’s house because of eating too much.

**Scatterplot Analysis.** Embedded within participants food diary was data collection for a scatterplot analysis (Touchette, MacDonald & Langer, 1985) on the temporal relations of eating behavior. Participant’s marked the start and end time within the food diary form for each intake instance.

**Dietary pattern analysis**
Dietary pattern analysis was established using the HHS and USDA criteria to identify and define problematic and unhealthy eating patterns. Embedded within participants food diary form was a column for quantitative reporting on the types of foods consumed and the quantity of the food. Total intake was measured for appropriateness of intake based on the guidelines in Table 18.

Table 18: 
*Healthy Dietary Pattern Analysis adapted from USDA Healthy eating guidelines.*

<table>
<thead>
<tr>
<th>Total calories per day should be:</th>
<th>Calories each day should be comprised of:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10% from added sugar</td>
<td>All types of vegetables</td>
<td>2.5 Cups</td>
</tr>
<tr>
<td>Less than 10% from saturated fats</td>
<td>Fruit, particularly whole fruit</td>
<td>2 Cups</td>
</tr>
<tr>
<td>Less than 2,300 mg sodium</td>
<td>Grains of which ½ should be whole grain</td>
<td>6 oz.</td>
</tr>
<tr>
<td></td>
<td>Low-fat or fat-free dairy</td>
<td>3 Cups</td>
</tr>
<tr>
<td></td>
<td>Protein both from animal and plant</td>
<td>5 ½ oz.</td>
</tr>
<tr>
<td></td>
<td>Oils</td>
<td>27g (5 tsp)</td>
</tr>
</tbody>
</table>

**Procedure**

Intake and subsequent meetings utilized telehealth communication systems such as Skype©. Intake meetings included the administration of the self-designed survey and training on completing the ABC diary form, including inter observer agreement (IOA) data collection. During training, participants were asked to recall their food intake through the last 24 hours and enter it into the food diary form. This was done as a teaching procedure on quantifying food, measuring portion sizes and practicing ABC narrative descriptions and checklists with the researcher’s assistance.

After the teaching procedure, participants were given a hypothetical food intake example including breakfast, lunch, dinner, snacks and variables surrounding those intakes. The participant and the researcher each quantified the intake independently
(e.g. a piece of chicken the size of the palm of a hand was entered as three ounces; Appendix F) and entered the data into the food diary. The forms were then evaluated to determine the percent of agreement for each hypothetical food. All participants’ IAO agreement reached 100% during the intake meeting.

Participants were then provided with a food diary form and asked to complete it for 7 days, without making any changes to their routine. Seven days is greater than the three days used in most research currently (Murakami & Livingstone, 2014). This was chosen due to the limited number of studies assessing real time eating behavior for long enough to account for the significant day-to-day variation of eating behavior and consumption (Murakami & Livingstone, 2014). Participants were asked to complete the form before and after all instances of food intake each day. Total calories and other macro and micro nutrient calculations were specially left out of the food diary during assessment to prevent behavior reactivity. Participants were also asked to report the amount of time (in number of minutes) they spent engaged in intentional physical activity per day.

After the seven-day period, participants and the researcher met again. During this meeting, the participants completed the DEBQ. Simultaneously, the researcher evaluated ABC data collection and created a scatterplot of caloric intake. Once an initial eating profile was established and the researcher identified preliminary maladaptive eating behaviors, the FAI/ BEI was administered with participants on those target behaviors and other behaviors identified by the researcher as problematic. After initial diaries were turned into the researcher, new forms were administered with the direction of continuing to collect food diary data until contacted for intervention training (see Chapter 5).

**Results**

123
Ava

Ava’s FBA packet and interview identified weekend overeating (>2,000 calories per day), eating large quantities in social settings (>650 calories per meal) and high fat and sugar consumption (>10% of daily calories respectively) as being most problematic within her eating behavior repertoire. After analysis of Ava’s FBA package, it is hypothesized that her overeating behaviors are multiply maintained (Figure 3). Ava’s overeating is maintained primarily by escape motivated, social negative reinforcement, specifically, escape from undesired social interactions. Secondly, Ava’s weekend overeating is maintained through automatic positive reinforcement by the intake of hedonic, preferred foods. The foods which Ava is targeting for overconsumption are hypothesized to be entering a state of deprivation through the week within a restrained eating paradigm, increasing the likelihood Ava will engage in eating behavior in the presence of preferred foods.

Figure 3.

*Number of times Ava reported consequences of eating behavior in ABC data collection*

<table>
<thead>
<tr>
<th></th>
<th>Social Relief</th>
<th>Tangible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Instances</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Antecedents for overeating (figure 4) were found to be social situations and the presence of preferred foods. Motivating operations were found in hunger, particularly
hunger in the presence of preferred foods which have heightened evocative properties due to the state of deprivation incurred through the week.

Figure 4.
Number of times Ava reported antecedents of eating behavior in ABC data collection

Ava’s self-identified problematic components of eating behavior in her FAI were confirmed though direct data collected, namely weekend overeating. One of Ava’s identified problematic components to her weekends was her rate of eating in social situations and the excess calories consumed in the meals she was selecting in restaurants during frequent visits. Ava reported that she was unaware of how many calories were in the foods she was eating at restaurants until she was asked to total them during the FAI meeting.

An example of one Friday night dinner at a restaurant can be seen in Table 19. Ava was asked to estimate how many calories she thought were in her meal before calculation was completed. She estimated 1,000 but, the actual caloric intake of her meal was 2,910, which equates to 910 calories over what her is considered a healthy total daily consumption, ingested in one meal equation. Additionally, Ava’s sugar, fat
and sodium intake were 3.2%, 36.6% and 850 mg., over the recommended daily intake, respectively.

Table 19. 
Calories consumed by course during Friday night dinner at a restaurant Ava attends regularly.

<table>
<thead>
<tr>
<th>Friday night dinner</th>
<th>Appetizer</th>
<th>Entre</th>
<th>Dessert</th>
<th>Drink</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheesecake Factory®</td>
<td>Fried Macaroni and Cheese ½ portion</td>
<td>Cobb Salad with B.B.Q Ranch Dressing</td>
<td>Chocolate Tuxedo Cream Cheesecake</td>
<td>Water and Mojito</td>
<td>Calories 765 1000 930 215 2,910 cal.</td>
</tr>
<tr>
<td>Target added sugar (&lt;10%)</td>
<td>2.4 g</td>
<td>16 g</td>
<td>53 g</td>
<td>24.9 g</td>
<td>96.3 g 375 calories 13.2% of intake</td>
</tr>
<tr>
<td>Target fat (&lt;10%)</td>
<td>31.5 g</td>
<td>68 g</td>
<td>51 g</td>
<td>0.4 g</td>
<td>150.9 g 1,358 calories 46.6% of intake</td>
</tr>
<tr>
<td>Target sodium (&lt;2,300 mg)</td>
<td>880 mg</td>
<td>1,890 mg</td>
<td>380 mg</td>
<td>0.3 mg</td>
<td>3,150 mg 850 over total daily intake</td>
</tr>
</tbody>
</table>

Scatterplot Analysis. Ava’s FBA package determined that she was most likely to engage in high calorie intake on Friday, Saturday and Sunday. A scatterplot analysis (Figure 5) visually represents Ava’s caloric intake on each day of the week. On Monday, Tuesday, Wednesday and Thursday, Ava successfully maintained her goal of eating less than 1,500-calories per day, which she had set for herself. Her average weekday intake was 1,470.75 calories through baseline. Ava has been adhering to this intake regiment for approximately 2 years. However, on Friday, Saturday and Sunday, Ava more than doubled this figure with an average of 3,341.83 calories. The below scatterplot depicts intake from initial baseline week as well as a second week of data collected after FAI interview. It is hypothesized that Ava’s weekend consumption
slightly decreased during week two due to an increased awareness of her eating patterns. Yet, it is important to note that her consumption remained significantly higher than recommended even with the knowledge of her patterns post FAI.

Figure 5. Scatterplot of Ava’s caloric intake per-day across two weeks.

**Eating Behavior Assessment.** Results from Ava’s DEBQ suggest that she engaged in high rates of external eating and overeating in the presence of desirable foods. Ava reported during her FAI that when she sees food she prefers, she does not think about her behavior and consumes significant quantities, particularly if it is high in sugar content (like cake) but only in the presence of others. Ava also reported that when she is at a restaurant and knows a highly preferred desert is available at the end of the meal, she will eat rapidly as to rush through her meal and gain access to the desert. Ava reported that she will continue to eat until she feels overfull in these settings.

Importantly, Ava reports only engaging in overeating behavior in the presence of social situations. For example, Ava reported having cake in the refrigerator at her place of employment which was left over from a birthday party but that she did not engage in eating it, nor did she feel as though she wanted it. She hypothesized that this
was due to being alone in the environment. However, during the birthday party, while there were numerous people present, she consumed three large slices.

It is important to note the confounding variable of possible satiation due to the three pieces consumed the day before. Yet, Ava reports over eating in the context of others as a frequent pattern and easily follows her set plan when she is alone. This report of only overeating in social settings was confirmed in the assessment of direct data collection measures where large intake instances were only recorded with social setting events.

Additional overeating episodes suggest social situation as an S\text{d} for Ava’s overeating behavior as seen in her antecedent analysis. Ava’s antecedent analysis shows that in the presence of highly preferred foods, Ava will overeat and that her behavior occurs at the highest and most intense levels when those desirable foods are paired with social situations such as being with family or going to restaurants.

The additional setting event of hunger was determined during Ava’s antecedent analysis. It was found that Ava’s most intense rates of eating are when she is hungry and enters into a social situation with preferred foods available. As Ava is in social situations most weekends and engages in restrained behavior during weekdays, putting access to preferred foods into deprivation, this is concerning for her eating behavior going forward.

Ava’s consequence analysis showed two clear categories due to her differential eating behaviors between controlled weekdays and overeating weekend behavior. On the weekdays, when Ava remained within her self-prescribed eating goals, Ava reports feeling happy after her intake most often. On 6 occasions, she also reported feeling excited, satisfied and content with her behavior. These results are similar to those from
Ava’s FAI where she reported feeling positive about weekday eating and enjoys her weekday routines.

During Ava’s FAI, she reported feeling pressure to eat in social situations and that other people, such as her mother and sister, encourage her to eat larger quantities and different foods she intends to. Additionally, Ava reports that her family consistently makes foods that she enjoys the most in an attempt to “be nice.” Yet, Ava reports feeling obligated to eat the food even if she does not want to because of the social pressure embedded in the effort they made to prepare it for her. Ava also reported that when going to restaurants, she frequently eats more than she intends to because of her fiancé’s request to share dishes together. For instance, Ava reported not wanting the appetizer listed in the example in Table 19 but her fiancé asked her to split the dish with him, so she did. Ava reported, and ABC data support her intake as, in part, maintained by socially mediated negative reinforcement through the removal of social prompts to consume foods prepared for her.

Cathy

The FBA process identified Cathy’s most frequently occurring problematic eating behaviors to be large inter response time (IRT) between consumption ($\geq$ 4 hours), infrequent intake of large quantities (>1 serving size) and excessive sugar intake (>10% of daily intake). After analysis of Cathy’s FBA package, it is hypothesized that her problematic intakes are maintained automatic negative reinforcement by removal of hunger and cravings for hedonic foods and escape of frantic states during busy days (Figure 6). Additionally, Cathy’s high sugar obtaining behavior is likely maintained by automatic positive reinforcement through access to preferred, hedonic foods.
Antecedents for overeating were found to be busy days with long IRT between intakes and the presence of preferred foods (Figure 7). Setting events were found in hunger, particularly hunger in the presence of preferred foods which have heightened evocative properties due to the state of deprivation incurred through the day. Finally, it was determined that Cathy is most likely to eat high sugar foods after dinner potentially due to a habit formation maintained by the frequent intake of preferred food after dinner.
Cathy’s food diary showed that she consistently consumed calories at the high end or over her metabolic need according to the IMO’s Estimated Energy Requirements (IMO EER, 2005). Cathy’s daily need based on her age, gender, height, weight and activity level is 1,931 according to the EER equation (EER = 354 - (6.91 x age [y]) + PA x \{(9.36 x weight [kg]) + (726 x height [m])\}; IOM 2005). However, her average daily caloric intake during baseline was 2,504 which equates to an average excess of 573 calories per day. Considering 1 pound of body weight is equal to 3,500 calories, it is likely that Cathy will continue to gain over 1 pound per week if consumption remains stable (Hill, Catenacci & Wyatt, 2006).

Cathy frequently ate lunch at what she considered a healthy alternative fast food restaurant (see Table 20). She reported selecting what she thought were healthy choices yet was unaware of true calorie contents. For example, Cathy was unaware of the number of calories in the dressing and cheese on her salad selection during lunch on

![Figure 7. Cathy’s reported antecedents to episodes of overeating.](image-url)
one of the reported days. During this intake, Cathy consumed 810 calories, or 41.9% of her total daily caloric intake in one meal. Additionally, Cathy’s sugar intake during lunch totaled 89% of her total daily allowance, fat intake was 9.5% over her daily allowance and her sodium intake was 66.3% of the recommended daily intake.

Table 20: Cathy’s calories consumed during Tuesday lunch at commonly visited restaurant as evaluated within the USDA/UHH Guidelines.

<table>
<thead>
<tr>
<th>Tuesday lunch</th>
<th>Entre</th>
<th>Side</th>
<th>Drink</th>
<th>Total lunch intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greek salad full size with chicken, dressing and feta cheese</td>
<td>Panera Bread® bag of chips</td>
<td>12 oz. Coca-Cola®</td>
<td></td>
</tr>
<tr>
<td>Calories</td>
<td>520</td>
<td>150</td>
<td>140</td>
<td>810 calories</td>
</tr>
<tr>
<td>Target added sugar (&lt;10%)</td>
<td>4 g</td>
<td>0 g</td>
<td>39 g</td>
<td>43g 172 Calories 8.9% of daily allowance</td>
</tr>
<tr>
<td>Target fat (&lt;10%)</td>
<td>34 g</td>
<td>8 g</td>
<td>0 g</td>
<td>42 g 378 calories 19.5% of daily allowance</td>
</tr>
<tr>
<td>Target sodium (&lt;2,300 mg)</td>
<td>1,310 mg</td>
<td>170 mg</td>
<td>45 mg</td>
<td>1,525 mg 66.3% of total allowance</td>
</tr>
</tbody>
</table>

**Scatterplot Analysis.** Cathy’s scatterplot analysis (Figure 8) showed that she was eating high yet, relatively even, amounts of calories during each meal of the day, but had large IRT between instances of eating behavior. Data showed an average of four hours between intake during the 7 days of data collection. Cathy reported her daytime schedule as a barrier to eating on a timely basis and that this leads to her most calorically dense meals being consumed at night. Yet, after scatterplot analysis of
Cathy’s intake, it was determined that she was eating high calorie meals throughout the entirety of her day, not just at night as she hypothesized.

At baseline Cathy was completing a master’s degree and working full time. Therefore, she frequently ate in her car during the day while moving between environments. Assessment showed environmental conditions as a factor in her IRT and that Cathy frequently ate in response to what she marked as a “frantic” antecedent. Cathy reported barriers to healthy eating in her lack of appropriate meal preparation and making eating decisions while in, what was reported to be frantic and hungry states. These covert antecedents were found to precede her most calorically dense intake periods.

Figure 8: Scatterplot summary of Cathy’s cumulative intake per two-hour period of the day across seven days.

**Eating Behavior Assessment.** Results from Cathy’s DEBQ suggested that she engaged in high rates of emotional eating and over eating in the presence of desirable
foods. Cathy reported during her FAI that when she is in the presence of food she prefers, she does not attend to the health of the food and consumes large portions of it. Particularly if the food is high in sugar content, such as ice cream. Cathy’s data showed a frequent pattern of eating sweet food after dinner. Baseline data showed the intake of a Dairy Queen™ Blizzard twice and a piece of carrot cake twice during the one week assessment phase. Cathy marked craving sweet food after dinner as an antecedent to dessert intake. This was marked even if she checked full and satisfied with her level of fullness after her dinner intake, suggesting a potential habitual intake whereby behavior engagement may be maintained by access to preferred foods.

Cathy’s antecedent analysis showed that in the presence of highly preferred foods, she will overeat and that her behavior occurs at the highest and most intense levels when those desirable foods are present after dinner. Additionally, Cathy was most likely to overeat on days where she was the busiest and reported “frantic” covert antecedents the most often. The setting event of hunger was also determined during Cathy’s antecedent analysis. It was found that Cathy’s largest portion and highest sugar intakes occur during the dinner and desert periods of days and when she had large gaps with no eating. It is hypothesized that these periods of no food intake created a state of deprivation, making it more likely that Cathy would eat large portions and high sugar foods.

Cathy’s consequence analysis showed that Cathy reported feeling guilty for eating foods she identified as unhealthy. Yet the covert consequence of guilt was experienced after an extended latency from the intake of the hedonic intake. Therefore, it is likely that the reinforcement obtained by the intake of food she was craving was likely stronger than the guilt experienced after intake. Cathy also reported that she will
occasionally attempt to refrain from unhealthy intakes but eventually “gives into” the cravings and consumes the food.

Maeve

Maeve’s FBA results identified nighttime overeating (>500 calories after dinner), restricting calories (<1,200 per day) and high sugar intake (<10% of daily intake) as her most problematic eating behaviors. Maeve’s assessment produced a complicated profile where the same behavior was maintained in varied fashions contingent on setting events and antecedents. That is, Maeve’s overeating on days where she restricted intake was maintained by automatic negative reinforcement through the removal of food cravings and hunger as well as automatic positive reinforcement in the form of access to preferred, hedonic foods. On days where Maeve broke restrained eating patterns, her overeating was maintained by escape motivated automatic negative reinforcement in the removal of negative affect (Figure 9).

Figure 9: Maeve’s reported over eating consequences..
Maeve’s antecedent analysis suggest that she was most likely to overeat when she experienced the covert antecedents of disappointment or failure (Figure 10). However, those antecedents did not occur without the instance of breaking restrained eating earlier in the day. This suggests that breaking restrained eating patterns could be eliciting the covert antecedents and increasing her self-reported negative affect.

Furthermore, data suggest that restrained eating was a setting event for her nighttime over-eating. On days in which Maeve restricted her caloric intake during the daytime hours, she was more likely to overeat during the nighttime and report the antecedents of craving and hunger to be stronger. Restrained eating and breaking restraint are both hypothesized to be temporal EOs for over-eating episodes for Maeve.

Figure 10. *Maeve’s reported over eating antecedents.*

<table>
<thead>
<tr>
<th>Antecedents to Over-eating</th>
<th>Number of Occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disappointment</td>
<td>5</td>
</tr>
<tr>
<td>Failure</td>
<td>5</td>
</tr>
<tr>
<td>Hunger</td>
<td>6</td>
</tr>
</tbody>
</table>

Foods with which Maeve was most likely to engage in over eating were categorized as open-ended foods or food which did not have a clear start/stop by portion
size. Examples were eating M&M’s© out of a large bag, eating from a full-size pizza (i.e. not portioned out slices). Foods targeted for overconsumption most often contained high sugar content.

During Maeve’s FAI, it was found that she intentionally ate less than what was satisfying on most days of the week as an attempt to control her weight and felt disappointed when she ate more than intended. When the internal consequences of guilt or disappointment occurred, it was found that she often discontinues restrained eating for the day. This was reported to be a result of feeling like the day has been “ruined” if she surpasses the restriction she set for herself. Consequently, Maeve proceeded to eat all of the items she had denied herself and planed how she would re-start her restrained behavior the next day.

**Scatterplot.** Scatterplot analysis (Figure 11) revealed that over-eating occurred most often on days where Maeve intentionally restricted caloric intake before 7:00 PM. That is, days where Maeve attempted to eat less than 1,200 calories most often resulted in overeating at night time. Additionally, Maeve engaged in over-eating behavior most often when her daughter was out of the house for the night or after she went to sleep and Maeve was alone watching TV. As seen in Figure 11, Maeve also ate what is considered a backwards day. Meaning she consumed very little in the morning, typically a 180-calorie protein shake, followed by increasingly large amounts. The consumption of increasing quantities through the day and the feeling of being full was determined to be a setting event for Maeve’s later overeating behavior as she considered feeling full as failing at her attempt to restrict calories for the day. Importantly, the one day where Maeve did not restrict calories pre-7 P.M she did not engage in overeating behavior in the evening.
Eating Behavior Assessment. Results from Maeve’s DEBQ suggested that she engaged in high rates of emotional eating and restrained eating. These results were similar to the outcomes of Maeve’s FAI finding she overeats frequently in response to negative affect. Importantly, scatterplot analysis and food diary analysis showed that the day where Maeve ate a balanced number of calories through the day she did not overeat.

Discussion

This study used self-reported direct and indirect measures to identify and functionally assess maladaptive eating behaviors among non-clinical OW and OB women. The study assessed the efficacy of data from both real-time assessments (monitoring forms and antecedent checklists) as well as retrospective assessments (interview and questionnaire) on the setting events, EO’s, antecedents and
consequences of maladaptive eating behaviors. Results from participants FBA packages show that all three women had similar, yet topographically and functionally, different eating behaviors. Furthermore, while each of the three women were either OW or OB, the behavioral contingencies which lead to those health concerns were different for each.

Ava’s results of over eating behavior were somewhat unexpected considering previous research suggests binge eating is most likely to occur in social settings where positive affect was present (Grilo, Shiffman & Carter-Campbell, 1994) and some research identified social situations as being inhibiting for the majority of binge eaters (Heatherton & Baumeister, 1991). Yet, Ava’s overeating behavior in social situations was present when combined with socially mediated prompting and overeating only occurred in the context of social situations. These results further support the individual nature of eating behavior, particularly outside of BED and BN. While some patterns found in BED and BN are clear from previous research, further investigation is required to assess behavior of individuals, rather than group based behavior, to persons without clinically disordered eating. This concept was highlighted in Chapter 3 as a limitation of current research and is supported by the current data.

Maeve’s profile revealed chronic restrained eating and disordered eating patterns (Slevec & Tiggemann, 2011), yet she did not meet the criteria for a clinical eating disorder as per the DSM (V) criteria and her BMI was not high enough to warrant medical intervention in standard treatment protocols (DSM, 2014). However, Maeve’s disordered eating pattern presented concern for her future health. Disordered eating in middle-aged women, 35-55 years old, is a novel area of focus in the literature (Slevec & Tiggemann, 2011). Research shows that there is a growing prevalence of maladaptive eating behaviors among women during middle-age (Slevec & Tiggemann, 2011).
Results show that 13.4% of women report eating little to nothing during the day as a means to control their weight (Marcus, Bromberger, Wei, Brown & Kravitz, 2007). Coupled with Maeve’s eating pattern, this presents concerns for her physical health, as she has been engaging in this pattern for 10 years. Furthermore, this presents a concern for Maeve’s future desired pregnancies, as she reported gaining over 50 pounds, 25 pounds above what is recommended, with her first daughter and that her eating patterns have been worse since that pregnancy. Future research should focus on decreasing disordered eating patterns as early as possible in an effort to prevent occurrences in all phases of life including the important child-bearing years as well as prevent carry over into middle age.

All three of the participants in this study reported an increased understanding and awareness of their behavior during the debrief meeting. This increased awareness highlights a necessary component for future intervention in the training of caloric, micro and macro nutrient intake individuals are consuming and the associated patterns. The increased awareness also supports the FAI/BEI being administered post direct assessment as important in controlling for reactivity effects on eating behavior. It was hypothesized that if participants were interviewed on their maladaptive eating pre-data collection, it could have altered their subsequent eating behaviors as awareness would have been increased. This can be seen in Cathy and Ava’s post baseline interview where each participant was unaware of how much they were consuming and what their food choices consisted of. This is concerning when considering patterns like Cathy’s where she was habitually eating enough to gain 1 pound per week without understanding her behavioral outcomes. However, if this was highlighted pre-data collection, there is the possibility of altered eating patterns due to this awareness. If behavior were to be altered during baseline due to an increase in knowledge, the data
collected would be invalid. This could lead to the development of inappropriate interventions and behavioral persistence. Therefore, these results support the necessity of blind data collection to occur first and FAI secondly.

Awareness also provides area of necessary training for intervention where health literacy and awareness training can assist. Future research should work to utilize data produced from FBA packages to tailor awareness training and replacement behaviors through health literacy as highlighted here and discussed in Chapter 3 in combination with direct and indirect measures of accurate data. Yet it is important to note that awareness did not appear to change behavior enough to make a significant change in individual health repertoire, supporting the need for tailored interventions.

**Assessment of Behavior.** This study offers a variety of novel approaches to eating assessment. This is the first study, to our knowledge, to assess maladaptive eating behaviors functionally within the eating pattern guidelines and the first to functionally assess eating behavior outside of binge eating. Furthermore, this study was the first to functionally assess eating behavior types and patterns for non-clinical OB and OW individuals of childbearing age.

This study utilized the current HHS and USDA dietary guidelines pattern analysis in the identification of problematic eating behavior. Utilizing the current eating pattern guidelines gave measurable parameters for identifying problematic eating and habitual patterns leading to health concerns. Eating behavior patterns were easily defined using the guidelines, as the data outcomes were assessed using behavior analytic methodologies such as scatterplot analysis for temporal relations and patterns of eating.

Scatterplot assessment of intake components such as IRT and duration were utilized to identify relative eating behavior dimensions for each participant. Scatterplot
analysis allowed for a further examination into the temporal distributions of eating behavior as related to specific environmental events and eating patterns. Results of the scatterplot analysis show some discontinuity between participants evaluation of their behavior and the real-time data collected. Cathy reported eating her most calorically dense meals at night but analysis showed high calorie intake through the entirety of her day. Inversely, Ava was able to accurately identify her most problematic eating as being over the weekends in social contexts. This further shows the individual nature of behavior and supports the necessity for comprehensive, individual assessment.

After the identification of maladaptive eating behavior was established, this study used modified versions of previously established measures to functionally assess those behaviors. Using modified versions of the BEI and FAI, this study was able to effectively identify maladaptive eating patterns, their setting events, antecedents and consequences. This assessment package effectively evaluated and provided information on the currently absent functions of behavior related to OW/OB, by giving information on the consequences of behavior. This was the first use of the combined BEI and FAI in the assessment of non-clinical eating behavior, to our knowledge. Moreover, this was the first functional assessment battery evaluated with non-clinical eating behaviors outside of binge eating, to our knowledge. The results of this research supports the necessity to individually assess eating behavior in relation to the current OB epidemic and establishes preliminary framework for assessment, not otherwise available. Without the individual assessment of each person’s behavior it is unlikely that all of the maintaining variables within each repertoire would have been clearly established.

**Future Research.** This study contributes to our understanding of maladaptive behaviors as well as the operant functions that each behavior may serve for an individual. Results show that each participant had similar weight status yet each had
different eating behaviors, setting events, antecedents and consequences, further supporting the need for individual assessment and function based treatment. Future research is needed to extend the evaluation of this procedure in additional and larger populations. Moreover, future research is needed on using the results of this assessment in the design and implement function based treatment for eating behaviors. Meredith et al. (2014) discuss the need for an established framework to tailor the implementation of interventions across multidisciplinary fields. This research aids in the development of such a framework, though further research is necessary to evaluate its generality.

As mentioned in Chapter 3 there is a clear need for the assessment and treatment of weight related behavior patterns in women of child-bearing age. Coupled with the results from Chapter 1 and 2 showing an increased risk in ASD and other suboptimal outcomes when OB was present, this study established an avenue for understanding this health concern from a behavior analytic perspective. Additionally, this study creates an ability for increased understanding of the behavior patterns leading to OB development and how to treat them.

**Conclusion**

The current study is a novel extension of previously established framework for the assessment of functional relationships within eating behavior patterns. The findings suggest that the use of self-reported direct and indirect measures provide substantial data with ease of use to both the participant and researcher. Findings suggest that a simple FBA could prove useful in the identification of eating behavior contingencies among nonclinical populations with OB related behavior patterns. This study has far reaching implications for the assessment and treatment planning in relation to the OB epidemic and potential in controlling for weight mediated health risks.
Chapter 5

Function Based Individualized Intervention for Problematic Eating Behaviors in Women of Childbearing Age
Chapter 5: Function Based Individualized Intervention for Problematic Eating Behaviors in Women of Childbearing Age

Justification for Study

Chapter 3 established the need for interventions to decrease weight globally and a specific need to decrease the weight among women of child bearing age (ACOG, CDC; Brahm et al., 2018b, in press). Previous studies which target weight change in women of child-bearing age specifically have primarily been randomized control trials that investigated large numbers of women who were provided with generalized recommendations, but not tailored to individual need (Bogaerts et al., 2013; Guelinckx, Devlieger, Mullie, & Vansant, 2010; Hartmann-Boyce, Johns, Jebb, & Aveyard, 2014; Hui et al., 2014). Previous treatments have shown to be minimally effective in the decrease of weight, prevention of weight regain and require further research (Brahm et al., 2018b in press; Bogaerts et al., 2013; Guelinckx, Devlieger, Mullie & Vansant, 2010; Hui et al., 2014).

As stated in Chapter 3, investigation needs to focus on the individualization of weight management strategies and increase the delivery of intervention components matched to the function of each person’s behavior. This gap is problematic considering areas such as health policy and promotion display a need for the individualization of weight supports, particularly in the years leading up to pregnancy, to increase efficacy (ACOG, 2013, CDC, 2016; Brahm et al., 2018b, in press). Therefore, the development of successful, individual weight interventions pre-pregnancy is crucial. Chapter 3 highlighted the need for function based approaches in changing weight behavior to aid the improvement of interventions and noted the lack of individual function as being a barrier to weight management at current and an area for future research.

Chapter 4 supports the advancement of individualized, function based
assessment of eating behaviors. Chapter 4 utilized a novel FBA package for the identification of maladaptive eating behavior patterns and the identification of contingencies surrounding those behaviors. Importantly, Chapter 4 showed that each individual displayed similar OW status, yet different behaviors leading to OW and different contingencies maintaining those behaviors. These findings support previous research hypothesis that individualization is needed for effective treatment. Therefore, the design of interventions utilizing FBA information, to target maintaining variables is crucial to behavior change success and a recommendation for future research (Carr, 1977; Umbreit & Ferro, 2015; Umbreit, Ferro, Liaupsin & Lane, 2007).

**Intervention**

As discussed in Chapter 3, there are a number of intervention strategies which have been developed to target eating behavior change. Procedures such as habit reversal and stimulus control have been used but have had minimal effect when delivered. It is hypothesized that this is due to the gap in functional assessment of behavior making it necessary for future interventions to include assessment of behaviors and select interventions which match assessment outcomes (Brahm et al., 2018b, in press; Umbreit & Ferro, 2015). Altering the delivery of intervention components to match function and to be delivered based on individual needs has the ability to increase efficacy of interventions (Umbreit & Ferro, 2015). Using the outcomes of Chapter 4, it is possible to implement the established components to interventions presented in Chapter 3, but apply them in ways which match the function of behavior and are individualized to need. Implementing previously established intervention strategies and increasing the efficacy of their delivery to function matched protocols need to be evaluated.
Self-Monitoring and M-Health Technology

Self-monitoring of behavior has traditionally been difficult in behavior change procedures (Pagoto & Bennett, 2013). Challenges in response effort associated with data collection, particularly the knowledge necessary to collect accurate data have been well established (Turner-McGrievy, Beets, Moore, Kaczynski, Barr-Anderson, & Tate, 2013). Barriers have been found in the cumbersome nature of food data such as type of food, amount, calories per serving, number of servings, micro-nutrients of the food and macro-nutrients (Turner-McGrievy et al., 2013). Although data collection is burdensome, it is important, as it leads to improved weight loss (Warziski, Sereika, Styn, Music, & Burke, 2008).

As a means to reduce the response effort of data collection, intervention research has begun utilizing mobile devices, or M-health technologies (Stephens & Allen, 2013). M-health technology has been found to be a useful part of interventions in the prevention of disease related to OB and other modifiable risk factors (Stephens & Allen, 2013). When combined with traditional components of interventions, M-health has been shown to be a successful addition in decreasing weight, waist circumference, BMI, fat mass, intake of sugary drinks and increasing physical activity (Stephens & Allen, 2013). Findings show M-health technology reduces the response effort through ease of use, accessible data bases of foods and exercises, embedded calculations, goal setting, major and macro nutrient tracking and tailored feedback (Higging, 2016; Turner-McGrievy et al., 2013). Mobile phones and applications also make it more likely that participants will engage in self-monitoring through data entry, which is an important factor in their success (Higging, 2016; Turner-McGrievy et al., 2013). Research should further evaluate the use of mobile phone application for self-
monitoring of behavior with participants with further specificity through individualized eating behavior interventions.

**Reinforcement**

Differential Reinforcement (DR) refers to the process of withholding reinforcement for a targeted behavior and delivering reinforcement for other behaviors or other rates of behavior (Marcus & Vollmer, 1996). Marcus and Vollmer (1996) highlighted that DR is the most common approach for the treatment of aberrant behavior, yet there are limitations to its application. There are five categories of DR procedures, namely; (1) differential reinforcement of higher rates of behavior (DRH), (2) differential reinforcement of lower rates of behavior (DRL), (3) differential reinforcement of other behaviors (DRO), (4) differential reinforcement of incompatible behavior (DRI), and (5) differential reinforcement of alternative behaviors (DRA). In all of the DR procedures, problematic behavior changes by withholding reinforcement based on the occurrence of targeted behavior, or extinction (Petscher et al., 2009). Instead reinforcement is delivered contingent on engagement in higher rates of appropriate behavior, lower rates of problematic behavior, behavior other than the target, behavior incompatible with the target, or specifically selected alternative behavior(s) (Petscher et al., 2009). DRA is a commonly used behavior analytic procedure to decrease the presence of unwanted behaviors and reinforce engagement in specifically selected alternatives (Petscher et al., 2009).

Within function based interventions, it is necessary to determine the maintaining variables of problematic behavior in order to implement an extinction procedure, while increasing replacement behaviors (Petscher et al., 2009). Yet, removing the maintaining variable for behavior alone is unlikely to produce lasting and appropriate
behavior change (Petscher et al., 2009). The reinforcement of alternative patterns of behavior is crucial to the maintenance of extinction, whereby novel behaviors become conditioned into established repertoires (Bouton, 2014). Differential reinforcement procedures offer an avenue for intervention on eating behaviors, utilizing data from FBA procedures paired with an understanding of individual replacement needs. Future research should consider the use of DR in eating behavior interventions following an FBA.

Health Knowledge and Literacy Intervention

An approach for improving health through dietary change was evaluated in the delivery of health education (Parmenter & Wardle, 1999). It was hypothesized that educating people on healthy diets and the implications eating has on health, people would independently alter their intake (Parmenter & Wardle, 1999). Yet, research has shown that education to improve diet has failed to change behavior (Parmenter & Wardle, 1999). Limitations were found in the individualization of education, participant’s inability to apply the education and their need for supports in behavior change (Parmenter & Wardle, 1999). Additionally, the discrepancy between knowledge and behavioral outcomes were found in poor knowledge assessments (Parmenter & Wardle, 1999).

The use of valid measures in the assessment of health knowledge has the potential to increase the individualization of interventions, targeting the skills and knowledge that individual’s need. As well as the ability to increase health literacy, an established barrier to current health (Brahm et al., 2018b, in press). Furthermore, the identification of health knowledge limitations provides the opportunity to create
functional and healthy replacement behaviors for maladaptive patterns which can be embedded into DR procedures, but requires investigation.

**Replacement Behaviors**

It has been established that learning new behaviors and creating an extinction condition for previously reinforced behaviors does not permanently replace old behavior (Bouton, 2014). Rather, it has been suggested that previous behaviors diminish, yet are consistently available for resurgence (Bouton, 2014). Resurgence can occur, and likely will occur, without functional replacement skills which can take place of the target behavior and continue to keep target behavior in extinction (Bouton, 2014). Therefore, replacement behaviors which are functionally equivalent to the problem behavior are necessary to increase the likelihood of behavioral maintenance (Bouton, 2014).

Yet, as stated in Chapter 3, functional replacement behaviors need to be equally reinforcing and importantly, established within a person’s repertoire such that they can readily engage in the alternative behavior as easily as the target. Furthermore, as discussed, a movement away from dieting behavior and into more health conscious behavioral repertoires is needed. Especially when considering that research has shown traditional dieting and weight loss practices tend to increase binge eating, weight gain and OB (van den Akker, 2014). Consequently, interventions should assess the validity of functional replacement behavior repertoires within health literacy and DR interventions.

**Current Study**

This Chapter will utilize the results from the FBA process presented in Chapter 4 to design intervention packages which are individualized, matched to function and
target the maintaining variables associated with each participant eating behavior patterns. Additionally, Chapter 5 will use M-Health technology, health literacy assessment, matched stimuli replacement, components of previous interventions delivered matched to function, and DR procedures to decrease maladaptive eating behaviors and establish repertoires of novel, functionally equivalent healthy eating behavior.

**Methods**

**Participants**

Participants were three (N=3) women, within the child bearing years of 24-35 (M=29.3, SD 5.5). Participants for this chapter were the same participants in Chapter 4. Results from participants’ Chapter 4 FBA were used to create the function based intervention packages in this chapter. Components of interventions were selected, in part, from the interventions reviewed in Chapter 3, as well as the outcomes of measures used in this study, and delivered to match the function and preference of each individual’s behavior.

**Measures**

**General Nutrition Knowledge Questionnaire (GNKQ).** The GNKQ (Appendix D) is a 50-item, multiple choice, assessment of general knowledge designed to assist with the planning and designing of educational interventions for dietary behaviors. Questions are categorized into four sections. Section one assesses respondent’s knowledge of recommended dietary intake. Section two covers information on food group knowledge and the nutrients contained within each food group. Section three assesses a person’s ability to select foods based on specific dietary goals such as selecting the lowest fat soup from three examples. Section three also
assesses a person’s ability to accurately read food labels. Section four assesses a respondent’s knowledge of the health risks and disease risks associated with diet and weight. The measure has been shown to have high construct validity, internal reliability, and test-retest reliability. The GNKQ was administered pre-intervention to determine variables for increasing health literacy and replacement behavior planning.

**Goal Setting Questionnaire.** A custom made questionnaire (included in Appendix G) was used in the two-step goal setting process. Firstly, each participant was asked to identify their five most important goals. Then each goal was systematically separated into short objectives which were easily targeted on a weekly basis. Goals were broken into 3-5 objectives to increase the likelihood that participants would successfully meet the criteria set for them each day. Goals and objectives were measurable and specific, for example the goal of losing 20 lbs. was broken into losing 1 lbs. each week by decreasing caloric intake by 500 calories per day.

**Eating pattern analysis.** Eating pattern analysis of micro and macro nutrient was defined using the HHS and USDA guidelines and occurred within the FBA process (Chapter 4). Additionally, dimensions like frequency of intake and IRT between intakes were consistent problematic eating behaviors targeted within this intervention.

**Preference assessment.** A 10-item rank order preference assessment was administered within this study. Preference assessment consisted of 10 blank lines which participants were asked to fill in based on their top 10 most preferred objects or activities, which were not food related. Participants were asked to identify the objects and activities, then place them in a most to least rank order of how willing they were to work to achieve these items.

**Matched Stimuli Replacement Assessment.** A stimulus preference assessment was utilized for each participants most highly consumed, unhealthy foods
Assessment evaluated the preferred components of food based on taste (sweet, bitter, sour, salty and savory) and food texture (soft chewy, hard chewy, crunchy, smooth and thin liquid). Assessment asked participants to rank their preference for a variety of foods listed within each of the food groups and then assessed the matched traits of each food. Assessment focused on identifying and rank ordering the relative components of food targeted for overconsumption.

**My Fitness Pal (MFP).** MFP is a free weight management website with corresponding mobile application (iOS, Android and Windows Mobile capabilities) which allows users to track their weight, food and exercise in real-time. MFP has a database of food and exercises of over 1,000,000 verified items for accurate food logging. Logging food allows for the immediate analysis of the target variables of (a.) portion size (b.) calories (c.) micro-nutrients (d.) macro-nutrients (e.) timing of intake (f.) meal or snack, among others. Furthermore, MFP allows users to share their data in real time with other select users and for users to interact on a private platform. Data sharing is password protected for security and confidentiality and conversations are kept private. This feature allows for researchers to access data collection easily and provide real-time feedback and prompting. MFP also includes an exercise data base which allows users to track their activity on a daily basis. Compatibility and interaction with additional movement tracker applications (e.g. iOS Health App™ step tracker) allows for daily tracking of activity level.

MFP allows for specific user profiles and the customization of individual intake needs, goal setting and monitoring. MFP allows for the visual representation of self-selected goals and objectives through the use of graphs and charts (Appendix H). The application also allows users to set self-selected alarms to single behaviors (Appendix
Personalized reminders can be set to remind users to engage in activity, log their food, warn when they are approaching the daily intake limit for a certain nutrient, among others (Appendix H).

Lastly, when users enter the last intake of their day, MFP offers users an approximate ‘weight in 5 weeks’ time if consumption remains in the same pattern. MFP gives a notification stating “If every day were like today… You’d weigh ____ lbs. in 5 weeks*.” MFP does state that “*Your projected weight loss is an estimate based on your total net calories for today. Actual results may vary.”

Acceptability Questionnaire (AQ). The AQ (Appendix I) is a self-report measure social validity measure used to assess the ease and acceptability of treatment packages, developed by Bosh et al. (2008), as an adaption of Redlin et al., (2001) measure. A modified version of the AQ social validity measure consisting of five questions was used in this study. One question evaluated treatment integrity measured by the percentage of time each participant engaged in the intervention protocol. The next four questions utilized a Likert scale of 1 to 7 to assess the ease of treatment, how disruptive treatment was to their daily routine, how time consuming the treatment was, and how helpful they found the treatment to be in changing their eating behavior.

Experimental Design

A concurrent multiple baseline across behaviors design was used to target eating behaviors for each participant (Kazdin & Kopel, 1975). Following stable baseline, intervention packages targeted behavior changes in a step-wise fashion across three separate behaviors per-participant. A range bound changing criterion design (McDougall, 2005) was used to establish and monitor activity level each week for one participant.

Procedure
Baseline

Baseline data were analyzed from continuation of data collection procedure, post FBA process described in Chapter 4. Baseline information was obtained during pre-intervention meetings which were conducted in the same manner as meetings from Chapter 4. During the pre-intervention meeting, women were coached on the principles of behavior as well as the contingencies maintaining their maladaptive behavior (i.e. automatic, attention, escape/avoidance, access to tangibles). It was important for women to understand the eliciting stimuli and maintaining consequences of their eating, as a large component of this intervention is self-monitoring. Women were also taught to identify temporal relations of their eating behavior. Participants were asked to complete the GNKO, stimulus preference assessment and goal setting in pre-intervention meetings to determine dependent variables, reinforcers, skill targets, and goals.

Dependent Variables

Individualized DVs were determined based on the results of participants’ FBA packages and are listed in each participants’ intervention protocol below.

Independent Variables

Individualized intervention packages focused on antecedent modifications to decrease the presence of EO’s which increase the reinforcing value of the maintaining variable and $S^d$ which elicit maladaptive eating behaviors. Importantly, intervention also focused on decreasing the reinforcing contingencies of eating while establishing a repertoire of functional replacement behavior. Individual independent variables can be found in each participant’s treatment package outlined below.

Treatment Applied to all Participants
The treatment package components presented below were utilized with each participant. Components were individualized where necessary to target specific behaviors and/or functions of behaviors. Further individualization of treatment specific to need can be found in participant’s protocols.

**Goal Setting.** As stated in Chapter 3, inappropriate goals or disagreement between participant and intervention with regard to goal setting can lead to discontinuation of interventions. Therefore, the establishments of goals occurred during pre-intervention meetings with the researcher to increase the likelihood that participants would select and be prepared for appropriate behavior change. Goals were aligned with the USDA/HHS healthy guidelines described in Chapter 3.

During pre-intervention meetings, participant’s goals were broken down into weekly objectives targeting systematic behavior change. During each week of intervention participants were presented with an objective and strategies to target the objective. Behavior change targets were implemented in a stepwise fashion from closest to current levels of behavior, through significant changes. Starting with where participants were already successful, goals changed using data driven results and small systematic increases.

At the end of each week, participants were presented with a summary of their progress on goals from the week, and given a new set of goals for the coming week. If previous weeks goals were not met, an evaluation of the barriers to progress was conducted through discussion with participant and data review. Supports were implemented (e.g. increased prompting) and goals continued until criteria was met. Additionally, preventative measures were implemented during the weeks to prevent errors or lack of goal attenuation, described below.
Self-monitoring. As stated, self-monitoring was an important skill addressed during intervention. Self-monitoring was established through the recording of caloric, micro and macro nutrient intake daily as well as though activity monitoring, by using MFP. During the first treatment session, participants MFP applications were synchronized with the researchers online MFP page. Participants gave the researcher access to their password protected food diaries and an online group between the researcher and participant was formed for monitoring and feedback purposes.

MFP goals were created and set to match each participant’s goal for the week (e.g. eat less than 100 g of sugar a day). MFP allowed for the simple tracking of goals each day and were set to deliver warnings when participants were approaching their max intake. MFP also allowed for the setting of alarms to remind participants to eat a small meal where IRT was a setting event for overeating behavior (see picture 9 in Appendix H for Cathy’s MFP alarm example).

Health Literacy. The results of the GNKQ allowed the researcher to determine specific knowledge deficits among participants in regard to appropriate diet. The researcher created lessons to be delivered with the participants as a means to increase knowledge and skill level on nutrition and exercise behaviors and to create functional replacements for targeted behaviors. Information was delivered both within the written instruction sheet for each week delivered to participants, messages sent through MFP and discussion with participants.

Matched Stimuli Assessment. A significant component to participant’s health literacy is the selection of alternative foods which provide reinforcement equal to the current unhealthy consumption. After completion of the matched stimuli assessment, participants and the researcher identified the preferred components of foods most often targeted for overconsumption (e.g. high sugar content). Participants were given a
variety of resources for determining healthier versions of their favorite foods.

Participants were presented with a list of mobile phone applications such as Pinterest®, Healthy Eating Meal Planning®, Recipes.com®, Healthy Fast Food® and Hello Fresh® which allowed for the identification of alternative foods. Each participant was trained on identifying components of foods which they preferred the most (e.g. the sweet taste) and to select alternative items through the applications.

Participants were trained to review the applications while preparing meals for the day or when presented with the occurrence of eating outside of prepared and planned meals. This was used to decrease the response effort in alternative selections and to provide participants with accurate information on their choices.

**Antecedent Intervention.** A component of self-monitoring was embedded within participant’s antecedent intervention. Participants were taught to enter their food selection into MFP before consumption, rather than after. This was used to provide the participants with accurate information regarding how much they are eating and what their foods were comprised of. This strategy also gave participants the opportunity to make a different selection where necessary because they were able to view the outcome of their selection behavior consumption. From that data, participants could make selections which met their goals.

Lastly, this step supported the habit reversal component to intervention. It was found that participants were eating in a habitual manner and avoiding the outcomes of their behavior. This step served to alter their behavior chain by interrupting the previous pattern and decrease any ability to engage in a delayed discounting (DD) paradigm. Additionally, where avoidance of intake was present, viewing real time data before consumption placed avoidance on extinction and required the evaluation of behavior.
Stimulus control. Each participant was provided with individualized stimulus control interventions, reported below. Focus was placed on $S^d$ which were identified through the FBA and baseline packages. Additionally, stimulus control was utilized to alter the portions participants were consuming and re-train appropriate portion sizes.

Data Collection. MFP was used as the data collection method for each participant throughout the duration of intervention. Because the participants gave the researcher access to their data, it was possible to withdraw relevant data on each day or week’s goals. The effectiveness of treatment was evaluated based on participant’s behavior levels changing enough to meet the defined performance criteria during each goal through the MFP data analysis.

Prompting. MFP was also used as the topography for prompting procedures. During treatment sessions, each participant was taught to set daily reminders in their app (see Appendix H) which served as prompts for entering food and eating behavior. As the researcher had real-time access to participants MFP account, the team was able to send prompts to the participant with regard to meeting their goal for the day as well.

Reinforcement. This intervention unitized an individualized differential reinforcement procedure for each participant. DR was utilized to withhold the reinforcement which was previously delivered to target behaviors. Then, reinforcement was delivered contingently on new, functionally equivalent, alternative behaviors. DRH was used to increase amount of eating behavior for one participant where long IRT were placed on extinction and increased intake was reinforced. Specific, individualized DR procedures can be found in each participant’s intervention protocol.

Contingency Management. This intervention utilized a self-report procedure to gather preferred activities and stimuli for each individual. Importantly, participants were not able to select reinforcers related to food or drink intake. As research has
shown that OW and OB individuals have increased reinforcing value with regard to food obtaining behaviors, it was necessary to abstain from utilizing food themes as reinforcers and to re-train the concept of food as health. Each week participants chose a different reinforcer from their list, which they were motivated to work for. Access to the selected reinforcer was contingent on meeting their weekly goals set forth through the course of intervention.

**Individualized Intervention Packages**

**Ava Intervention.** Ava’s FBA identified weekend overeating (>2,000 calories per day), eating large quantities in social settings (>650 calories per meal) and high saturated fat and added sugar consumption (>10% of daily calories, respectively) as being most problematic within her eating behavior repertoire. Ava’s overeating was maintained primarily by escape motivated, social negative reinforcement. Secondly, Ava’s overeating is maintained through automatic positive reinforcement by the intake of hedonic, preferred foods. Antecedents for overeating were found to be social situations and the presence of preferred foods. Setting events were found in hunger, particularly hunger in the presence of preferred foods which have heightened evocative properties due to the state of deprivation incurred through the week, as found in Chapter 4.

Therefore, Ava’s intervention package consisted of three primary behavior targets found in Table 21 below. Goals for intervention were developed to target the antecedents to problematic behavior, decreasing the reinforcing contingencies associated with problematic intake and establish a healthy alternative repertoire of behavior. Ava’s top five goals were (1) lose 20 lbs., (2) Eat 1,500 calories a day on Monday, Tuesday, Wednesday, Thursday, Saturday and Sunday, (3) Allow for one cheat day a week with a max intake of 2,000 calories, (4) Eat less sugar, (5) Workout 4
days a week. Goals and objectives were developed to match the behavior change targets identified as priority through the FBA procedure.

The first behavior targeted for change within Ava’s intervention package was the number of calories consumed on Fridays. Criteria was set for consuming no more than 2,000 calories on Friday and specifically no more than 1,000 Friday evening between 3 P.M and 12 A.M. Secondly, social calorie (excluding Friday) consumption was targeted for change. This goal required Ava to stay within her 1,500 calorie a day goal even when engaged in social settings. Lastly, percent of calories from fat and added sugar was targeted for intervention.

Table 21. Ava’s behavior change targets and operational definition of behavior

<table>
<thead>
<tr>
<th>Target Behavior</th>
<th>Operation Definition</th>
<th>Outcome Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday night calorie consumption</td>
<td>Consuming greater than 1,000 calories between 3 pm and 12am on Friday.</td>
<td>Cathy will engage in eating behavior during 3pm and 12am on Friday’s which totals 1,000 calories or less</td>
</tr>
<tr>
<td>Social setting overconsumption</td>
<td>Consuming greater than 650 calories while in the presence of 1 or more individuals.</td>
<td>Ava will consume less than 650 calories per meal and less than 1,500 calories per day, total, when in social settings.</td>
</tr>
<tr>
<td>High fat and sugar intake</td>
<td>Consuming greater than 10% of daily calories from saturated fat sources and greater than 10% of daily calories from added sugar sources.</td>
<td>Ava will consume less than 10% of daily calories from saturated fat sources and less than 10% of daily calories from added sugar sources.</td>
</tr>
</tbody>
</table>

Antecedent Interventions. The most reliable antecedent to Ava’s Friday overeating behavior was eating at restaurants. As a means to alter the selection of high calorie foods eaten during these settings, Ava was taught to select her meal before going into restaurant environments. This provided Ava with the ability to analyze her food choices through MFP and select appropriate foods before being in the environment.
where previously unhealthy selections were reinforced. It was important to Ava and her fiancé that their ability to eat out on the weekends was not diminished. Therefore, this tactic of pre-selection was used to make it more likely that Ava would be successful in her meal choices and still able to engage in the preferred activity of eating out.

**Consequence Intervention.** Because Ava’s overeating behavior was found to have a social negative reinforcement contingency, it was important that socially mediated variables no longer occur. Ava’s family was taught to provide her with social reinforcement for healthy choices and no longer prompt or reinforce unhealthy eating. Therefore, social attention for inappropriate eating was placed on extinction and healthy eating behaviors were set to be differentially reinforced by her family.

Ava’s intervention required that she train her family regarding her goals and their influence on them. Ava was taught to train her family on these goals, the types of reinforcement and the antecedents they were delivering, inadvertently. Then, Ava trained her family on delivering reinforcement contingent on her healthy decisions. Additionally, Ava’s fiancé was asked to select restaurants which provided healthy options that were easily calculable for caloric and micronutrient content. In particular, Ava’s fiancé was asked to assist in choosing healthy restaurants, reinforce Ava for making healthier selections while eating out, deliver contingent reinforcement appropriately for her and decrease the social demands to share foods.

MFP was used as a means of delivering contingent social reinforcement on specified goals through the week by the researcher. Contingent reinforcement was delivered in the form of a personalized comment on each eating and exercise entry, immediately after entry. Reinforcement was faded systematically through the week as goals were met. Reinforcement moved down a hierarchy of social praise beginning with comments delivered on every successful entry, then one comment at the end of the
day, fading down to “likes” on each day’s entry to, and finally one “like” at the end of the week.

Ava’s consequence based intervention targeted the hedonic nature of her overeating episodes. Because Ava’s overeating was secondarily maintained by access to preferred foods, yet deprivation was shown to be an EO altering choice making in response to hedonic food opportunity, matched stimuli was targeted. A frequently used tactic was training Ava to order a cup of tea after finishing her meal at a restaurant, before deciding on dessert. This was used to give access to a preferred sweet taste in the tea but with minimal calories and sugar content. This was also used to interrupt the habitual chain of eating a large dessert after consumption of a meal in a dining out setting. If Ava still wanted dessert after her cup of tea, she then ordered her pre-chosen lower calorie and low sugar dessert. Example of dessert ordered during week eight was sorbet rather than cheesecake.

Lastly, Ava’s contingency management protocol assisted in providing her on independently delivered reinforcement for meeting specific goals each week. Ava met all goals through her 10-week intervention course and was able to access reinforcement each week.
Table 22. *Ava’s intervention protocol.*

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Identified Function</th>
<th>Antecedent Interventions</th>
<th>Consequence Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Environmental and Antecedent Modifications</td>
<td>Alternative behavior</td>
</tr>
<tr>
<td>Friday night calorie consumption</td>
<td>Socially mediated negative reinforcement</td>
<td>Select novel restaurants</td>
<td>Select alternative foods with same preferred stimuli but healthier versions. E.g., Jell-O rather than ice cream</td>
</tr>
<tr>
<td></td>
<td>Automatic positive reinforcement</td>
<td>Chose meal before entering restaurant</td>
<td>Enter meal into MFP before finalizing choice</td>
</tr>
<tr>
<td></td>
<td>Automatic positive reinforcement</td>
<td>Enter calories into MFP pre-intake</td>
<td>Request family prepare alternative foods if they are cooking</td>
</tr>
<tr>
<td>Over consumption in social settings</td>
<td>Social mediated negative reinforcement</td>
<td>Serving size measuring. Use desert size plates where possible.</td>
<td>Bring alternative foods to social gathers, where appropriate</td>
</tr>
<tr>
<td></td>
<td>Automatic positive reinforcement</td>
<td>Evaluate specific MFP micro and macro nutrient percentages pre-intake.</td>
<td>Prepare alternative versions of preferred foods.</td>
</tr>
<tr>
<td>Percent of total calories from fat and sugar intake</td>
<td>Automatic positive reinforcement</td>
<td>Prepare alternative versions of preferred foods.</td>
<td>Availability of high fat and high sugar foods reliably targeted for consumption</td>
</tr>
</tbody>
</table>
Cathy Intervention

Cathy’s most frequently occurring problematic eating behaviors were found to be latency between intake, eating excess quantities (>1 serving size) and excessive sugar intake (>10% of daily intake). After analysis of Cathy’s FBA package, it is hypothesized that her problematic intakes are maintained automatic negative reinforcement by removal of hunger and cravings for hedonic foods. Additionally, Cathy’s high sugar intake behavior is likely maintained by automatic positive reinforcement through access to preferred, hedonic foods.

Antecedents for overeating were found to be busy days with long periods of no food intake and the presence of preferred foods. Setting events were found in hunger, particularly hunger in the presence of preferred foods which have heightened evocative properties due to the state of deprivation incurred through the day. Finally, it was determined that Cathy is most likely to eat high sugar foods after dinner potentially due to a habit formation maintained by the intake of preferred food. Cathy’s intervention goals are presented in Table 23. Cathy’s top five, self-identified goals were (1) lose 10 lbs., (2) eat less sugar, (3) walk more, (4) drink more water, (5) workout 3 days a week. The first behavior targeted for change within Cathy’s intervention was latency between meals intakes to meet the goal of no greater than 180 minutes.

The first target for Cathy was latency between episodes of intake. Criteria was set to meet the goal of no greater than 180 minute latencies between each intake. Secondly, decreasing the total calories consumed per meal was targeted for change within Cathy’s intervention. Intervention targeted max caloric intake per eating episode for each meal and criteria was set for mean calories consumed across each of the five meals a day for one week. Lastly, targeted for change was the amount of sugar Cathy was ingesting each day. Cathy’s baseline data shows high rates of added sugar intake.
each day (>10%). This criteria was set to match the food intake guidelines of no more than 10% of total daily calories from added sugar.

Table 23. *Cathy’s target behaviors*

<table>
<thead>
<tr>
<th>Target Behaviors</th>
<th>Operational Definition</th>
<th>Goal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRT between eating episodes</td>
<td>Engaging in eating behavior with an inter response interval of 4 hours or more.</td>
<td>Cathy will decrease the IRT between food intake from 4+ hours to &lt;3 hours, totaling 5 small meals per day.</td>
</tr>
<tr>
<td>Decrease amount eating per-intake</td>
<td>Engaging in eating behavior of small meals with a total consumption of no less than 200 and no more than 500 total calories.</td>
<td>Cathy will decrease the number of calories she is consuming per-meal throughout the day</td>
</tr>
<tr>
<td>Decrease the amount of sugar consumed per-day.</td>
<td>Consuming greater than 10% of calories from sugar sources</td>
<td>Cathy will decrease the amount of sugar she is consuming across the day to total no more than 10% of her total daily caloric intake.</td>
</tr>
</tbody>
</table>

**Antecedent Intervention.** The first component in Cathy’s intervention was to decrease the IRT between meals and increase the frequency with which she was consuming small meals through the day. At baseline and during FBA data collection, Cathy had an average IRT between meals of 4 hours. To target latency of intake, MFP was set deliver a stimulus prompt to eat at specified intervals through the day. If no food was entered into MFP by specified intervals the application would send Cathy a reminder to eat. Likewise, the research team received a notification which allowed for the opportunity to send additional prompt to Cathy for consumption.

Cathy was also trained on a meal preparation procedure during the week. Meal preparation was particularly important on days Cathy had class, as these were found to be the highest caloric days. Having meals prepared established conditions for the intake of five similar calorie intake instances, over the course of the day. Five small (200-500 calories) meals were chosen as a means to keep Cathy full for even durations.
throughout the day and prevent hunger when getting home in the evenings, which was previously determined as an antecedent to overeating.

Cathy’s second target behavior was calories consumed per-meal. During baseline, Cathy consumed an average of 669 (517-824) calories per meal throughout the day. As a means to keep her intake even across the day and to decrease caloric intake, Cathy was given the goal of eating 300 calories (1,500/5=300) per-meal. This was targeted through the use of mobile phone applications for recipe construction, MFP data entry and stimulus control procedures.

**Stimulus Control.** Cathy’s FBA found that eating in her car was a frequent setting for over and rapid consumption of foods. Therefore, eating outside of the car was a targeted intervention component for Cathy. Cathy was taught to eat only when she was sitting down at a table and was able to attend to her consumption. Additionally, Cathy was taught to alter the areas in her house which frequently had high sugar foods available and rather have healthy alternatives based on matched stimuli assessment available in those location. For instance, Cathy was trained to keep an open container of washed grapes in the front of her refrigerator, where unhealthy foods were previously. This allowed for a significant decrease in response effort for consuming healthier options and removal of the Sd for consumption in that context and provided access to matched sweet alternatives.

Lastly, Cathy was prompted to utilize stimulus control procedures in the preparation of meal sizes. During meal preparation, Cathy was taught to utilize specific Tupperware© containers which were portioned out to the appropriate meal sizes for intake. This allowed Cathy to learn what an appropriate portion size looked like. Containers were faded out as Cathy learned what portions of each food group were and was able to generalize the portion across meals and food types.
**Consequence Intervention.** Similar to Ava, MFP was used as a means of delivering contingent social reinforcement on met goals by the researcher. During each step to intervention, contingent reinforcement was delivered in the form of a personalized comment on each eating and step entry. Again, reinforcement was faded systematically through the week as goals were met.

DRH procedures were used for appropriate calorie meal consumption at specified intervals as well as free access to preferred matched stimuli foods. Cathy’s decreased IRT between meals served an automatic reinforcement function as it increased access to food intake and decreased the aversive covert feeling of hunger.

To decrease Cathy’s sugar intake, Cathy’s DRA procedure targeted selecting alternative foods to consume in order to access automatic reinforcement from hedonic intake while decreasing sugar consumption. Examples included drinking lemonade rather than coke during lunch, have chocolate granola bar rather than cookie, have Dairy Queen© skinny banana split rather than blizzard when she wants to go out for a dessert.

**Contingency Management.** Like Ava, Cathy’s preference assessment provided 10 rank-ordered high preference items which were non-food related and utilized for contingency management each week. On Sunday, Cathy chose a reinforcer which she wanted to work for over the course of the week. Reinforcers were delivered on Saturday, contingent on the outcome of her data through the week. Cathy met all goals through her intervention and accessed the selected reinforcer each week.

**Steps.** A component of Cathy’s intervention was a range bound changing criterion for the increase of steps taken per day. Cathy was provided with a Ronkøen© Smart Fitness Band for the purpose of collecting step data. During baseline meeting, Cathy was asked to download the application which supports the smart bracelet and
allows for Bluetooth™ tracking of the data collected. Data was sent from the bracelet to the participant’s phone in real time. Cathy was instructed to wear the bracelet either on her wrist or ankle, as suggested by makers, for the duration of participation. Cathy was also instructed not to check her step data during baseline and to make the selections she normally would such as taking the elevator rather than stairs. Baseline data showed Cathy was taking 3,252 steps per-day, when averaged across 7 days.

These data were then used as the starting point for the changing criterion design with the aim of increasing physical activity throughout the day. Criterion were set as a terminal goal of 100% increase from baseline with step wise changes each week for a total of 10 weeks. Data was automatically transferred from Ronkoen© application into MFP for goal prompting and monitoring by and data collection procedures.

During the pre-intervention meeting Cathy and the research created a list of ways to target increasing step amounts each day. Targets were:

- Parking in the furthest spot from office door at work.
- Parking on the opposite side of campus from class building and walking rather than taking the shuttle.
- Taking the stairs rather than elevator/escalator/travellator
- Walking laps around office building during breaks.
- Walking to and from the post office during work rather than driving.
Table 24. *Cathy’s intervention protocol.*

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Identified Function</th>
<th>Antecedent Intervention</th>
<th>Alternative Behavior</th>
<th>Consequences Based Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease IRT between intake</td>
<td>Automatic negative</td>
<td>Establish MFP prompts to single eating times</td>
<td>Increased frequency of meals and deceased latency between intake.</td>
<td>Eating in response to hunger</td>
</tr>
<tr>
<td></td>
<td>reinforcement</td>
<td>Schedule eating times prior to beginning day and contingent of schedule</td>
<td>Meal preparation utilizing M-health and measured containers</td>
<td>Automatic positive reinforcement of higher rates through increased consumption</td>
</tr>
<tr>
<td>Amount of calories ingested per meal</td>
<td>Automatic negative, automatic positive</td>
<td>Enter calories before consuming.</td>
<td>Prepare meals night before or in the morning, using portion controlled containers.</td>
<td>Eating in response to covert antecedents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If have to eat from fast food restaurant chose food from applications and enter into MFP before entering restaurant.</td>
<td>Utilize M-health targets for selection of meals to prepare</td>
<td>Automatic positive reinforcement through intake</td>
</tr>
<tr>
<td>Decrease sugar intake</td>
<td>Automatic positive</td>
<td>Free access to alternative foods Make selection on MFP data availability</td>
<td>Selection of alternative desert after dinner with same hedonic stimuli.</td>
<td>Access to high sugar targets</td>
</tr>
<tr>
<td></td>
<td>reinforcement</td>
<td></td>
<td></td>
<td>Non-contingent Automatic reinforcement through alternative hedonic choices</td>
</tr>
</tbody>
</table>

MFP social reinforcement
Maeve

Maeve’s FBA results identified nighttime overeating (>500 calories after dinner), restricting calories (<1,200 per-day) and high added sugar intake (>10% of daily intake) as her most problematic eating behaviors. Maeve’s assessment showed that the same behavior was maintained in varied fashions contingent on setting events and antecedents. That is, Maeve’s overeating on days where she restricted intake was maintained by automatic negative reinforcement in the form of removal of food cravings and hunger as well as automatic positive reinforcement though access to preferred hedonic intake. On days where Maeve broke restrained eating patterns, her overeating was maintained by escape motivated automatic negative reinforcement by the avoidance of covert negative affect.

Maeve’s antecedent analysis suggest that she is most likely to overeat when she is hungry paired with the covert antecedents of disappointment or failure. However, those antecedents did not occur without the instance of breaking restrained eating earlier in the day. This suggests that breaking restrained eating patterns could be eliciting the covert antecedents and increasing her self-reported negative affect. Furthermore, data suggest that restrained eating was a setting event for her nighttime over-eating. Meaning days where Maeve restricted her caloric intake during the daytime hours, she was likely to overeat during the nighttime. Restrained eating and breaking restraint is hypothesized to be a temporal EO and Sd for over-eating episodes for Maeve. Maeve’s goals for intervention (Table 25) which were embedded in behavior change targets were (a) eat five even calorie meals per-day, (b) allow for one healthy dessert after lunch (c) workout 3 days per week (d) lose 10 lbs., (e) stop eating past 8 P.M.
The first behavior targeted for intervention within Maeve’s protocol was her nighttime overeating. Criteria was set and intervention focused on Maeve consuming 150 calories or less, after 8 P.M. Secondly, the number of calories Maeve was consuming before 5 P.M. was targeted for change. Intervention targeted increasing the number of calories Maeve was consuming before 5 P.M with a goal of no less than 700 and no more than 1,200 across 7 days. Lastly, Maeve’s excessive sugar intake was targeted for change within Maeve’s intervention protocol.

Table 25.
*Maeve target behaviors.*

<table>
<thead>
<tr>
<th>Target Behaviors</th>
<th>Operational Definition</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime overeating</td>
<td>Defined as any intake of food past 8 P.M which exceeded 300 calories.</td>
<td>Maeve will decrease the number of calories she is eating past 8 P.M to ≤150</td>
</tr>
<tr>
<td>Restricting caloric intake</td>
<td>Defined as eating less than 1,200 calories before 8 P.M.</td>
<td>Maeve will increase the number of calories she is consuming before 5 P.M. to a minimum of 700 and maximum of 1,200.</td>
</tr>
<tr>
<td>Decreasing added sugar</td>
<td>Consuming greater than 10% of calories from added sugar sources.</td>
<td>Maeve will decrease the amount of sugar she is consuming across the day to total no more than 10% of her total daily caloric intake.</td>
</tr>
</tbody>
</table>

**Antecedent Intervention.** Maeve’s antecedent interventions focused on decreasing inappropriate nighttime overeating behavior and increasing the likelihood that Maeve would engage in appropriate daytime eating behavior. MFP was used to prompt Maeve to times for intake and to the goals for each intake. MFP prompts were set to alert Maeve at specific intervals through the day and single her engagement in eating behavior as well as what type of intake she was scheduled for (i.e. lunch, snack)
Maeve was also taught to plan her meals for the day to keep her intake stable. In the morning when Maeve was preparing her daughter’s school lunch, she was instructed to prepare her meals for the day ahead as well. This was meant to provide her with access to appropriately measured intake through the day. It was found that Maeve was likely to engage in overeating behavior on nights where her daughter was out of the house. Maeve was encouraged to select an activity the day before her daughter left, as to set the occasion for success proactively, rather than having to determine and engage in an appropriate alternative in-vivo.

**Alternative Behavior Selection.** An important component of Maeve’s intervention was the selection of alternative behaviors which are preferred and potentially reinforcing. These behaviors were compiled into a hierarchical list based on rank of preference, and the list was placed in visible areas around environments which Maeve frequently came in contact with overeating episodes. One list was placed in Maeve’s car, one list in her kitchen and the other on her phone. The goal for her alternative behavior list was to be able to quickly select an alternative behavior when the occasion was set for traditional episodic overeating. Therefore, she could check her list of reinforcing things to do, instead of eat, that provided the same avoidance of negative affect which was previously achieved through eating. A goal of alternative activity selection when negative affect occurred was to incorporate activities with properties which Maeve identified as calming to her (i.e., taking a bubble bath). This was used to place eating in response to negative affect on extinction and differentially reinforce alternative behaviors. Furthermore, reminders were set in Maeve’s phone to prompt alternative behavior selection when entering times which traditionally occasioned overeating.
**Stimulus Control.** Because of Maeve’s long history of overeating on the couch while watching TV and while lying in bed, it was necessary to decrease the rate of eating within these environmental contexts. It was determined that the couch and bed overtime had potentially become S^d for overeating and required specific retraining to decondition these environments with overeating behavior. Maeve was instructed to consume food only while sitting at the kitchen table. The kitchen table was an environmental context where the majority of Maeve’s appropriate meal time behavior already occurred and therefore where she was most likely to engage in appropriate eating. When the instance of eating away from the table occurred in an appropriate context, such as watching a movie with her daughter, Maeve was taught to use measured foods as a means to control her intake. For instance, Maeve and her daughter frequently had movie nights on the weekends when her daughter had a good week in school. During these night, Maeve and her daughter would build a “fort” which they would eat popcorn in while watching a movie. Maeve purchased 100 calorie bags of popcorn which aided in controlled intake away from the table. If the occasion occurred where Maeve was consuming the previously mentioned open-ended foods, Maeve was taught to measure a serving size out then place them into a container before eating.

**Consequence Based Interventions.** A self-implemented DR procedure was implemented within Maeve’s intervention package to increase her engagement in behaviors other than overeating. During Maeve’s FBA it was reported that meeting her set goals was a potential reinforcer. Therefore, it was hypothesized that success on the objectives set for her each week would be reinforcing when achieved. Maeve reported the “awards” delivered by MFP automatically and the social praise delivered from the researcher as reinforcing as well.
Additionally, MFP was used as a means of delivering contingent reinforcement on goals by the research team. DRA was used in the form of social praise for appropriate calorie meals eating at specified intervals and access to preferred matched stimuli foods. During each step to intervention, contingent reinforcement was delivered in the form of a personalized comment on each eating and step entry. Again, reinforcement was faded systematically through the week as goals were met. Additionally, Maeve’s decreased overeating behavior likely served an automatic reinforcement function as it increased access to success which was an identified reinforcer for Maeve.

**Contingency Management.** Maeve’s contingency management was successful each week. Maeve was able to achieve reinforcers from a self-selected preference list for each of the 10 weeks of intervention. However, Maeve had a difficult time identifying reinforcers which were not food based. In the initial meeting Maeve was able to identify 5 reinforcers yet needed time to identify others but did so two weeks into intervention.
Table 26.
Maeva’s intervention protocol.

<table>
<thead>
<tr>
<th>Target Behaviors</th>
<th>Identified Function</th>
<th>Antecedent Intervention</th>
<th>Consequences Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease nighttime overeating</td>
<td>Automatic negative reinforcement (escape) Automatic positive reinforcement (access)</td>
<td>Eat at table Place items for consumption into measured portions Remove previously targeted foods from home Awareness training of affect</td>
<td>Create list of alternative preferred alternative activities Identify antecedents and select alternative activity rather than eating</td>
</tr>
<tr>
<td>Increase calorie consumption during the day</td>
<td>Automatic positive reinforcement</td>
<td>MFP alarms for food consumption times. Consume even calorie meals through the day</td>
<td>Use applications to select healthy meals Covert hunger due to deprivation Automatic reinforcement in goal attenuation</td>
</tr>
<tr>
<td>Decrease added sugar intake</td>
<td>Automatic positive reinforcement</td>
<td>Choose portion measurement based on available calories from MFP.</td>
<td>Use portion measuring for “open ended” foods such as M&amp;M’s Eating high sugar in response to failure Automatic reinforcement for hedonic intake MFP social praise Automatic reinforcement for goal attenuation.</td>
</tr>
</tbody>
</table>
Chapter 5

Results

Ava results

Results from Ava’s intervention package shows a decrease in rates on all targeted behavior. Figure 12 shows the results of Ava’s multiple-baseline design across these three eating behaviors where all of her self-selected goals and intervention targets were embedded. Ava’s initial baseline data was extended to a duration of two weeks. This was done to ensure accurate data collection on Ava’s weekend behavior as compared to weekday behavior. Additionally, it was important to collect data on Ava’s engagement in a variety of different social settings, as social situations are her most significant area of concern.
Figure 12. *Ava Multiple Baseline across Eating Behavior.*

<table>
<thead>
<tr>
<th>Calories consumed on Friday evenings</th>
<th>Ava's Intervention Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories Consumed</td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>Baseline</td>
</tr>
<tr>
<td>3500</td>
<td>Treatment</td>
</tr>
<tr>
<td>3000</td>
<td>Maintenance</td>
</tr>
<tr>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

| Social calorie intake                |                            |
| Calories Consumed                    |                            |
| 4000                                 |                           |
| 3500                                 |                           |
| 3000                                 |                           |
| 2500                                 |                           |
| 1500                                 |                           |
| 1000                                 |                           |
| 500                                  |                            |
| 0                                    |                            |

| Calories from fat and sugar          |                            |
| Percent of calories                  |                            |
| 70                                   |                            |
| 60                                   |                            |
| 50                                   |                            |
| 40                                   |                            |
| 30                                   |                            |
| 20                                   |                            |
| 10                                   |                            |
| 0                                    |                            |

Weeks:
- Baseline: 1, 2
- Treatment: 3, 4
- Maintenance: 5, 6, 7, 8, 9, 10
The first behavior targeted for change within Ava’s intervention package was the number of calories she consumed on Fridays. Criteria was set for consuming no more than 2,000 calories on Friday and specifically no more than 1,000 Friday evening between 3 P.M and 12 A.M., for three consecutive weeks. On the first Friday of intervention, Ava’s intake decreased from 3,565 to 1,530 calories. On the second Friday of intervention, Ava consumed 1,312 total calories. Behavior 1 met criteria on the second week of intervention and data show that Ava’s Friday intake maintained below criteria for 6 weeks of maintenance.

During week 5, social calorie (excluding Friday) consumption was targeted for change. This goal required Ava to stay within her 1,500 calorie a day goal even when in social settings which were previous Sd for over consumption. Ava’s social setting caloric intake decreased from a mean of 3,150 (range of 3,571 to 2,910) to a mean of 1,465 (range of 1,465 to 850) during tier two of intervention. Criteria of 1,500 or less during social days was met during week two of tier two. Social setting intake remained within criteria for the remaining four weeks of intervention.

On week 7 intervention targeted the percent of calories from fat and added sugar which Ava was ingesting. The USDA/HHS criteria of <10% from saturated fat and <10% from added sugar was used for this phase of intervention. Ava met criteria for mean daily intake of <20% on the combined micronutrients during week 9 of intervention. During the first week of tier three Ava did not meet criteria for her intake, having consumed a mean of 24% of her calories from saturated fat and added sugar. Ava’s MFP was evaluated with the researcher and lesson was delivered on selection of alternative targets which aided Ava in meeting criteria over the next two weeks.

Figure 12 also shows a decrease of fat and sugar intake within initial baseline phase, before intake was specifically targeted for decrease. The decrease in
consumption during baseline phase is attributable to a ceiling being placed on intake capabilities within the previous two phases of intervention. As total caloric consumption was targeted for decrease, it was expected that sugar and fat intake would decrease as well because of the limitation to intake. Yet, it was hypothesized that sugar and fat would not decrease to target rates without direct intervention. This outcome measure is evident within week 4-10 of intervention. Once the ceiling was placed on Ava’s total consumption, her fat and sugar decreased yet also stabilized at a higher than goal rate. Once intervention was implemented, intake decreased and maintained at target levels, displaying experimental control within this phase of intervention.

Results from Ava’s GNKQ show an overall score of 60% correct responses. Ava scored highest in the expert recommendations yet lowest in the food selection sections. This suggested a discrepancy in her knowledge on what is recommended but her ability to make recommended decisions in-vivo. Ava scored low on the food groups and nutrients assessment but within that section of the assessment scored highest on questions surrounding protein intake. Health literacy targets were chosen based on the results of Ava’s GNKQ and targeted selection of foods based on health as that was shown to be her most problematic and largest barrier to health in all measures.

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall score</td>
<td>60%</td>
</tr>
<tr>
<td>Expert recommendations</td>
<td>77%</td>
</tr>
<tr>
<td>Food groups and nutrients</td>
<td>57%</td>
</tr>
<tr>
<td>Food selections</td>
<td>46%</td>
</tr>
<tr>
<td>Health related to weight</td>
<td>61%</td>
</tr>
</tbody>
</table>
Cathy

Results from Cathy’s intervention package show a change in all target behaviors. Outcome measures were concerned with decreasing the latency between meals, decreasing the number of calories eaten in each meal and decreasing the amount of sugar eaten each day. Figure 13 shows the results of Cathy’s multiple-baseline design across three eating behaviors which targeted all of her goals and where intervention components were embedded.
Figure 13.
*Cathy Multiple Baseline across eating behavior.*

Cathy Multiple Baseline Across Eating Behavior Outcomes

- **Latency between meals**
  - Baseline
  - Treatment
  - Maintenance

- **Calories consumed per meal**
  - Days: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71

- **Number of calories**
  - Days: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71

- **Percent of calories from sugar**
  - Days: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71

Days: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71

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The first behavior targeted for change within Cathy’s intervention was latency between meals. Antecedent interventions were put in place to prevent long latencies between meals and extinguish eating when in a state of deprivation. Cathy’s eating behavior latency decreased from a mean of 250 minutes (range of 240 to 270) between intakes to meet the goal of no greater than 180 minutes. Cathy met criteria for eating with even latency after three days of intervention and maintained through the course of intervention. While Cathy’s data showed some variability, she remained within latency criteria for each of the days of targeted intervention as well as the 9 weeks of maintenance data. MFP prompts for eating times were removed on day 24 of intervention. As a result, there was a slight increase in latency between meals, though this increase was still within criteria. This was the longest duration of the intervention and maintenance means. Latency decreased again and results show that latency stayed within criteria through the last 9 weeks of intervention. Cathy’s final four data points show a slightly decreasing trend from 140, 120, 115 to 105-minute mean durations between meals. 105 minutes was the shortest mean latency of intervention.

Calories consumed per meal was targeted for change secondly within Cathy’s intervention package. On day 10 of intervention, MFP was used to create a 300-calorie max intake goal for each meal. Criteria was set for mean calories consumed across each of the five meals a day for one week. Cathy’s total caloric intake per-day was calculated at 1,567 to meet her goal of 10 lbs. weight loss in 10 weeks. 1,567 calories per day equates to 313 calories per meal to meet her goal of five small meals per day. One week was used as a means to implement intervention across all of the variables Cathy comes in contact with through the week. Cathy meat criteria for calorie intake across meals on day 17 of intervention. Probe data continued weekly on number of calories consumed per meal and behavior maintenance was seen through 8 weeks of maintenance.
Lastly targeted for change was the amount of sugar Cathy was ingesting each day. Cathy’s baseline data shows high rates of added sugar intake each day (>10%), yet similar to Ava’s results, sugar decreased slightly without direct intervention. Again, this was an anticipated outcome due to the decrease in caloric consumption per meal placing a ceiling on the amount Cathy was capable of ingesting. This goal was set to match the food intake guidelines of no more than 10% of total daily calories from added sugar.

There was some concern that removing sugar too quickly would set the occasion for deprivation of the actual substance and result in over consumption, as restraint was already present in Cathy’s repertoire leading to over consumption. It was also considered important to manage sugar decline as the goal was not to decrease sugar to zero rates, rather to decrease to a healthy level and to train alternative responses in its place. However, Cathy’s percent of calories sugar intake decreased to goal levels on the first day of targeted intervention and remained within criteria until week eight of intervention which was unexpected. Probe data on week 7 show a mean intake of 12.5% and mean intake during week 9 of 16% of calories from added sugar. During debriefing meetings, it was found that Cathy attended a number of summer BBQ’s and parties during those two weeks to celebrate the end of school and the 4th of July holiday which is where the additional sugar was consumed.

Intervention was also applied on Cathy’s number of steps taken through the day. A range bound changing criterion design was used to increase Cathy’s intentional movement through her day. Step count baseline data showed that Cathy was taking an average of 3,252 steps per day. Weekly goals were set for Cathy to increase her steps by a daily average of 500. Cathy was able to access reinforcement if her average steps equated to 400 or more per day as it was important not to inadvertently punish her step
taking behavior. Figure 14 shows the range bound changing criterion for Cathy’s average steps per day over a 10-week period. Cathy’s steps increased from 3,252 at baseline to 9,250 at the end of the 10-week intervention. Cathy met criteria and accessed reinforcement on all weeks but four (see Figure 14). It was found that Cathy worked extra hours during this week and therefore her access to time for movement was limited. Although Cathy engaged in extra movement breaks at work, it was not enough to make up for her sedentary times of the day. Results from Cathy’s intervention package show a decrease in target eating behaviors across the 10-week intervention. Behaviors 1, 2 and 3 show maintenance effects across 9, 8 and 7 weeks respectively.

Results from Cathy’s GNKQ show a relatively low accuracy rate across all assessment categories. Cathy’s lowest score was on the recommendations for eating behaviors and foods. Her highest score was related to the health considerations related to weight. Results from the GNKQ highlighted the need to teach Cathy further information on what recommended intake patterns are as well as food selection opportunities and recommendations.

Table 28.

Cathy’s GNKQ results

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall score</td>
<td>65%</td>
</tr>
<tr>
<td>Expert recommendations</td>
<td>55%</td>
</tr>
<tr>
<td>Food groups and nutrients</td>
<td>68%</td>
</tr>
<tr>
<td>Food selections</td>
<td>61%</td>
</tr>
<tr>
<td>Health related to weight</td>
<td>71%</td>
</tr>
</tbody>
</table>
Maeve results

Results from Maeve’s intervention package show a clear change in three targeted outcomes. Namely, Maeve’s caloric intake past 8 P.M. decreased, average daily calorie intake before 5 P.M increased and average daily percentage of sugar intake decreased to goal rates across 10 weeks of intervention. While Maeve did engage in high rates of over eating episodes it is important to note that she did not meet the diagnostic criteria for BED due to an absence in the loss of control criteria for diagnosis (APA, 2013). Maeve specifically reported that she did not feel out of control while eating but rather that she was intentionally eating because she had broken her restrained eating pattern and would plan how she would restart the next day.
Figure 15:
Maeve’s multiple baseline across behaviors.
On day 4 intervention was implemented on Maeve’s intake past 8 P.M. Maeve began intervention with a mean of 1,641 calories consumed past 8 P.M. When intervention was implemented Maeve met criteria for 150 calories or less consumed past 8 P.M in seven days. Maeve’s nighttime intake went into maintenance on day 11 of intervention. On days 8, 27, 38 and 65 there is a 100-calorie intake after 8 P.M. This occurred as Maeve’s high sugar content items she was targeting for intake pre-intervention were placed on extinction and instead she consumed a 100-calorie snack pack during appropriate periods. Appropriate times were defined as watching a movie with her daughter and when she had friends over. Maeve successfully used this tactic to decrease nighttime sugar intake in these contexts and showed maintenance of the tactic post direct interventions through 9 weeks of maintenance data.

Secondly, the number of calories Maeve was consuming before 5 P.M. was targeted for change. Baseline data show Maeve was consuming a mean of 312 calories before 5 P.M. intentionally, as a means to control her weight. On day 11 intervention targeted increasing the number of calories Maeve was consuming before 5 P.M with a goal of no less than 700 and no more than 1,200 across 7 days. Maeve met criteria for intake before 5 P.M. on day 17 of intervention. Eating 700-1,200 calories pre-5 P.M. maintained through the 8 weeks of maintenance data collection.

Like Cathy, Maeve’s intake of sugar was targeted last and decreased before consumption was specifically targeted for intervention. Again, this is not surprising due to the extinction of eating past 8 P.M where the majority of Maeve’s sugar intake occurred. However, data suggest that the topography of Maeve’s sugar intake altered from single occurrence over consumption, to increase frequency of small sugar intakes but decreased amount through the day. During tier three baseline, on day 6 Maeve’s sugar intake decreased to 34% of her total calories and remained between 34% and 41%
until day 13 where rates of intake increased back up to between 50% and 55%. Sugar intake remained at this rate until intervention was implemented. On day 17, sugar intake was targeted within Maeve’s intervention protocol. On the first day of sugar intervention, Maeve consumed 11% of her calories from added sugars, which is 1% over criteria. On day 18 Maeve’s added sugar consumption decreased to 9% of total calories and remained within criteria through maintenance probes until day 59. Like Cathy, Maeve reported attending a variety of BBQ’s for the holiday and over consumed added sugar. These events also explain the two outlying data points within day 52 and 59 of calories consumed before 5 P.M. While Maeve remained in criteria for these days they were both daytime picnics where she ate a higher number of calories early in the day.

Results of Maeve’s GNKQ show the highest rates of overall knowledge. This is consistent with outcomes of Maeve’s BEI/FAI discussion. There it was noted that Maeve had a high knowledge of foods and which foods aided in her controlled diet behavior yet was not able to identify a healthy plan where restraint was not a theme. Results from her GNKQ show similar outcomes where she understood food selections quite well for the purpose of dieting but lacked the ability to identify what is actually recommended for health.

Table 29:

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall score</td>
<td>68%</td>
</tr>
<tr>
<td>Expert recommendations</td>
<td>50%</td>
</tr>
<tr>
<td>Food groups and nutrients</td>
<td>71%</td>
</tr>
<tr>
<td>Food selections</td>
<td>84%</td>
</tr>
</tbody>
</table>
Health related to weight 61%

Weight Effects

While this study did not specifically aim to decrease weight, it is worth noting the decrease in weight and BMI of each participant from baseline to end of intervention. Ava’s pre-intervention weight was 178 lbs. At the end of intervention her weight was 157 lbs., totaling 21 lbs. weight loss in 10 weeks, or 11.7% body weight. Ava’s BMI begin at 30.5 (OB) and decreased to 26.7 (OW). Cathy began intervention at 155 lbs. with a BMI of 28.4 (OW). Post intervention Cathy weighed 146 lbs. totaling 9 lbs. weight loss, 5.8% body weight decrease and a BMI decrease to 26.8 (OW). Lastly, Maeve began intervention weighing 153 lbs. and with a BMI of 27.1 (OW). At the end of intervention Maeve weighed 141 lbs., totaling 12 lbs. weight loss, 7.4% body weight loss and decreased to a BMI of 24.1 (Normal).

Figure 16:
Amount of Weight Change per participant from Baseline to End of Intervention and change in BMI Categorization

<table>
<thead>
<tr>
<th>Participant</th>
<th>Weight in pounds</th>
<th>BMI Categorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ava</td>
<td>180</td>
<td>Obese</td>
</tr>
<tr>
<td>Cathy</td>
<td>160</td>
<td>Overweight</td>
</tr>
<tr>
<td>Maeve</td>
<td>140</td>
<td>Normal</td>
</tr>
</tbody>
</table>

Weight and BMI Change Perparticipant
Social Validity and Treatment Integrity

During the final debriefing sessions, participants were asked to complete the acceptability questionnaire ( Appendix I; Bosh et al., 2008). This questionnaire provided percentage sores for treatment integrity and a Likert score rating on the ease and utility of treatment packages. Participants reported engaging in the prescribed treatment 71-90% of the time. Participants reported the treatment to be extremely easy, minimally disruptive, minimally time consuming and extremely helpful in changing their eating behavior. Note, items three and four are shaded to highlight that lower numbers represent a positive score.

Table 30: Social validity and treatment integrity per-participant.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>Ava</th>
<th>Cathy</th>
<th>Maeve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Treatment integrity</td>
<td>80%</td>
<td>71-80%</td>
<td>81-90%</td>
<td>71-80%</td>
</tr>
<tr>
<td>(percent of time engaged in treatment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Treatment ease</td>
<td>6.3/7</td>
<td>7/7</td>
<td>7/7</td>
<td>5/7</td>
</tr>
<tr>
<td>3. Treatment disruptiveness</td>
<td>2/7</td>
<td>3/7</td>
<td>1/7</td>
<td>2/7</td>
</tr>
<tr>
<td>4. Treatment time consumption</td>
<td>2.6/7</td>
<td>3/7</td>
<td>3/7</td>
<td>2/7</td>
</tr>
<tr>
<td>5. Treatment helpfulness</td>
<td>6/7</td>
<td>6/7</td>
<td>6/7</td>
<td>6/7</td>
</tr>
</tbody>
</table>

Discussion

This chapter utilized a function based, individualized intervention package across three participants with previously identified maladaptive eating behaviors.

Results show that when treatment was matched to function and systematic measures were taken to decrease problematic behaviors while teaching functionally alternative behaviors, healthy eating behaviors were established and maintained. Furthermore, results suggest focusing on healthy eating patterns and specific behavior lead to weight
and BMI decrease for each participant. After engaging in a number of different, yet equally maladaptive behaviors, each participant’s eating behavior decreased towards healthy target levels during intervention. Multiple-baseline design shows that maladaptive behavior did not decrease to appropriate levels until intervention was implemented, demonstrating a strong relationship between intervention and behavior change across participants. Likewise, the latency of effect, or time it took for behavior to begin changing, for each participant and in each phase show that intervention components were efficient in changing behavior.

Each of the three participants reported an increased understanding of their behavior, increased ability to identify opportunities for healthier decisions, and increased repertoire of alternative behaviors and choices. Furthermore, the participants rated the treatment package as extremely easy and helpful, minimally disruptive and minimally time consuming in changing their eating behavior. Each of the participants reported that the reduction in their problematic behaviors and change in weight was primarily due to the intervention protocol. Ava reported the highest level of disturbance due to the intervention, 3 out of 7, reporting that this was primarily due to the response effort required in changing restaurants and food prepared by the family as a whole.

Maeve reported the lowest scores on treatment ease, 5 out of 7. This was likely due to her extensive learning history of engagement in target behavior, having to be altered. Maeve also expressed that changing her belief and pattern of restricted eating was difficult, yet once access to reinforcement for new behaviors occurred she was more confident in the approaches used. Cathy reported the highest level of treatment integrity and reported this was due to the decrease in aversive covert antecedents and increase in access to reinforcement and increasing her target behavior. The ease of use and the low response efforts of intervention packages has important implications for the
treatment of OW and OB related behaviors and future applications and should be
considered in future research.

Ava

Ava’s data show the strongest degree of experimental control. It was clear
from Ava’s results that her behavior change was due to the conditions of treatment and
her data showed the least variability within maintenance phase. This is likely due to the
family’s maintenance of extinction procedures and DRA procedures through
intervention showing the importance of individualized environments on behavior. Also
showing the importance of individualized assessment on variables maintaining, as
without social extinction, it is unlikely Ava’s behavior would have changed to reach
target rates. Moreover, a generalized outcome of Ava’s intervention on social eating
was found in both her mother and sister reported weight loss. Presumably this was due
to the decrease in unhealthy cooking and baking which was occurring while they were
together each weekend, showing an important outcome on the family as a whole.

Ava’s Friday caloric intake remained relatively stable through the maintenance
phase of intervention due to her increased awareness of the calories which she was over
consuming at restaurants. Ava and her fiancée established a selection of restaurant
options that they could visit which had either the calories written on the website or
chain establishments which had their menus included within the MFP database. This
data meant that Ava calculated her intake appropriately before entering the environment
and she was able to cycle through appropriate choices and maintain criteria. At the
debriefing meeting Ava reported having a selection of 5-6 restaurants in her area which
she could reliably go to and eat an appropriate meal and that her and her fiancée were
planning to continue visiting new healthy restaurants.

Cathy
Cathy’s data showed perhaps the most variability within both baseline and intervention. Variability was in part, anticipated due to Cathy’s considerable variation in her day paired with intervention occurring during the most variable time of year for Cathy. That is the end of the semester, finals, beginning of summer break and a number of holidays. Yet, even with the high variability, Cathy’s data show consistency in meeting criteria on her goals and maintaining those through the considerable differentiation in her days. This is an important outcome for the application of applied interventions, whereby participants days and weeks will likely be inconsistent. Yet determining the maintaining variables to be targeted for extinction across contexts and variable environments and establishing a strong repertoire of replacements has shown to be important. Cathy’s results are an additional strong example of the importance of altering maintaining variables along with antecedents to ensure behavioral maintenance and generalization.

Cathy’s FBA process determined that she was engaging in high rates of calorie consumption, unknowingly, throughout her day. Awareness training and health literacy were used successfully to increase Cathy’s knowledge of her intake and increase her success and health. A priority of Cathy’s intervention was to stabilize her calorie intake through the day. At baseline, Cathy was incurring strained schedules of eating, where there was 4 or more hours between consumption. This was found to be creating a state of deprivation and hunger which increased the likelihood that Cathy would engage in behavior to obtain high sugar food and would consume excess calories in one sitting. Additionally, eating in response to frantic feelings was related to Cathy’s overconsumption of calories. A component of Cathy’s intervention was to alter the IRT between intakes, then to decrease the amount eaten during each intake. Using antecedent strategies allowed Cathy to subsequently access higher rates of
reinforcement and establishing this pattern increased the likelihood of eating behavior maintenance over time.

**Maeve**

It was hypothesized that Maeve’s behavior would be slow to change due to her extended learning history of restrained eating and her belief that eating less during the day would help to control her weight. Maeve received training on the mechanisms of the body and how food consumption works through articles she was asked to read and information she was given in meetings with the researcher. Maeve’s behavior changed faster and more significantly than was anticipated, and maintained more proficiently than expected. This is both promising but remains an area for monitoring due to Maeve’s history of rigid behavior around eating. Therefore, teaching flexibility within Maeve’s intervention and maintenance was considered in her intervention. For instance, Maeve identified her goal for nighttime eating as being zero rates of eating past 8 P.M. However, this caused concern in Maeve’s ability to maintain zero rates potentially leading to failure and discontinuation of the plan. Concerns were also highlighted in the reality and likelihood of meeting the goal. When these two issues were discussed with Maeve, it was agreed that a 150-calorie intake past 8 P.M. was both realistic and sustainable.

This identifies two considerations for future research and further supports the necessity of appropriate goal setting. Firstly, ensuring that goals are flexible enough to incorporate the changing components of individual days and allow for changes in routines which do not alter people’s view of success. Secondly, incorporating the flexibility of behavior by changing a missed goal from an antecedent for additional eating to a neutral and acceptable outcome is important what considering the high relapse rates aforementioned.
Maeve’s data and feedback suggest a number of significant change outcomes. Frequently during intervention and maintenance, Maeve’s alternative behavior selection for when her daughter was gone was engaging in exercise. Exercising rather than engaging in overeating was a significant improvement within Maeve’s repertoire, unprompted by the researcher. Maeve also reported that if she had friends over (twice within intervention) and there was left over food, she would package one portion size for herself to eat the next day then give the rest to her friends as to avoid having unhealthy food in her house and decrease the availability of overeating. Moreover, Maeve reported a change in her knowledge on dietary versus health behaviors and reported understanding how to engage in more health-conscious behaviors.

**Contingency Management**

Contingency management was an embedded component to this intervention. Each participant was asked to identify and rank-order 10 non-food, preferred items and or activates which could be used for reinforcement for meeting goals. This study specifically differed away from the traditional contingency management targets of monetary incentives and food provisions (Bray & Bouchard, 2004) for two reasons. Firstly, because it was determined that small monetary values were not reinforcing enough for participants to expel work to earn and reinforcing food consumption was incompatible with the goals of this study. Rather, self-identified and managed contingencies were utilized and resulted in more significant reinforcer availability.

Additionally, prompting and social praise was utilized within this study through M-health in the form of the MFP application and website. Prompting and social praise was delivered at a high rate and dense schedule beginning each phase of intervention and was systematically decreased as participants were successful with goals. M-health
provided ease of prompting and delivery of reinforcement in real-time increasing the likelihood of immediate behavior change.

Considerations for future research

Behavioral Topography. A consideration for future research within these results is the decrease in micro and macro nutrient intake pre-intervention. Specifically, Ava’s fat and sugar intake, as well as Cathy and Maeve’s sugar intake decreased before direct intervention on those behaviors. It should be noted that while micronutrient intake did decrease in baseline, this was an anticipated outcome. Each of the participants were engaging in maladaptive eating behaviors within the first two phases of intervention, in which consuming high fat/sugar was present. By decreasing those previous behaviors, the participant’s ability to consume high micro nutrient rates was diminished. Therefore, micronutrient intake decreased in all baselines prior to intervention. However, it is also important to note that micronutrient intake did not decrease to appropriate levels until intervention was applied. Once targeted through direct intervention the intake decreased to appropriate levels.

These results are consistent with the discussion in Chapter 3 of OB binge eater’s symptomology changing but intake altering in other places. Particularly in Maeve’s data, where sugar intake decreased within the first 12 days of intervention, but then began an upward trend directly prior to being targeted. After a review of her MFP diary, it was determined that this occurred due to Maeve consuming increased sugar during alternative parts of her day and within different foods. This concept of target behavior changing topography, but remaining problematic elsewhere, should be evaluated and considered in future research.

Health Literacy. The results of participants GNKQ show the highest scores as reflective of the previous diets each participant reported during FBA data. For instance,
Ava reported having followed a protein focused diet previously and scored the highest on questions surrounding protein in the GNKQ. Likewise, Cath reported following a sports and health focused diet plan previously and scored highest in the health related to foods categories and recommended intake. Maeve, had the highest scores in understanding foods yet the lowest ability to identify healthy patterns and create a healthy pattern for herself where restraint was not a theme. During individual interviews, each participant was able to identify their unhealthy consumptions independently. Yet, when prompted to identify an alternative for the food they ate, participants were unable to which was consistent with the GNKQ outcomes. Measures for the GNKQ should be used in future research and applied settings for the assessment of individual need and education. Additionally, it was found to be important to gather health and dieting history as to identify areas for error correction in dietary beliefs as these results show may be related.

Skills training was used as a means to prevent weight re-gain in previous studies (Bray & Bouchard, 2004). This approach, called relapse prevention training, provides participants with information on how to react to “slips and relapses” of unhealthy behavior or weight re-gain. Studies have shown that this approach is unsuccessful unless paired with therapist contact and is most successful when individualized in nature (Bray & Bouchard, 2004). The current study approached skills training in an inverse fashion. Skill training was evaluated pre-intervention and intervened on within the treatment protocol through health literacy as a specified and intentional replacement program targeted at the function of current maladaptive eating behaviors. Replacement behaviors and skills teaching was individualized to each person’s needs, preferences and functions of behavior pre-intervention. This supports the need to view skills
teaching as a contingent process in the DR procedure which should be included within treatment protocols going forward.

**Weight Change.** A secondary outcome of weight change was found in this study. It was found that once behaviors of concern were decreased and healthy behaviors were put in place instead, weight decreased. This initial change in behavior then subsequent weight loss is an important consideration of interventions and research going forward. As highlighted in Chapter 3, the target of weight loss may not be appropriate for participants as it is unlikely that weight will change without a change in behavior. These results support the hypothesis presented in Chapter 3 that weight related behaviors need to change before weight should be focused on and that as healthy behaviors replace unhealthy ones, weight will decrease along with it. In this study participants were initially able to access reinforcement for their healthy behaviors and secondary reinforcement was obtained through a decreasing weight overtime. It should be considered in future research and clinical applications that reinforcement be individualized and delivered at high rates for initial behavior change, then faded to natural reinforcement of weight decrease overtime.

In post treatment interviews and AQ, all three participants reported that their change in behavior was a result of the intervention implemented and that the intervention was successful in teaching them the functions of their behavior. As well, teaching function of behaviors and the variables which were associated with problematic patterns, increased participants awareness contributing to their success in this intervention. Maeve and Ava in particular reported understanding their behavior as an important component of this intervention, which impacted their ability to decrease problematic behavior and which was lacking in diets they had tried previously. The training of alternative selections was reported as helpful for each participant. Cathy
reported the ease of access to M-health in making healthy decisions while she was feeling rushed and frantic was successful in aiding in her decision making and lead to her selecting healthier meals and parts of meals than she would have previously.

Conclusion

This chapter supports the use of ABA in the management of weight related and unhealthy eating behaviors leading to OW and OB in women of child bearing age. Utilizing an individualized approach allowed for the identification of behaviors and maintaining variables specific to each individual in the study. This research was able to use previously established tactics in a function matched way as to increase the likelihood that the appropriate supports were given to each woman and were individualized using M-health to decrease previously identified barriers to success. The results of this study should be considered in increasing application to additional populations and settings in response to the global OB epidemic.
Chapter 6

General Discussion
Summary of Studies

OB is one of the world’s leading health conditions particularly among women of child-bearing age. Previous research shows gaps in knowledge regarding the impact OB has on mother and offspring outcomes, in successful assessment of behaviors which lead to OB and in successful interventions for decreasing OB and related health concerns. This thesis consisted of five studies which report on environmental risk factors for ASD influenced by OB (Chapter 1). This thesis then found that OB and related health complications are significant, modifiable, risks for offspring ASD development (Chapter 2). It was then found that there is a lack of successful interventions for the treatment of OB to alter weight status pre-pregnancy (Chapter 3) but that individualized functional assessment and function matched interventions can contribute to the outcomes of weight loss attempts and decrease this modifiable risk (Chapter 4 and 5).

Chapter 1

Chapter 1 reports on an updated sample of maternal health conditions as potential risks in relation to the prevalence of ASD, including and extending beyond the meta-analysis by Gardner et al. (2009). Findings from this literature review suggest similar risk identification namely, maternal health history, maternal mental health, stress in pregnancy, medication use in pregnancy, infections and sickness during pregnancy, and bleeding during pregnancy as potential risk factors for offspring development of ASD. Most notably, this review highlighted weight mediated conditions as a crucial and novel area of risk requiring further evaluation.

This review discussed the importance of modifiable health considerations as an emerging avenue for ASD risk. Specifically Chapter 1 discussed that preliminary findings throughout the reported literature suggest a need for replication and of OB,
EGWG, DM and HY pre-pregnancy research (Bilder et al., 2013). Chapter 1 described the importance of these risks as they are, in part, modifiable and should be assessed with regard to their impact in relation to ASD risk. These risk are further important considering a continuously increasing prevalence in the conditions among women of child-bearing age, paralleled with increasing ASD diagnoses (Bilder et al., 2013).

It was also emphasized that OB and EGWG should be examined further in regard to risk of ASD in offspring, as each have been found to be independent risk factors and the risk of ASD was reported to increase when they are combined. Furthermore, OB and EGWG are commonly co-occurring, and are mediating factors to other risks (i.e. GDM) but are highly controllable (Bilder et al., 2013; Gardner et al., 2015). Chapter 1 concluded with the recommendation to evaluate these weight mediated conditions in varied and novel populations.

**Chapter 2**

Chapter 2 was an investigation into DM, HY and/or OB as risk factors for the development of offspring ASD. The aim of this study was to determine if the presence of those conditions lead to an increase in the risk of a child being diagnosed with ASD. This study retrospectively identified participants from the Atlantic DIP study, assessed the presence of conditions of interest during pregnancy, assessed the presence of offspring ASD diagnosis made outside of the studies research team, and screened respondents for the presence of red flags for ASD and confirmation of diagnosis through the SCQ.

Chapter 2 consisted of \( n=447 \) respondents who had children aged 5 to 10 years old. HY was found to be a significant risk factor in previous research, but the sample within this chapter’s occurrence rate was too low to be assessed and therefore not
considered a risk in the outcomes of this study. It was found that pre-pregnancy OB increases a child’s risk of being diagnosed with an ASD 5-fold and DM increases by 4-fold. Results of this study are consistent with previous research and suggest that the risk of offspring ASD diagnoses are significantly impacted by the presence of DM and/or OB in pregnancy.

Mothers of children with ASD were marginally younger in this study as compared to mothers of neurotypical children \((M=33.5, SD=5.19, M=33.2, SD=5.02)\). Fathers of neurotypical children were slightly higher than those with ASD, \(M (37.49) SD (6.82)\) as compared to \(M (33.2) SD (6.53)\). Fathers of children with ASD were more likely to be White/Irish as compared to any other race or ethnicity. The household income of children with ASD diagnoses was slightly less than those of neurotypical children \(\€27,000, \€40,000\). A Chi-square cross tabulation tests of association was used to evaluate variables related to pregnancy and perinatal time periods. Three variables were found to be significantly associated with increased ASD risk in offspring, namely, offspring feeding type increased the likelihood that a child would be diagnosed with an ASD by half-a-fold. Maternal DM in pregnancy was found to increase the risk of a child being diagnosed with an ASD by 4-fold. When adjusted for the additional significantly correlated variables, DM in pregnancy remained significantly associated with an increased risk of ASD. Pre-pregnancy OW/OB was also found to be a significant risk for ASD development when additional correlated risk factors were incorporated into regression models. Maternal OB was found to increase the risk of ASD by 5-fold, even when controlling for the influence of maternal DM.

DM during pregnancy was also found to be significantly related to a number of other previously identified risks. It was found that 74% of women who had DM in pregnancy were of an OW or OB BMI classification pre-pregnancy as compared to
55.3% of the non-DM group. Eighty-seven percent of women in the DM group presented with DM which had first onset within pregnancy (GDM and IGT). GDM and IGT are both related to pre-pregnancy weight, suggesting that weight could be the factor which is leading to increased DM in pregnancy. DM was associated with having been pregnant more than one time, as 98% of DM women compared to 61.5% of non-DM women had more than one pregnancy. Additionally, DM where first onset was detected in pregnancy, occurred at a higher rate than any other type of DM among mothers of children with ASD, 83% and 17%, respectively.

Furthermore, pre-pregnancy OB was found to impact a number of additional sub-optimal offspring outcomes such as other diagnoses requiring special education (e.g. dyslexia and Fragile X Syndrome) and was related to the mothers other children also having a diagnosis requiring special education supports. These findings add to the growing research pool suggesting that pre-pregnancy OB is in need of supports and modification before women become pregnant as a way to support optimal offspring outcomes.

This study has a number of strengths. Firstly, while initial diagnosis of ASD was made outside of the study team, this study utilized the SCQ to confirm diagnosis and scree for possible delays in development related to red flags for ASD. Secondly, while self-report survey data collection was utilized, this study had access to a medical database with valid record kept by doctors and additional medical personal. While many previous research studies utilized participant report of conditions (Krakowski et al., 2012) this study had access to reliable hospital records increasing the accuracy of variables assessed. Therefore, the access to medical records collected through hospital
Chapter 6

data systems regarding medical conditions, vitamin use, insulin use, weight, and perinatal conditions provided arguably additional valid data on variables assessed.

**Conclusion.** Chapter 2 evaluated the risk of offspring ASD when the conditions of DM (all types) and HY were present in pregnancy. Results show a significantly higher risk for children’s development of ASD when conditions of interest were present in pregnancy. This research supports the global concern regarding the increasing OB epidemic and highlights the need to control OB pre-pregnancy as a means of impacting risk occurrence and potentially impact offspring outcomes. An important next step for research is the continued evaluation of methods to decrease this modifiable risk factor.

**Chapter 3**

The aim of Chapter 3 was to review the current literature in the management of weight and the available supports for decreasing weight in people with OB and OW, outside of eating disorders. Chapter 3 found limited efficacy in the current avenues for weight supports and identified three major barriers to efficacy in current interventions: (1) the lack of individualization in treatment, (2) lack of functional assessment of eating behavior (3) lack of interventions which target function. Furthermore, it was found that there is large variability in the definition of maladaptive eating behavior among current research causing additional barriers in treatment targets. Meaning the lack of individual assessment creates a barrier to understanding individual behavior and needs, which in turn causes a limitation in the ability to deliver appropriate intervention components and does not target the maintaining variable, making resurgence likely.

Chapter 3 concluded that current interventions are minimally successful but might be improved upon if delivered contingent on functions of behaviors and with identification of individual needs. Chapter 3 also established that there is a lack of application of functional perspectives on eating outside of BED/BN with individuals. Previous research suggested that identifying the antecedents and consequences, which
are functionally related to eating behavior is necessary to understand and intervene on
the behavior in meaningful and individualized ways (Lee & Miltenberger, 1997;
Stickney & Miltenberger, 1998; Stickney et al., 1999). Previous studies have shown
that maladaptive eating behaviors serve different functions for individuals, and that the
identification and treatment of behavior with regard to function is imperative (Stickney
& Miltenberger, 1998; Stickney et al., 1999), yet there is a lack of application outside of
clinical eating disorders.

Chapter 3 highlighted the use of a “one size fits all” approach to intervention, as
component in the lack of treatment efficacy (O’Neill et al. 2012), and proposed
individualized management protocol in the treatment of OB, which includes the
analysis of individual behaviors that contribute to increase weight and decreased health
(O’Neill et al. 2012; Brahm et al., 2018b, in press). It was found that pre-pregnancy
OB and OW were significant risks for ASD and that OB mediates the additional GDM
risk, therefore it is important to determine mechanisms for decreasing this controllable
risk factor. Considering the impact of maternal weight related health on offspring, the
need for interventions is significant. Individualized interventions and counseling for
women of childbearing to decrease body weight before becoming pregnant should be a
priority of risk management and intervention (ACOG, 2013; Brahm et al., 2018b, in
press). Yet, Chapter 3 found there is a lack of successful supports to offer.

Chapter 4

Chapter 4 aimed to use self-reported direct and indirect measures to identify and
functionally assess maladaptive eating behaviors among non-clinical OW and OB
women. The study assessed the efficacy of data from both real-time assessments
(monitoring forms and antecedent/consequent checklists) as well as retrospective
assessments (interview, questionnaire and rating scale) on the antecedents and consequences of maladaptive eating behaviors.

Identification of problematic eating (DV) was obtained from the current HHS and USDA dietary guidelines pattern analysis and scatterplot assessment of intake dimensions such as IRT and duration. Utilizing the current guidelines provided objective and measurable approach for identifying problematic eating and habitual patterns leading to health concerns. Eating behavior guidelines provided a procedure for evaluation which aligns with behavior analytic tactics and principles of analysis. Eating pattern dimensions were analyzed in relation to their frequency, IRT, duration, timing of intake (Cameron et al., 2011; Leech et al., 2015). Additional components of eating patterns were combined through previous research recommendations of factors leading to healthy weight such as eating breakfast, eating frequency and size of meals (Murakami & Livingstone, 2014). Type of intake was defined as a meal, snack or drink and were assessed with regard to eating dimensions, calorie content of total intake over the day and micro/macro nutrient content per intake (Leech, Worsley, Timperio, & McNaughton, 2015). Eating frequency was an especially important variable considering previous research has nearly always found a positive association with high caloric intake and high eating frequencies (Murakami & Livingstone, 2014). Additionally, Murakami and Livingstone (2014) found a positive association between eating frequency BMI and waist circumference.

This study used modified versions of previously established measures in the functional assessment of contingencies maintaining maladaptive eating behavior. This chapter was the first use of a functional assessment battery, including the BEI and FAI, to evaluate eating behaviors outside of binge eating, to our knowledge. Analysis of the measures allowed for the determination the EO’s, S^4, antecedent and consequence
variables surrounding identified instances of intake. Bar graphs were created to visually represent the contingencies and dimensions of eating behavior. Scatterplot graphs were created to visually assess the temporal relations of eating behaviors. Summary statements regarding hypothesized functions of the identified problematic eating instances were determined after analysis of behavioral contingencies. Using modified versions of previously developed tools for the functional assessment of binge eating, this study was able to effectively identify maladaptive eating patterns, their setting events, antecedents and consequences. This assessment package effectively evaluated and provided information on the currently absent component of behavior related to OB, by giving information on the consequences of behavior, rather than focusing on antecedents.

This is the first study, to our knowledge, to assess maladaptive eating behaviors functionally using the eating pattern guidelines and the first to functionally assess eating behavior outside of binge eating. Results suggest that all three women had similar OW/OB, yet topographically and functionally different eating behaviors. These results present a strong case for the necessity to individually assess eating behavior in relation to the current OB epidemic.

This is one of the first studies to collect baseline data for extended durations as to assess multiple eating periods in generalized contexts (Murakami & Livingstone, 2014). This was important when considering patterns like Ava’s where her most problematic components of the week were found during weekend days. This could have been overlooked without extended analysis. Cathy as well had the greatest level of eating behavior on days where she had class, which could have been missed without extended analysis providing further evidence for the need for individual assessment. These results are different than the outcomes of previous research on high frequency
intake being related to increased calorie intake (Murakami & Livingstone, 2014) yet would likely have been overlooked without extended evaluation into individual repertoires of eating behavior. Future research should consider the use of extended baseline data collection to fully understand behavioral repertoires before intervention.

A notable concern is that each participant reported using food as a reward. For instance, Cathy reported “treating” herself to a piece of cake or similar food item when she received a high grade on a paper. Chapter 4 argues that it will be important going forward that interventions work to decrease the view of food as a “prize” or “treat” as it has the potential to alter the purpose of food from being fuel for bodies to work, into a tangible treat one must work for, inadvertently increasing its value.

This study aids in our understanding of maladaptive behaviors as well as the operant functions that each behavior may serve for an individual. Results clearly show that each participant had similar OW/OB yet each had different eating behaviors, setting events, antecedents and consequences and were all of an unhealthy weight. Further solidifying the need for individual assessment procedures to evaluate and treat maladaptive eating patterns.

Chapter 5

Chapter 5 utilized the information found in Chapter 4 as well as the components of intervention reviewed in Chapter 3 to develop function matched individualized interventions for \( n=3 \) women of child bearing age. This study aimed to utilize previously established intervention components, but to implement those in a way which matched individual need and function of each separate behavior found in the Chapter 4 FBA process.

Data allowed for the development of comprehensive, functional treatment protocols which address specific, measurable behaviors for each participant.
Intervention packages were developed to target the antecedents of maladaptive behavior, teach functionally equivalent alternative behavior, to decrease the reinforcement for inappropriate behavior and increase the reinforcement obtained for more appropriate behavior repertoires. The participants rated the treatment package as extremely easy and helpful, minimally disruptive and minimally time consuming in changing their eating behavior. Each of the participants reported that the reduction in their problematic behaviors and change in weight was primarily due to the intervention protocol.

Results show that when treatment was matched to function and systematic measures were taken to decrease problematic behaviors while teaching functionally alternative behaviors, healthy eating behaviors were established and maintained overtime. Furthermore, results suggest focusing on healthy eating patterns and specific behavior lead to weight and BMI decrease for each participant. Participant behavior was targeted within a multiple baseline design. Behaviors were selected for change based on a systematic step-wise procedure towards terminal healthy behaviors. For instance, Ava’s treatment package focused on decreasing high rate of consumption on Friday evenings before targeting her high social intake over all. This was done to separate complex behaviors into their component parts and establish a repertoire of reinforced behavior change, before targeting additional behaviors and environments. This step-wise progression and systematic approach increased the likelihood of success and provides evidence to support the need to focus on small behavior change to impact health and weight. As participants met a pre-defined criteria on tier one behaviors, they were systematically moved onto the next tier while the first was placed on maintenance. By the end of intervention, participant’s top three most problematic eating behaviors
had been decreased and these decreases maintained, while functional alternative behaviors increased and were maintained in their place.

Ava’s treatment package focused on decreasing the socially mediated reinforcement which was maintaining her high rate of eating on Friday evenings and high rate of consumption in social settings. Ava’s package focused on decreasing socially mediated prompts for eating unhealthy patterns and implemented a DRA procedure for specific healthy eating behavior patterns.

Cathy’s package targeted her pattern of large response time between intake and eating in response to negative covert antecedents while decreasing her habitual sugar intake. Awareness training and health literacy were significant components to Cathy’s intervention, as her behavior was in part maintained by automatic negative reinforcement through the removal of cravings and hunger. Cathy had a high rate of antecedent strategies to place previous behavior on extinction and reinforce alternative eating schedules and choices. Cathy’s reinforcement was also delivered simply though the automatic reinforcement of increased intake throughout the day, making it more likely that Cathy would maintain behavior change, and supported the importance of her health literacy skills as to prevent overconsumption patterns.

Maeve presented with the longest and most significant history of maladaptive eating. Still, her data and feedback suggest a number of significant behavior change outcomes. Perhaps most importantly was Maeve’s reported change in her knowledge on dietary versus health behaviors and reported understanding how to engage in more health-conscious behavior which decreased the antecedents and reinforcement from problematic eating behavior. This additionally, aided in her establishment of a repertoire of healthy alternative behaviors.
Evaluation of each behavior was critically important when establishing participant’s intervention packages. FBA results showed that each participant presented with multiple problematic behaviors which were maintained by different consequences not just between participants, but between behaviors within the same person’s repertoire as well. This underscores the necessity of assessing for all possible behaviors and the eliciting and maintaining variables of each. Should the same intervention have been implemented for all behaviors within a repertoire it is unlikely that each behavior would have changed to meet criteria, or maintained overtime, as the maintaining variables would not have been targeted.

Results of this chapter also show the necessity for direct measurement of dietary intake. An example in caloric discrepancies is evident in Ava and Maeve’s calorie consumption at restaurants. Both participants hypothesized that their intake was less calorically dense than it actually was. Without direct measurement of quantity and calories of intake, it is likely that participants would continue to eat in excess of a recommended healthy amount.

Also important was the blind data collection of intake during baseline. It was hypothesized, and participants reported, that they would have eaten differently if they knew how many calories they were consuming in baseline. Not only does this suggest the need for blind procedures in baseline but strengthens the argument for nutrition and healthy eating literacy intervention components which are individualized and tailored to each person’s specific eating repertoire.

The results of this study show potential to evaluate increasingly effective treatment and establish best practice in treatment related to eating behavior (Argas, 1993; Giddings & Miltenberger, 2010). In their discussion of CBT and BED Giddings & Miltenberger (2010) discuss CBT as typically taking 24 weeks and achieve about
40% abstinence in bingeing behavior. Authors report that the behavior analytic approach represents a best practice shift towards the treatment of BED, which this chapter supports. Chapter 5 offers treatment conditions which should be further evaluated for best practice in the treatment of OB and OW behavior patterns related to the current epidemic. With Part 2 of this thesis clearly outlining the lack of effective interventions for this problem, the function based approach and matched treatment presented in this thesis should be further considered in the treatment of these behavior problems.

Implications of Research Findings

Risk for ASD

The Interagency Autism Coordinating Committee Strategic Plan for Autism Research prioritized the identification of exposures and lifestyle factors which may be modifiable, and highlight metabolic environments as an important area to study. This thesis highlights modifiable health complications as being an emerging avenue for risk research, specifically the areas of weight and weight mediated risk factors. Recently, Lyall, Schmidt and Hertz-Picciotto (2014) discuss the research surrounding modifiable risk factors as needing a great deal of additional research. The authors specifically suggest that more work is needed in investigating maternal nutrient status during pregnancy as well as metabolic conditions during pregnancy. The clarification of risks, some of which may be preventable, has the potential to alter the trend in ASD diagnosis and treatment (Klug et al., 2003).

To date, the body of data evaluating ASD risks has largely been confined to specific countries (e.g. Sweden, Finland), despite it being reported that comparing prevalence across countries and identifying how community exposures to environmental conditions
Chapter 6

affect the risk of ASD are some of the most important variables in identifying risks (Rosanoff, 2014). At current, the majority of environmental risk factor research and prevalence data comes from a small set of countries and regions which have access to public health registries, allowing for substantial data sets. While the population cohorts are robust and the methodologies are rigorous, a limitation remains in the lack of geographical variation within the research pool. This suggests the need for research to be conducted in additional and varied regions, as the development of universally relevant risk factors may further advance the diagnosis and treatment of ASD. This thesis expands the evaluation of modifiable risk to a country not yet assessed and adds to the breadth of global research being conducted on ASD risk.

**Early Identification.** Risk factor validation and identification presents an avenue for increasing the success of early identification of ASD. In an application context, an enhanced understanding of risk factors and their association with ASD creates an opportunity for earlier screening when risks are identified in health history. The importance of early diagnosis and early intervention has been well documented, yet there are multidimensional difficulties associated with the improvement of early identification procedures in ASD (Zwaigenbaum, Bryson & Garon, 2013). Still, the necessity of effective methods for early identification and diagnosis procedures is clear (Dawson, 2008; Zwaigenbaum et al, 2013). Research demonstrates that significant gains can be made when a child receives a diagnosis, and subsequent intervention, as early as possible with some authors recommending intervention as young as 12 months of age (Dawson, 2008; Peters-Scheffer, Didden, Korzilius, & Sturmey, 2011). Dawson (2008) and Fernell, Eriksson & Gillberg, (2013) discusses the potential to alter brain development and behavioral outcomes in ASD when gene-environmental risks combinations are identified and intervened on as early as infancy. Evidently, outcomes
of risk research can bring greater awareness to offspring who may be at risk for ASD and allow for more proficient monitoring, earlier diagnosis and earlier intervention, yet this information is significantly under-utilized. Earlier screening, when risks are present, should be utilized to support diagnosis and subsequently, crucial interventions as early as possible, leading to increased gains and the greatest potential for optimal outcomes. The outcomes of this research can bring greater awareness to offspring who may be at risk for ASD and allow for more proficient monitoring, earlier diagnosis and earlier intervention.

**Comorbidity in ASD and OB**

Comorbidity is defined as the presence of two or more conditions in the same person and are prevalent among individuals with ASD (Mannion et al., 2014). Studies have reported as many as 72% of individuals with an ASD were diagnosed with at least one comorbid disorder (Gjevik et al., 2011) such as intellectual disabilities, anxiety, ADHD and epilepsy (Smith and Matson, 2010). Pre-pregnancy OB and DM were found to be associated not only to risk for ASD development but additional co-morbid diagnoses in Chapter 2. Additionally, maternal OB has been associated with increased offspring ID, DD, cognitive deficits and a number of medical complications in previous research (Brahm et al., 2018a, in press).

In 2017, Razaz, Tedroff, Villamor and Cnattingius investigated the association between BMI levels in early pregnancy and the risk of childhood epilepsy in the offspring as well as the association between pregnancy and neonatal complications resulting from OB in pregnancy and the risk of offspring development of epilepsy. Authors found that as amount of OB increased in mothers, so did rates of epilepsy in offspring. Furthermore, ID, DD, diminished cognitive abilities and ASD have all been shown to be higher and problematic for children where OB impacted their pregnancy.
Pugh et al. (2015). In 2017, Deardroff, Smith, Petito, Kim & Abrams found 9-11 year old male offspring of OB mothers had significantly higher behavior problems as compared to the offspring of normal weight mothers. Considering the high incidence rates of these co-morbid diagnoses with ASD, it is important that pre-pregnancy OB be controlled for not only for ASD risk mitigation but for the control of the co-morbid conditions which are prevalent as well.

In addition to the risk of ASD associated with OB and OW pre-pregnancy, there are a number of additional medical conditions impacted by OW and OB which occur in and around pregnancy and birth as mentioned in Chapter 2. Importantly, where excess weight is present, GDM, HT and PE occur at much higher rates. These additional diseases lead to further complications and risks for the child, in addition to what is present with OB alone. Research has shown that as many as 50% of these additional health concerns could be diminished if women were entering their pregnancy at healthy weights (ACOG, 2013).

**Conditions of Interest and Prevention**

Perhaps the most significant outcome of this thesis is the progression of the discussion regarding prevention of potential risk factors. Nevison (2014) reviewed temporal trends in ASD as compared to trends in certain environmental risk factors. Findings show that rates of ASD and maternal OB are simultaneously increasing, suggesting that the increase may be, at least partially due to corresponding environmental risk factor of OB. Authors report that the correlation between the increase of OB and ASD might represent a direct influence of diet on ASD. Additionally, Xu et al (2014) suggest that is possible that nutrition and/or hormonal changes such as in GDM could be interacting with genetic predisposition for ASD, increasing the likelihood of diagnosis. Authors also report that due to the robustness of
GDM risk outcomes, targeting women at risk for GDM is an avenue for possible prevention of ASD (Xu et al., 2014). The outcomes of Chapter 2 of this thesis add to the robustness of the conclusions of Xu et al. (2014) that modifiable factors related to diet and weight are an avenue of prevention. Chapter 4 and 5 serve to extend the limited evidence-base of successful interventions for dietary and weight related behaviors. The research and discussion presented in this thesis significantly add to the discussion on valid methodologies in decreasing these modifiable risks.

**Public Health**

This research noted a need for improved prenatal care and health education for women of childbearing age. Research has supported pre-pregnancy care as having an important role in reducing maternal health risks and improving offspring outcomes, suggesting a 50% reduction in adverse prenatal events when mothers had access to pre-pregnancy care (ACOG, 2013). Previous research has shown diabetes, OB and hypertension to be growing issues (ACOG, 2013). The outcomes of this research has the potential to positively impact awareness of pregnancy risks and will support public health research in Ireland and abroad.

Furthermore, this research will help to increase development of, and access to antenatal care by providing a scientifically and methodologically sound intervention to control of the highest risk on mothers and fetus. As stated, EGWG is the leading contributor to suboptimal outcomes for both mothers and fetus, and is growing at an alarming rate. Developing a valid intervention to control this manageable variable pre-pregnancy has the potential to a significant difference universally.

**Decreasing Cost Burdens**

Research and health promotion has focused recently on the economic burden of OB (Dee et al., 2014; Spieker & Pyzocha, 2016). Research from the United States
show nearly 20% of health care expenditure, $209.7 billion, is associated with OB care (Spieker & Pyzocha, 2016). Because of its high co-morbid rate, it has been established that OB is the main influence of healthcare costs in developed countries (Dee et al., 2014). Cost consumption arises from health care needs for things like aches, pains, sleep disturbances up through major endocrine and metabolic complications such as T2DM, heart disease and cancer (Lehnert, Sonntag & Konnopka, 2013). It has been found that the cost of health care for an individual increase as BMI increases (Dee et al., 2014).

Indirect cost burdens associated with OB are also a major contributor to social implications in the increasing rates of OB (Dee et al., 2014). Indirect costs refer to things like reduced productivity and early mortality. It is clear that OB creates a significant health and societal burden. Therefore, addressing this significant health concern has the potential to decrease cost burdens on an individual, governmental and global scale (Dee et al., 2014).

Due to the high cost burden globally, medical and economists are calling for effective weight reduction measures (Spieker & Pyzocha, 2016). It has been estimated that effective weight reduction could save upwards of $610 billion over the next 20 years, just in the United States alone (Spieker & Pyzocha, 2016). However, without effective weight management procedures, the cost burden is likely to increase rather than decrease (Brahm, et al., 2018b, in press; Spieker & Pyzocha, 2016). This thesis provides evidence that decreasing weight related behaviors impact individual weight and that removing maintaining consequence of maladaptive eating serve to decrease those behavioral repertoires. Therefore it is recommended that the procedures provided in this thesis are implemented with the goal of impacting individual weight behaviors.

**Longitudinal Implications**
Bellamy, Casas, Hingorani and Williams (2009) report women who have the presence of GDM have a minimum of seven-fold increased risk of developing T2DM in the future when compared to women with no GDM in pregnancy. A hypothesized component of this increased risk is that of gestational weight retention. Furthermore, when women retain weight post pregnancy, they are significantly more likely to enter into subsequent pregnancies further OW (Bellamy et al., 2009) and women who are of increased BMI pre-pregnancy have been shown to gain excessive weight during pregnancy (Catalano and Shankar, 2017). Due to increased gestational weight gain, OB women tend to also have significant postpartum weight retention (Catalano and Shankar, 2017). Furthermore, women of increased BMI and EGWG tend to have substantial increased postpartum weight gain beginning 6-12 months after birth (Catalano and Shankar, 2017). These progressive weight retention considerations are an important area of future research in limiting the amount an individual gains during pregnancy by supporting health behaviors before becoming pregnant.

Research has also shown that increased BMI and EGWG lead to a long-term increased risk of disease and complications later in life for both mother and child, suggesting a transmission of conditions from mothers to their infants during pregnancy (Shaikh, Robinson & Teoh, 2010; Sen et al., 2010; Yu et al., 2011). Increased BMI and EGWG has also been shown to increase health risks of offspring and to increase their child’s risk of OB later in life (Catalano and Shankar, 2017). Children of high BMI and EGWG pregnancies were found to have higher waist circumference, higher BMIs themselves, higher fat mass are more likely to be large for gestational age and more likely to be OB by three years of age (Catalano and Shankar, 2017; Olson, Strawserman & Dennison, 2009).
These potential complications have broad reaching health implications not only for the mother herself but for the child of each pregnancy she may have. Pre-pregnancy weight increases with each subsequent pregnancy when it is not directly targeted suggesting an increased risk of suboptimal offspring and mother outcomes with each subsequent pregnancy. These increased disease risks and increased transmission of disease present a critical area for prevention. As stated in Chapter 3 the risk of GDM could be reduced by nearly 50% if pre-pregnancy weight was decreased (ACOG, 2013). Therefore the risk of GDM needs to be targeted for decrease before women become pregnant. However, to date there are a number of limitations to decreasing this trend, including a barrier in effective interventions (Brahm et al., 2018b, in press).

**Improving Behavioral Treatment for Obesity**

As is stated by the USDA and HHS (2010), evidence shows healthy eating patterns are associated with positive health outcomes. Growing support shows that healthy eating patterns are associated with reduced risk of cardiovascular disease risk, reduced risk of T2D. Utilizing the healthy eating guidelines in this research allowed for a measurable intake which participants could clearly understand and track themselves. Subsequently there has been an increase of interest in behavioral treatment for OB and related weight patterns (Brahm et al., 2018b, in press).

However, there are concerning trends among eating behavior research which attempts to utilize behavior analytic principles. The misuse of principles is a frequent occurrence in research. One example can be seen in the misuse of stimulus control interventions within the behavioral treatment of OB reported by Johnston, Tyler and Foreyt (2005). Authors reported previous studies where participants who were provided with meal replacements were more successful than participants given instructions on following a low-calorie diet independently with no assisted food
preparation and classify these as stimulus control interventions. Increasing the accuracy of behavioral principles and procedures within intervention research has the potential to impact the efficacy of outcomes but additional application of accurate science is necessary.

As was stated in Chapter 3, there has been significant growth in the area of weight management interventions. However it is argued that these components to interventions are mis-delivered. That is, there are components to the interventions which work and are successful with certain people. However, currently the components are delivered with a lack of regard for individualization of person’s specific needs as well as lack of identification of the maintaining variables of behavior.

Not surprisingly, inaccuracies are also seen in individual perception of eating behavior. FAI data as compared to direct data collection showed that women were labeling and discussing their behavior in ways which did not match their behavioral engagement. Additional research should consider increasing the use of awareness training on the behavioral components of each individual’s behavior as well as what is eliciting and maintaining it. Increased understanding has the potential to impact successful outcomes for individuals but requires additional research.

Furthermore, the definition and understanding of antecedents to eating should be considered in future research. Terms like “impulsive” were commonly identified by participants in relation to their overeating and was described as being something they could not control, for example tacting “I can’t control my eating, it just happens impulsively”. Yet, with more in-depth analysis it was determined that impulsivity was used to avoid the identification of foods being ingested. For example, Cathy frequently ate high calorie foods and reported being aware of her sugar consumption, yet continued in this pattern. When discussed in FAI process, Cathy was able to identify
the avoidance and that she was using impulsivity as an excuse to eat without feeling
guilt for it. This information should be further examined in additional eating patterns
with further individuals. Matching interventions to misinterpreted antecedents and
consequences could be a component to the lack of efficacy seen currently.

**Generalized Effects.** Ava’s family weight loss is an important outcome to
consider as an avenue for future research relating to the effect an individual’s behavior
has on the family environment. This, outcome suggests the potential for a successful
intervention to have generalized outcomes for the family as a whole. This is important
for future research when considering the health behaviors of mothers have a direct
impact on the health of their children and others in their environment as well as
discussed in Chapter 3.

**Towards Evidence-based Treatment.** Meredith et al. (2014) discuss the need
for an increase in established framework to tailor the implementation of interventions
across multidisciplinary fields. These authors discuss the discrepancy in the delivery of
incentive-based intervention design, individuals implementing the intervention, the
behaviors that are selected for change, and the types and schedule of incentive delivery
as components of the lack of outcomes in the research base. The authors also highlight
the push for incentive-based interventions with relation to policy and providers. Yet,
the lack of systematic investigation into the components of intervention and lack of
evidence-base have led to a shift in adaptation of interventions which are not informed
by research outcomes. The authors recommend the principles of behavior analysis as
providing a framework for incentive-based interventions in health care.

The research presented in this thesis aids in the development of such framework,
though further research is necessary to evaluate its generality. This research presents a
framework not only in the incentivizing of interventions but also in the assessment and
match treatment which can be applied in a broader context and provide an evidence-based framework in which health care could function. Yet, importantly, further research is needed following this research on its generality and additional use.

**Access to Care through Telehealth**

As was highlighted in this thesis, access to tailored treatment in the area of OB support is a barrier to health globally. Telehealth is a relatively new development in the diagnosis and treatment of medical conditions (Koch, 2006). Telehealth uses internet technologies in the communication and electronic data sharing for healthcare purposes (Koch, 2006). This thesis utilized telehealth through the use of MFP and Skype® technology between the research team and the participants. These two avenues of web based contact represent topographies of patient-practitioner contact which could close the gap in access to support and treatment at current

Telehealth technologies are increasing in popularity and efficiency (Koch, 2006). Research has shown an increase in patients self-management of their health leading to an increase in telehealth and technology based management (Koch, 2006). This study utilized a M-Health application in MFP for several intervention components. MFP was used for multiple purposes described below including, goal setting, intake reminders, corrective feedback and self-monitoring. MFP had reported ease of use and set up as well as increased likelihood of use due to its ease of food input and exercise input. Participants specifically commented on the ability to find foods from restaurants on the app as well as the barcode scanner as useful.

Mobile methods of dietary self-monitoring allowed for real-time recording of food consumption and allowed for continuous monitoring and reinforcement from the researcher (Turner-McGrievy et al., 2013). Recent studies have shown that self-monitoring through M-Health applications was related to increased success in weight
interventions (Turner-McGrievy et al., 2013). This thesis supports previous findings on the use of M-Health technology on behavioral interventions for weight behaviors. Therefore, it is recommended that combining the evidence-based practice of behavior analysis with the ability to access qualified professionals is a significant opportunity for increased success in the treatment of OB. Future research should focus on the delivery of behavior analytic principles within weight behavior interventions, delivered utilizing M-Health and trained professionals in the broader reaching implications on the OB epidemic.

**Applied Behavior Analysis**

ABA has long been faced with the challenge of disseminating and supporting interventions which employ the principles of the science into large, broad reaching social constructs (Slocum, Detrich, Wilczynski, Spencer, Lewis, & Wolfe, 2014). Baer et al., (1968) discussed the importance of developing effective and validated behavior-change techniques, with improved understanding of the principles of behavior and which lead to effective interventions across populations. The authors emphasize the need for applied interventions to transition into larger research application to improve efficacy and efficiency of interventions (Miltenberger et al, 1998). As a foundational goal of behavior analysis, the translation of the seven dimensions of behavior analysis to eating behavior is lacking.

The application of ABA into eating behavior in response to the OB epidemic has the potential to increase the reach of the science to broader applications. While ABA has been established as the leading treatment for ASD, it has also inadvertently found the science largely confined to a box of ASD treatment only (Freedman, 2016). Freedman (2016) discuss the lack of behavior analysis applied specifically to the OB epidemic as a significant concern for the field. Stating that instead of acknowledging OB as a behavior problem and that behavior analysis has a significant role in weight
loss, there is a marked absence in behaviorism or behavior analysis with regard to the OB epidemic. Instead the author describes media portrayal of things like cold weather, lack of sleep and a deficit of gut bacteria as the cause of the OB epidemic (Freedman, 2016).

Freedman (2016) offers three solutions to the problem of the media and public distorted view of behavior analysis particularly as it related to OB related behavior. Namely; reframing the science to better connect with the mass public, publicizing comparisons of behavior analysis outcomes to non-behavior analysis outcomes, and more readily changing what was referred to as the “warm and fuzzy” and humanistic side of behavior analysis, while moving away from the technical language and techniques in dissemination (Freedman, 2016). The strategies presented in this thesis give an avenue for not only expanding behavior analysis into additional realms outside of ASD specifically but into more up to date and consumer friendly fashions through things like M-Health applications. The concepts presented in this thesis should be expanded and considered for generalized public effects, such as increasing the rate of behavior analysts in weight treatment.

**Potential Limitations**

Despite the strengths of the current thesis, there are a number of identified limitations.

**Chapter 2**

Chapter 2 aimed to determine the prevalence rates of ASD among a large population based sample in the country of Ireland. This study found the prevalence rates of ASD to be 6% among all respondents. This outcome is higher than the current global estimates available of ~2% (CDC, 2016). There are two potential reasons for this larger number in this data set. Firstly, response bias could be present among this
population. It is possible that parents of children who have an identified ASD diagnosis responded at higher rates because of their relationship with ASD and tendency towards ASD research. Future research should focus on increasing the sample size and assessing the ASD rates.

Secondly, this study evaluated a particular geographical area within the country of Ireland. Specifically, the participants within this study resided within the counties of Mayo, Galway, Roscommon and Donegal. This is a high concentration of participants in the West of Ireland. Considering the geographical breakdown of special needs in Ireland showing differential rates of needs across the country (Boilson, Staines, Rameriez, Pasada & Sweeney, 2016) it is important for additional research to evaluate the presence of these risk and the rates of ASD across Ireland.

**Response Rates and Response Bias.** Response rates and response bias are potential limitations to this research. In Chapter 2 recruitment could be considered low, yet there are a number of influences to this response limitation. There is a potential that more parents of children with ASD responded to the survey invitation than parents of children without ASD. Similarly, there is a possibility that mothers who had DM in their pregnancy were more or less likely to respond to this survey. Firstly, because they may have been more interested in the research or secondly because they may have avoided the research due to the presence of metabolic condition during pregnancy potentially being associated with a deficit in their child. While every effort was made to ensure an even response rate, particularly by calling and discussing the research with participants, it is still a consideration that response rates could have been biased due to the nature of the research. As Chapter 2 evaluated sensitive health and developmental histories of mother and children, it is hypothesized that there may be a lack of returned data in regard to the rates of ASD. 13% of women responded with “Uninterested in
participation.” It is hypothesized that a portion of those women chose not to respond due to the sensitive nature of metabolic conditions potentially influencing their child’s development. Again, while all best efforts were made to ensure mothers were well informed the potential for a lack of responding due to these factors is present.

Additional limitations to data collection can be found in the acquisition of initial data likely limiting the amount of responses available. Post mail was the required method of acquisition due to the availability of post addresses only. When the Atlantic dip study began, e-mails were not a readily used form of communication and therefore email addresses were not collected. Therefore, there were a significant number of potential participants within the Atlantic DIP study who were unable to be reached within this study’s recruitment phase even though subsequent phone calls were used.

**Reliance on Parental Reporting.** ASD and child development was obtained through parent report within Chapter 2. While it is often thought that parental reports of child behavior and development can be subjective, research has shown a high agreement between clinical and parents opinions of behavior (Mannion & Leader, 2016). Parental report was not found to be a major limitation within the current thesis as the SCQ scores which parents completed were used to verify already present diagnosis. The SCQ tool was validated using a sample of 200 children, ages 4 and above with a variety of developmental disabilities including ASD. The tool discriminates between likely ASD and non-ASD outcomes using a 15-point cut off score with sensitivity=0.85 and specificity=0.75 (Berument, Rutter, Lord, Pickles & Bailey, 1999) and is therefore likely to have provided accurate scores even with parental reporting.

**Sampling Bias and Sample Size in Chapters 4 and 5**
Sampling bias may be present within the Chapter 4 and 5 participants. It is possible that women who responded to postings for a weight intervention were more aware of their unhealthy eating behavior and were more motivated to participate and follow a program set forth for them with regards to their weight than participants who would not have been independent volunteers. However, volunteering is the standard approach to weight interventions as by nature the program requires a certain level of motivation to engage with.

A potential limitation of this study is the relatively small sample size. While this research specifically focused on single subject research design for the individualization of treatment, future research should consider replications of the protocols to additional populations of non-clinical OW and OB individuals. To determine the robustness of the procedure, additional subjects are needed and additional behaviors are warranted for evaluation. While a sample size of three is considered adequate in single subject research design (Cooper et al., 2007, Bailey & Burch, 2002) future research should aim to expand methods used in this thesis to additional and varied populations.

Reliance on Self-Reporting of Eating

A potential limitation in Chapter 4 and 5 was the use of self-monitoring in data collection procedures. Hypothetically participants could have entered inaccurate food into both the FBA data collection as well as into MFP which functioned as data collection measures for outcomes. While, verifiable data on daily consumption is preferable, it is likely not possible to verify each instance of intake across lengthy durations of eating in natural contexts (Giddings & Miltenberger, 2010). However, considering the outcomes of the data not only showed the change in behavior but the
Chapter 6

A generalized outcome of weight loss, it is unlikely that participant’s falsified data entry to a significant degree.

**Maintenance Data in Chapter 5**

An identified limitation of the current study is the lack of long-term maintenance data. This study continued only until participants met the pre-determined 10-week duration of intervention. Each participant has up to 9 weeks of maintenance data on specific goals, but due to an identified limitation of previous research being lack of weight loss maintenance, behavioral maintenance needs to be assessed as well. Future research will evaluate maintenance data on targeted behavior. While this study did not specifically target weight loss, it did target behaviors which influence weight loss. Therefore, the maintenance of these behaviors is necessary to maintain weight loss effects.

**Future Research Emerging from this Thesis**

This thesis offered a number of significant and impactful findings. Still, there are many areas on which future research can be conducted following the results of this thesis.

**Metabolic Conditions and Child Outcomes**

Chapter 2 found that children of mothers with increased BMI pre-pregnancy had higher SCQ scores, potentially suggestive of increased ASD symptomology but not meeting criteria for ASD. Additionally, previous research has found where metabolic conditions were present in pregnancy, there were increased rates of cognitive deficits, DD, and additional disabilities among children. It was recommended that OB and should be independently evaluated for their role in the development of GDM, as the implications of weight with respect to ASD risk associated with GDM is under-researched and unclear.
Krakowiak et al. (2012) examined the gestational metabolic conditions of DM, HT, and OB in groups of participants with ASD, DD and typically developing controls. Results indicated all three metabolic conditions were more prevalent within the ASD and DD case mothers as compared to control mothers. The authors also examined the developmental outcomes in groups of children with regards to associated maternal metabolic conditions. Results from the Mullen Scale of Early Learning and the Vineland Adaptive Behavior Scales suggested the risk of maternal DM was related to higher impairments in cognitive and language development. The authors note that evaluating outcomes based on risks is an area where much work is needed.

Additionally, Dionne, Boivin, Séguin, Pérusse, and Tremblay (2008) reported that children of mothers where GDM was present in pregnancy, as compared to no GDM, had significant expressive language impairments even without ASD. The results of this thesis also support that further investigation between identified metabolic risks and outcomes for children are required to determine the full scope of childhood outcomes where OB and related metabolic conditions impact pregnancy.

**Obesity and Overweight in Children/Adolescence with ASD**

An important area of consideration for future research is found in eating and health behaviors in children with ASD. OB rates among US children between 6 and 17 years of age are reported to be 20%, yet rates of OB among children with ASD are nearly 32% and adolescents with learning and behavioral developmental disorders generally are 60% more likely to be OB than neuro-typical controls (Phillips et al., 2014). Likewise, further research found prevalence of OB in children with ASD to be 30.4% as compared to 23.6% in neurotypical children (Curtin, Anderson, Must & Bandini, 2010). Previous research also shows that children of mothers who were
OW/OB in their pregnancy and/or who gained too much weight in their pregnancy are at an increased risk of being OW themselves later in life (Curtin et al., 2010).

With the increased rate of OW/OB among children with ASD combined with the increased rate of transmission of OW/OB from mother to child impacting the child, there is an increased rational for focusing on decreasing weight behaviors among children with ASD as well as mother. Considering the success mentioned previously with ABA and the treatment of ASD, the research presented in this thesis should be considered for generalization and tailoring to children with ASD in the treatment of their own weight and health behaviors.

**Longitudinal and Outcome Research**

While it was not within the scope of this thesis, there is an underlying goal of determining ways to modify the variable of OB in the risk of ASD. It was made clear that OB is a risk factor for ASD and that there is not a sufficiently effective intervention protocol to manage this risk. The evidence from this thesis suggest tactics used could be beneficial, and therefore the extension of this process and evaluation of its impact on the risk of ASD is recommended for future research.

**Behavioral Maintenance**

This study specifically targeted self-control and replacement training measures to ensure behavior change maintenance. There was an intentional and gradual fading of support and contrived reinforcement utilized within this study. It is hypothesized that behavioral maintenance will persist, at least in some part, due to the acquisition of novel eating and choice repertoires as well as the extinction of previously reinforced behavior patterns; however data is needed to evaluate this outcome.

It would be efficacious to conduct a post intervention follow up with current intervention participants to determine if behavioral maintenance occurred. A stated
limitation of OB intervention is lack of weight maintenance overtime. Accordingly, it will be necessary to ensure behavioral maintenance persists overtime as a means to increase success overtime. This research has planned one year follow up check with each participant to determine their level of behavior maintenance. This research has also presented the participants with the opportunity to contact the study team should they require additional supports before their one year post check.

Another consideration in increasing the maintenance of intervention outcomes is the concept mentioned previously of awareness training. Awareness training has the potential to increase individuals’ understanding of their behavior, what elicits it, and what maintains it, increasing the likelihood that they might be able to adapt their behavior in-vivo. For example, the use of mindfulness and present moment training procedures could increase participants’ understanding and noticing of their own behavior (awareness), making it more likely that self-management and committed action outcomes will be successful. Future research should expand this training and consider utilizing acceptance/mindfulness strategies such as Acceptance and Commitment Therapy (ACT; Hayes, Strosahl & Wilson, 2011) for example to do so. ACT is a behaviorally based approach that could increase the efficacy of stated limitations to current interventions through the use of psychological flexibility training (Hayes, Luoma, Bond, Masuda, & Lillis, 2006).

Participants in the present research reported a number of covert internal antecedent and consequences to eating behaviors which were not directly intervened on in the scope of this research, but on which an approach such as ACT might focus in analogous future research. As an example, ACT could be used to work with someone such as Maeve by increasing psychological flexibility with regard to a rule such as “having to eat less to maintain weight”. Future research could extend the present
paradigm by drawing on ACT or similar approaches to create a potentially more robust and efficacious intervention package.

**Behavior as the Focus**

As stated, health has been deemed firstly a behavioral concern and attention needs to shift towards changing the behaviors which impact weight and a movement away from pounds on the scale (Brahm et al., 2018b, in press). Yet, before further refined interventions can be developed, improvement in the assessment of behaviors which impact weight is necessary. This thesis provides evidence for the focus on behavior as being an important paradigm shift in the field of weight and health behavior. As was seen in this thesis, when participants were presented with clear expectations, goals for their behavior change outcomes, and altered contingencies they were able to access success, high rates of reinforcement and experienced very low discontent with the treatment. As a subsequent outcome of this behavior change focus, each participant in the study lost weight and changed BMI levels. While weight and BMI change were not the focus of this research, this outcome needs to be evaluated in additional research and transferred into practice applications where patient’s success is measured by behavior change firstly.

**Conclusion**

In conclusion, this thesis found that pre-pregnancy OB and DM among women of child bearing age is a significant risk factor for ASD. The current options for weight supports to decrease BMI before becoming pregnant are significantly lacking, while OB grows globally. ABA provides an evidence-based focus for the assessment and matched treatment of weight related behavior patterns which can aid in decreasing this global health epidemic. Research needs to focus on the mitigation of controllable risks.
for ASD and this thesis opens the discussion to ABA as a key factor in decreasing these controllable risks and improving the quality of life for mothers and their children.
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Appendices
Appendix A: Survey based data collection on demographics, history of identified risk factors, presence of ASD, Social Communication Questionnaire screening measure.
Participant Survey
An investigation into maternal metabolic conditions as risk factors for development of Autism Spectrum Disorder in offspring and the impact on development.

- Respondents Information

  - What is your marital status?
    - Single/never been married
    - Married
    - Separated
    - Divorced
    - Widowed
    - Partnership

  - Including yourself, how many people live in your house?

  - What is your gross annual household income?
    - Less than €10,000
    - €10,000 to €29,999
    - €30,000 to €49,999
    - €50,000 to €69,999
    - €70,000 to €99,999
    - €100,000 or more

  - What is the highest level of education you have completed?
    - Primary school
    - Secondary school
    - Third level

  - If you have completed Third level education, what did you earn?
    - Certificate
    - Diploma
    - Degree
    - Masters
    - PhD.
In relation to baby delivered on __/______/_____

Did you experience any infection or sickness during pregnancy?  □ Yes  □ No
If yes, please specify the type of condition and during which trimester(s) it occurred

During which week of your pregnancy did you first receive antenatal care?

During your pregnancy, did you take antenatal vitamins?  □ Yes  □ No

During your pregnancy, did you take folic acid supplements?  □ Yes  □ No

During your pregnancy, did you take vitamin D?  □ Yes  □ No

Please indicate, by ticking, if you used any of the following prescriptions or over-the-counter medications during your pregnancy?

- Anti-anxiety
- Antibiotics
- Antidepressants
- Antiemetic (medication that prevents or relieves nausea and vomiting)
- Antifungal (medication to treat fungal infections)
- Anti-inflammatory (e.g. Neurofen)
- Decongestant
- Fever reducers (e.g. Paracetamol)
- Mood stabilizers
- Sleeping tablets
- Stimulants (e.g. Ritalin)
- Other

Did you smoke cigarettes during your pregnancy?  □ Yes  □ No

Did you consume alcohol during your pregnancy?  □ Yes  □ No

Did you use illicit drugs during your pregnancy?  □ Yes  □ No

What was your employment status during your pregnancy?

- Employed
- Out of work and looking for work
- Out of work but not looking for work
- A student
Appendices

- Housewife
- Unable to work and receiving disability
- Other ____________________________

- What was your occupation during your pregnancy? ____________________________

Family Medical History

In relation to the father of baby delivered on _____/_______/_______

- What is the father’s date of birth? ______________

- What is the father’s race/ethnicity?
  - Asian or Asian Irish
    - Chinese
    - Any other Asian background
  - Black or Black Irish
    - African
    - Any other Black Background
  - White
    - Irish
    - Irish traveller
    - Any other white background

- What was the father’s country of birth? ______________

Please indicate, by ticking, if you or the father of your child born in ________, has a history of any of the following:

<table>
<thead>
<tr>
<th>Autism Spectrum Disorder (ASD)</th>
<th>Mother</th>
<th>Father</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety Disorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention Hyper Activity Disorder (ADHD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-immune Disease (e.g. rheumatoid arthritis, lupus, thyroid disease)</td>
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<td></td>
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<tr>
<td>Bipolar Disorder</td>
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<tr>
<td>Depression</td>
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<tr>
<td>Eating Disorder (e.g. anorexia, bulimia)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal disorders (e.g. celiac disease, Crohn's disease, Ulcerative colitis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fragile X, or been told that you are a carrier for fragile X</td>
<td></td>
<td></td>
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<tr>
<td>Intellectual Disability (IQ &lt;70)</td>
<td></td>
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<tr>
<td>Learning Disability (e.g. dyslexia, dyspraxia)</td>
<td></td>
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<tr>
<td>------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Major Mood Disorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personality Disorder (e.g./ antisocial personality, borderline personality disorder)</td>
<td></td>
<td></td>
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<tr>
<td>Schizophrenia</td>
<td></td>
<td></td>
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<tr>
<td>Seizure Disorder/Epilepsy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Disorder (e.g. insomnia, dyssomnia)</td>
<td></td>
<td></td>
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<tr>
<td>Speech delay or impairment</td>
<td></td>
<td></td>
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<tr>
<td>Other psychiatric disorder</td>
<td></td>
<td></td>
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<tr>
<td>Metabolic conditions (e.g. diabetes, hypertension)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Down Syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Chromosomal abnormality</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Has your child, born in ________, been diagnosed with an Autism Spectrum Disorder (ASD)? □ Yes □ No
  - If so, Please specify your child’s diagnosis
    - □ Autism Spectrum Disorder (ASD)
    - □ Asperger’s Syndrome
    - □ Pervasive Developmental Disorder - Not Otherwise Specified (PDD-NOS)
    - □ Childhood Disintegrative Disorder (CDD)
    - □ Rett’s Disorder

- Has your child born on, in 2009, received any other diagnosis? Yes □ No □
  - If so, please specify their diagnosis.__________________________
  - Are they currently eligible and/or receiving special education services for this diagnosis? □ Yes □ No

- Have any of your other children received a diagnosis of an autism spectrum disorder?
  - □ Yes □ No

- Have any of your other children received any other diagnosis? □ Yes □ No
  - If so, please specify their diagnosis.__________________________________
Please complete the following questionnaire in reference to your child born on
______/_______/_______

Social Communication Questionnaire

Thank you for taking the time to complete this 40 item questionnaire. Please answer
each question by circling yes or no. A few questions ask about several related types of
behaviour; please circle yes if any of these behaviours have ever been present. Although
you may be uncertain about whether some behaviours were ever present or not, please
answer yes or no to every questions on the basis of what you think.

Name of Subject:__________________ D.O.B __/__/___ Age:_____
Gender:______

Name of Respondent:_______________ Relation to Subject:______  Response
Date __/__/____

1. Is she/he now able to talk using short phrases or sentences? If no, skip to question 8.
   Yes     No

2. Can you have a to and fro “conversation” with her/him that involves taking turns
   or building on what you have said? Yes    No

3. Has she/he ever used odd phrases or said the same thing over and over in almost
   exactly the same way (either phrases that she/he has heard other people use or ones
   that she/he has made up)?        Yes     No

4. Has she/he ever used socially inappropriate questions or statements? For example,
   has she/he ever regularly asked personal questions or made person comments at
   awkward times?                Yes     No

5. Has she/he ever gotten her/his pronouns mixed up (e.g., saying you or she/he for I)?
   Yes     No

6. Has she/he ever used words that she/he seemed to have invented or made up to
   her/himself; put things in odd, indirect ways; or used metaphorical ways of saying
   things (e.g., saying hot rain for steam)?
      Yes     No

7. Has she/he ever said the same thing over and over in exactly the same way or
   insisted that you say the same thing over and over again?
      Yes     No

8. Has she/he ever had things that she/he seemed to have to do in a very particular
   way or order or rituals that she/he insisted that you go through?
      Yes     No
9. Has her/his facial expression usually seemed appropriate to the particular situation, as far as you could tell?
   Yes   No

10. Has she/he ever used your hand like a tool or as if it were part of her/his own body (e.g., pointing with your finger, putting your hand on a doorknob to get you to open the door)?
    Yes   No

11. Has she/he ever had any interests that preoccupy her/him and might seem odd to other people (e.g., traffic lights, drainpipes, or timetables)? Yes   No

12. Has she/he ever seemed to be more interested in parts of a toy or an object (e.g., spinning the wheels of a car), rather than using the object as it was intended?
    Yes   No

13. Has she/he ever had any special interests that were unusual in their intensity but otherwise appropriate for her/his age and peer group (e.g., trains, dinosaurs)?
    Yes   No

14. Has she/he ever seemed to be unusually interested in the sight, feel, sound, taste, or smell of things or people? Yes   No

15. Has she/he ever had any mannerisms or odd ways of moving her/his hands or fingers, such as flapping or moving her/his finders in front of her/his eyes?
    Yes   No

16. Has she/he ever had any complicated movements of her/his whole body, such as spinning or repeatedly bouncing up and down? Yes   No

17. Has she/he ever injured her/himself deliberately, such as by biting her/his arm or banging her/his head? Yes   No

18. Has she/he ever had any objects (other than a soft toy or comfort blanket) that she/he had to carry around?
    Yes   No

19. Does she/he have any particular friends or a best friend?
    Yes   No

   For the following behaviours, please focus on the time period between the child’s fourth and fifth birthdays. You may find it easier to remember how things were at that time by focusing on key events, such as starting school, moving house, Christmastime, or other specify events that are particularly memorable for you as a family. If your child is not yet 4 years old, please consider her or his behaviour in the past 12 months.

20. When she/he was 4 to 5, did she/he ever talk with you just to be friendly (rather than
21. When she/he was 4 to 5, did she/he ever spontaneously copy you (or other people) or what you were doing (such as vacuuming, gardening, or mending things)?
   Yes  No

22. When she/he was 4 to 5, did she/he ever spontaneously point at things around her/him just to show you things (not because she/he wanted them)?
   Yes  No

23. When she/he was 4 to 5, did she/he ever use gestures, other than pointing or pulling your hand, to let you know what she/he wanted?
   Yes  No

24. When she/he was 4 to 5, did she/he nod her/his head to mean yes?
   Yes  No

25. When she/he was 4 to 5, did she/he shake her/his head to mean no?
   Yes  No

26. When she/he was 4 to 5, did she/he usually look at you directly in the face when doing things with you or talking with you?
   Yes  No

27. When she/he was 4 to 5, did she/he smile back if someone smiled at her/him?
   Yes  No

28. When she/he was 4 to 5, did she/he ever show you things that interested her/him to engage your attention?
   Yes  No

29. When she/he was 4 to 5, did she/he ever offer to share things other than food with you?
   Yes  No

30. When she/he was 4 to 5, did she/he ever seem to want you to join in her/his enjoyment of something?
   Yes  No

31. When she/he was 4 to 5, did she/he every try to comfort you if you were sad or hurt?
   Yes  No

32. When she/he was 4 to 5, when she/he wanted something or wanted help, did she/he look at you and use gestures with sounds or words to get your attention?
   Yes  No

33. When she/he was 4 to 5, did she/he show a normal range of facial expressions?
   Yes  No

34. When she/he was 4 to 5, did she/he ever spontaneously join in and try to copy the
actions in social games, such as *The Mulberry Bush* or *London Bridge is Falling Down*?

Yes  No

35. When she/he was 4 to 5, did she/he play any pretend or make-believe games?

Yes  No

36. When she/he was 4 to 5, did she/he seem interested in other children of approximately the same age whom she/he did not know?

Yes  No

37. When she/he was 4 to 5, did she/he respond positively when another child approached her/him?

Yes  No

38. When she/he was 4 to 5, if you came into a room and started talking to her/him without calling her/his name, did she/he usually look up and pay attention to you?

Yes  No

39. When she/he was 4 to 5, did she/he ever play imaginative games with another child in such a way that you could tell that they understood what the other was pretending?

Yes  No

40. When she/he was 4 to 5, did she/he play cooperatively in games that required joining in with a group of other children, such as hide-and-seek or ball games?

Yes  No
Appendix B- Modified Binge Eating Interview/ Functional Assessment Interview Form
Eating Behavior Functional Assessment Interview

Name: __________________________ Date: __________________

Age: __________

Gender: _______________________

Interviewer: __________________________

Current height and weight:

___________________________________________

What was the date of this weigh-in? ___________________________

Are you currently employed? Yes  No. If so, what is your occupation? __________

Do you currently engage in intentional exercise? (Define intentional) __________

If so please describe type, frequency, duration, preference _________________________

________________________________________________________________________

In the last five years, have you engaged in any intentional dieting? (Provide examples)

If so, how many, determine the relative important components (e.g. Atkins- less than 50 grams of carbs per day, more than 50 grams of protein per day).

**Describe the behaviors**

Define behaviors of concern. For each behavior of concern, define the topography (how it is performed), frequency (how often it occurs per day, week or month), duration (how long it lasts when it occurs), and intensity (how damaging or destructive the behaviors are when they occur).

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Topography</th>
<th>Frequency</th>
<th>Duration</th>
<th>Intensity</th>
</tr>
</thead>
</table>

282
Description of Eating Behavior

The goal of this section is to gather general information regarding typical eating routine.

1. Would you please describe what a typical day is like for you? What foods and how much do you typically eat?

2. On the average, how many times do you eat per day? Would you consider these eating episodes meals, snacks or a combination?

3. On the average, how many times do you feel you overeat per week?

4. (Score only if binge eating is discussed) Do you feel a sense of lack of control over your eating during the binge? (rate on scale with 1=not at all-7=extreme lack of control)

Factors Related to Eating

The goal of this section is to gather information regarding the events in the environment which may be related to your different eating behavior such as side effects of medications, coexisting medical conditions, sleeping patterns, daily schedule, living arrangements, etc.

4. Are you currently taking any medications?

a. What is the name of the medication(s)?

b. For what reason was it prescribed?

c. What is the dosage?

d. How long have you been taking the medication(s)?
e. Are you aware of any side effects related to appetite or weight gain which may be associated with taking this medication (if yes, describe)?

5. Are you currently under a physician’s care for any medical conditions? (If yes, indicate condition and discuss whether you think it is related to your binge eating)

6. Typical Daily Schedule: (Indicate when you wake up, time you go to bed, time you typically eat meals, and timing of other typical activities) 5:00_________________________________ 3:00 ________________ 6:00

_________________________________ 4:00 ________________ 7:00

_________________________________ 5:00 ________________ 8:00

_________________________________ 6:00 ________________ 9:00

_________________________________ 7:00 ________________ 10:00

_________________________________ 8:00 ________________ 11:00

_________________________________ 9:00 ________________ 12:00

_________________________________ 10:00 ________________ 1:00

_________________________________ 11:00 ________________ 2:00

_________________________________ 12:00 ________________ 7.

Indicate the activities you engage in and find rewarding, and how frequently you engage in these activities.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

8. Do you live alone or with others (how many)? ________________

a. (Who do you live with):
(If you live with others):

b. Are your roommates or family aware of your desire to become healthier? 

____________

c. Does anybody you live with also engage in unhealthy eating? _____________

Describe what participants discusses:

**Antecedents**

The goal of this section is to gather information regarding feelings, thoughts, behaviors, events, etc. which may serve as triggers of unhealthy eating.

9. What time of day are you most likely to over eat or eat unhealthy foods?

10. What time of day are you least likely over eat or eat unhealthy foods

11. Where are you most likely to over eat or eat unhealthy foods

12. Where are you least likely to over eat or eat unhealthy foods

13. Do you over eat or eat unhealthy foods in the presence of others?
   a. If so, who are you most likely over eat or eat unhealthy foods with?

14. Are there particular situations which tend to trigger over eating or eating unhealthy foods eating or which cause you to want to eat?

15. Are there particular situations which never trigger an over eating for you?

16. Are there particular feelings, thoughts, or emotions which tend to trigger overeating or which cause you to want to eat unhealthy foods?

17. Are there particular feelings, thoughts, or emotions which never trigger overeating or which cause you to want to eat unhealthy foods?

**Function of Binge Eating**

The goal of this section is to gather information regarding what is maintaining the binge eating behavior for the client. In other words, what is rewarding about engaging in the binge for him/her?
19. What is going on with you before you over eat or eat unhealthy foods? (feelings, thoughts, emotions)

20. What is going on with you while you are over eating or eating unhealthy foods? (How does it contrast with before the binge?)

21. What is going on with you immediately after you over eat or eat unhealthy foods? (How does it contrast with before the binge and during the binge?)

22. Please describe how over eating or eating unhealthy foods may be satisfying for you or how it may bring relief in some way from some unpleasant feelings, thoughts, or emotions.

23. Is there anything you do besides over eating or eating unhealthy foods which brings the same satisfaction or the same sense of relief?

History of Eating Behavior

24. How long have you been over eating or eat high rates of unhealthy foods?

25. When did it first start?

26. What was happening in your life at that time?

27. Have you engaged in any other eating patterns which were of concern to you?

28. Have you ever sought treatment for your concerns related to your eating patterns?
   a. If yes, where/ from whom?

29. What kind of help did you receive?

30. Did you find it to be helpful?
   a. Why or why not?

Additional Notes:
Appendix C
Non-food preference assessment
Preference Assessment

Having activities to look forward to, other than food, is an important part of changing our behaviours surrounding health. When we use food to reinforce ourselves, we are changing the function of food from something meant to fuel our body, to something which is praised. Eating “junk” food when we have done something good also creates an improper understanding of food as a luxury, rather than necessity for health. As a means to start changing our relationships with food, please list at least 10 items/activities that you really enjoy, which are not food related, below. I have provided an example for you to review.

<table>
<thead>
<tr>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going to the beach</td>
</tr>
<tr>
<td>Getting a manicure</td>
</tr>
<tr>
<td>New shoes</td>
</tr>
<tr>
<td>Eye shadow pallets</td>
</tr>
<tr>
<td>New makeup brushes</td>
</tr>
<tr>
<td>Fresh flowers</td>
</tr>
<tr>
<td>New sheets</td>
</tr>
<tr>
<td>Going for a drive in the countryside</td>
</tr>
<tr>
<td>Going to the movies</td>
</tr>
<tr>
<td>A good TV series</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
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<tr>
<td>3.</td>
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<tr>
<td>4.</td>
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<tr>
<td>5.</td>
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<tr>
<td>6.</td>
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<tr>
<td>7.</td>
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<tr>
<td>8.</td>
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<tr>
<td>9.</td>
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<tr>
<td>10.</td>
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</tbody>
</table>
Appendix D
General Nutrition Knowledge Questionnaire
GENERAL NUTRITION KNOWLEDGE QUESTIONNAIRE
This is a survey, not a test. Your answers will help identify which dietary advice people find confusing. It is important that you complete it by yourself. Your answers will remain anonymous. If you don’t know the answer, mark “not sure” rather than guess. Thank you for your time.

Section 1: The first few items are about what advice you think experts are giving us.

1. Do health experts recommend that people should be eating more, the same amount, or less of the following foods? (tick one box per food)

<table>
<thead>
<tr>
<th></th>
<th>More</th>
<th>Same</th>
<th>Less</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food and drinks with added sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatty foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processed red meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wholegrains</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salty foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
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</table>

2. How many servings of fruit and vegetables per day do experts advise people to eat as a minimum? (One serving could be, for example, an apple or a handful of chopped carrots) (tick one)

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<td>2</td>
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<tr>
<td></td>
<td>3</td>
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</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not sure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Which of these types of fats do experts recommend that people should eat less of? (tick one box per food)

<table>
<thead>
<tr>
<th></th>
<th>Eat Less</th>
<th>Not eat less</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsaturated Fats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans Fats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated Fats</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

4. Which type of dairy foods do experts say people should drink? (tick one)

<p>| | | | |</p>
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<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Full fat (e.g full fat milk)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced fat (e.g. skimmed and semi-skimmed milk)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixture of full fat and reduced fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither, Dairy foods should be avoided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
<td></td>
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</tbody>
</table>

5. How many times per week do experts recommend that people eat oily fish (e.g. salmon and mackerel)? (tick one)

<p>| | | | |</p>
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<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1-2 times per week</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3-4 times per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Every day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
6. Approximately how many alcoholic drinks is the maximum recommended per day (the exact number depends on the size and strength of the drink)? (tick one)

- 1 drink each for men and women
- 2 drinks each for men and women
- 2 drinks for men and 1 drink for women
- 3 drinks for men and 2 drinks for women
- Not sure

7. How many times per week do experts recommend that people eat breakfast? (tick one)

- 3 times per week
- 4 times per week
- Every day
- Not sure

8. If a person has two glasses of fruit juice in a day, how many of their daily fruit and vegetable servings would this count as? (tick one)

- None
- One serving
- Two servings
- Three servings
- Not sure

9. According to the ‘eat well guide’ (a guideline showing the proportions of food types people should eat to have a balanced and healthy diet), how much of a person’s diet should be made up of starchy foods? (tick one)

- Quarter
- Third
- Half
- Not sure

Section 2: Experts classify foods into groups. We are interested to see whether people are aware of food groups and the nutrients they contain.

1. Do you think these foods and drinks are typically high or low in added sugar? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>High in added sugar</th>
<th>Low in added sugar</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet cola drinks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural yoghurt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice cream</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato ketchup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melon</td>
<td></td>
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</tbody>
</table>

2. Do you think these foods are typically high or low in salt? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>High in salt</th>
<th>Low in salt</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast cereals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frozen vegetables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bread</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baked beans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red meat</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Do you think these foods are typically high or low in fiber? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>High in fiber</th>
<th>Low in fiber</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bananas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White rice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes with skin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasta</td>
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</tbody>
</table>

4. Do you think these foods are a good source of protein? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>Good source of protein</th>
<th>Not a good source of protein</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baked beans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Which of the following foods do experts count as starchy foods? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>Starchy food</th>
<th>Not a starchy food</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Which is the main type of fat present in each of these foods? (tick one box per food)

<table>
<thead>
<tr>
<th>Food</th>
<th>Polyunsaturated fat</th>
<th>Monounsaturated fat</th>
<th>Saturated fat</th>
<th>Cholesterol</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Which of these foods has the most trans-fat? (tick one)

<table>
<thead>
<tr>
<th>Food</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biscuits, cakes and pastries</td>
<td></td>
</tr>
<tr>
<td>Fish</td>
<td></td>
</tr>
<tr>
<td>Rapeseed oil</td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

8. The amount of calcium in a glass of whole milk compared to a glass of skimmed milk is: (tick one)

<table>
<thead>
<tr>
<th>Amount</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>About the same</td>
<td></td>
</tr>
<tr>
<td>Much higher</td>
<td></td>
</tr>
<tr>
<td>Much lower</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>
9. Which one of the following nutrients has the most calories for the same weight of food? (tick one)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td></td>
</tr>
<tr>
<td>Starchy</td>
<td></td>
</tr>
<tr>
<td>Fibre/roughage</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

10. Compared to minimally processed foods, processed foods are: (tick one)

<table>
<thead>
<tr>
<th>Comparison</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher in calories</td>
<td></td>
</tr>
<tr>
<td>Higher in fiber</td>
<td></td>
</tr>
<tr>
<td>Lower in salt</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

**Section 3: The next few items are about choosing foods**

1. If a person wanted to buy a yogurt at the supermarket, which would have the least sugar/sweetener? (tick one)

<table>
<thead>
<tr>
<th>Yogurt</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0% fat cherry yogurt</td>
<td></td>
</tr>
<tr>
<td>Natural yogurt</td>
<td></td>
</tr>
<tr>
<td>Creamy fruit yogurt</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

2. If a person wanted soup in a restaurant or cafe, which one would be the lowest fat option? (tick one)

<table>
<thead>
<tr>
<th>Soup</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mushroom risotto soup (field mushrooms, porcini mushrooms, arborio rice, butter, cream, parsley and cracked black pepper)</td>
<td></td>
</tr>
<tr>
<td>Carrot butternut and spice soup (carrot, butternut squash, sweet potato, cumin, red chillies, coriander seeds and lemon)</td>
<td></td>
</tr>
<tr>
<td>Cream of chicken soup (British chicken, onions, carrots, celery, potatoes, garlic, sage, wheat flour, double cream)</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

3. Which would be the healthiest and most balanced choice for a main meal in a restaurant? (tick one)

<table>
<thead>
<tr>
<th>Meal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Roast turkey, mashed potatoes and vegetables</td>
<td></td>
</tr>
<tr>
<td>Beef, Yorkshire pudding and roast potatoes</td>
<td></td>
</tr>
<tr>
<td>Fish and chips served with peas and tartar sauce</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

4. Which would be the healthiest and most balanced sandwich lunch? (tick one)

<table>
<thead>
<tr>
<th>Sandwich</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ham sandwich + fruit + blueberry muffin + fruit juice</td>
<td></td>
</tr>
<tr>
<td>Tuna salad sandwich + fruit + low fat yogurt + water</td>
<td></td>
</tr>
<tr>
<td>Egg salad sandwich + crisps + low fat yogurt + water</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

5. Which of these foods would be the healthiest choice for a pudding? (tick one)

<table>
<thead>
<tr>
<th>Pudding</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Berry sorbet</td>
<td></td>
</tr>
<tr>
<td>Apple and blackberry pie</td>
<td></td>
</tr>
<tr>
<td>Lemon cheesecake</td>
<td></td>
</tr>
<tr>
<td>Carrot cake with cream cheese topping</td>
<td></td>
</tr>
</tbody>
</table>
6. Which of these combinations of vegetables in a salad would give the greatest variety of vitamins and antioxidants? (tick one)

<table>
<thead>
<tr>
<th>Combination</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce, green peppers and cabbage</td>
<td></td>
</tr>
<tr>
<td>Broccoli, carrot and tomatoes</td>
<td></td>
</tr>
<tr>
<td>Red peppers, tomatoes and lettuce</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

7. If a person wanted to reduce the amount of fat in their diet, but didn’t want to give up chips, which of the following foods would be the best choice? (tick one)

<table>
<thead>
<tr>
<th>Choice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick cut chips</td>
<td></td>
</tr>
<tr>
<td>Thin cut chips</td>
<td></td>
</tr>
<tr>
<td>Crinkle cut chips</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

8. One healthy way to add flavour to food without adding extra fat or salt is to add: (tick one)

<table>
<thead>
<tr>
<th>Additive</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut milk</td>
<td></td>
</tr>
<tr>
<td>Herbs</td>
<td></td>
</tr>
<tr>
<td>Soya sauce</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

9. Which of the following cooking methods requires fat to be added? (tick one)

<table>
<thead>
<tr>
<th>Method</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grilling</td>
<td></td>
</tr>
<tr>
<td>Steaming</td>
<td></td>
</tr>
<tr>
<td>Baking</td>
<td></td>
</tr>
</tbody>
</table>

10. Traffic lights are often used on nutrition labelling, what would amber mean for the fat content of a food? (tick one)

<table>
<thead>
<tr>
<th>Fat Content</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low fat</td>
<td></td>
</tr>
<tr>
<td>Medium fat</td>
<td></td>
</tr>
<tr>
<td>High in fat</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

11. “Light” foods (or Diet foods) are always good options because they are low in calories. (tick one)

<table>
<thead>
<tr>
<th>Opinion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

The following questions are related to food labels:

<table>
<thead>
<tr>
<th>Product</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 1</td>
<td></td>
</tr>
<tr>
<td>Product 2</td>
<td></td>
</tr>
<tr>
<td>Both have the same quantity</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>
12. Looking at products 1 and 2, which one has the most calories (kcal) per 100 grams (tick one)

13. Looking at product 1, what are the sources of sugar in the ingredient list? (tick one)
   - Sugar and malt syrup
   - Sugar, fructose and lecithin
   - Sugar, fructose and malt syrup
   - Not sure

**Section 4: This section is about health problems or diseases related to diet and weight management:**

1. Which of these diseases is related to a low intake of fibre? (tick one)
   - Bowel disorders
   - Anaemia
   - Tooth decay
   - Not sure

2. Which of these diseases is related to how much sugar people eat? (tick one)
   - High blood pressure
   - Tooth decay
   - Anaemia
   - Not sure

295
3. Which of these diseases is related to how much salt (or sodium) people eat? (tick one)

<table>
<thead>
<tr>
<th>Disease</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothyroidism</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
</tr>
<tr>
<td>High blood pressure</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

4. Which of these options do experts recommend to reduce the chances of getting cancer? (tick one)

<table>
<thead>
<tr>
<th>Option</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking alcohol regularly</td>
<td></td>
</tr>
<tr>
<td>Eating less red meat</td>
<td></td>
</tr>
<tr>
<td>Avoiding additives in food</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

5. Which of these options do experts recommend to prevent heart disease? (tick one)

<table>
<thead>
<tr>
<th>Option</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking nutritional supplements</td>
<td></td>
</tr>
<tr>
<td>Eating less oily fish</td>
<td></td>
</tr>
<tr>
<td>Eating less trans-fats</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

6. Which of these options do experts recommend to prevent diabetes? (tick one)

<table>
<thead>
<tr>
<th>Option</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating less refined foods</td>
<td></td>
</tr>
<tr>
<td>Drinking more fruit juice</td>
<td></td>
</tr>
<tr>
<td>Eating more processed meat</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

7. Which one of these foods is more likely to raise people’s blood cholesterol? (tick one)

<table>
<thead>
<tr>
<th>Food</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs</td>
<td></td>
</tr>
<tr>
<td>Vegetable oils</td>
<td></td>
</tr>
<tr>
<td>Animal fat</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

8. Which one of these foods is classified as having a high Glycaemic Index? (tick one)

<table>
<thead>
<tr>
<th>Food</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholegrain cereals</td>
<td></td>
</tr>
<tr>
<td>White bread</td>
<td></td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td></td>
</tr>
</tbody>
</table>

9. To maintain a healthy weight people should cut fat out completely. (tick one)

<table>
<thead>
<tr>
<th>Agree</th>
<th>Disagree</th>
<th>Not sure</th>
</tr>
</thead>
</table>

10. To maintain a healthy weight people should eat a high protein diet. (tick one)

<table>
<thead>
<tr>
<th>Agree</th>
<th>Disagree</th>
<th>Not sure</th>
</tr>
</thead>
</table>
11. Eating bread always causes weight gain. (tick one)
   - Agree
   - Disagree
   - Not sure

12. Fibre can decrease the chances of gaining weight. (tick one)
   - Agree
   - Disagree
   - Not sure

13. Which of these options can help people to maintain a healthy weight?
    (answer each one)
    - Not eating while watching TV
    - Reading food labels
    - Taking nutritional supplements
    - Monitoring their eating
    - Monitoring their weight
    - Grazing throughout the day

14. If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be? (tick one)
    - Underweight
    - Normal weight
    - Overweight
    - Obese
    - Not sure

15. If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be? (tick one)
    - Underweight
    - Normal weight
    - Overweight
    - Obese
    - Not sure

16. Which of these body shapes increases the risk of cardiovascular disease (Cardiovascular disease is a general term that describes a disease of the heart of blood vessels, for example, angina, heart attack, heart failure, congenital heart disease and stroke)? (tick one)
    - Apple shape
    - Pear shape
    - Not sure

17. In general, would you say your health is… (tick one)
Poor  
Fair  
Good  
Very good  
Excellent

18. Do you have any nutrition related qualifications (or are you studying to get a nutrition qualification)? (circle one)
   Yes
   No
   If yes, please specify: ________________________________

____________________

____________________
Appendix E:
The Dutch Eating Behaviour Questionnaire
### The Dutch Eating Behaviour Questionnaire

1. **When you have put on weight, do you eat less than you usually do?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

2. **Do you try to eat less at mealtimes than you would like to eat?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

3. **How often do you refuse food or drink offered because you are concerned about your weight?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

4. **Do you watch exactly what you eat?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

5. **Do you deliberately eat foods that are slimming?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

6. **When you have eaten too much, do you eat less than usual the following day?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

7. **Do you deliberately eat less in order not to become heavier?**
   - 1  2  3  4  5

8. **How often do you try not to eat between meals because you are watching your weight?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

9. **How often in the evenings do you try not to eat because you are watching your weight?**
   - 1  2  3  4  5
   - Never  Rarely  Sometimes  Often  Very often

10. **Do you take into account your weight with what you eat?**
    - 1  2  3  4  5
    - Never  Rarely  Sometimes  Often  Very often

11. **Do you have the desire to eat when you are irritated?**
    - 1  2  3  4  5
    - Never  Rarely  Sometimes  Often  Very often

12. **Do you have a desire to eat when you have nothing to do?**
    - 1  2  3  4  5
    - Never  Rarely  Sometimes  Often  Very often

13. **Do you have a desire to eat when you are depressed or discouraged?**
    - 1  2  3  4  5
    - Never  Rarely  Sometimes  Often  Very often

14. **Do you have a desire to eat when you are feeling lonely?**
    - 1  2  3  4  5
<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Do you have a desire to eat when somebody lets you down?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. Do you have a desire to eat when you are cross?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. Do you have a desire to eat when you are approaching</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>something unpleasant to happen?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. Do you get the desire to eat when you are anxious, worried or</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>tense?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. Do you have a desire to eat when things are going against you or</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>when things have gone wrong?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Do you have a desire to eat when you are frightened?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. Do you have a desire to eat when you are disappointed?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Do you have a desire to eat when you are emotionally upset?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. Do you have a desire to eat when you are bored or restless?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. If food tastes good to you, do you eat more than usual?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25. If food smells good and looks good, do you eat more than usual?</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26. If you see or smell something delicious, do you have the desire</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>to eat it?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>27. If you have something delicious to eat, do you eat it straight</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>away?</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>28. If you walk past the baker do you have the desire to buy something</td>
<td>Never</td>
<td>Rarely</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very</td>
</tr>
<tr>
<td>delicious?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Never  Rarely  Sometimes  Often  Very
often

29. If you see others eating, do you also have the desire to eat?
1  2  3  4  5
Never  Rarely  Sometimes  Often  Very
often

30. Do you find it hard to resist eating delicious foods?
1  2  3  4  5
Never  Rarely  Sometimes  Often  Very
often

31. If you walk past a snack bar or a café, do you have the desire to buy something delicious?
1  2  3  4  5
Never  Rarely  Sometimes  Often  Very
often

32. Do you eat more than usual, when you see others eating?
1  2  3  4  5
Never  Rarely  Sometimes  Often  Very
often

33. When you are preparing a meal are you inclined to eat something?
1  2  3  4  5
Never  Rarely  Sometimes  Often  Very
often

Thank you for your time in completing this assessment and I look forward to working with you! Meghan M. Brahm, M.A., BCBA, PhD. Candidate
Appendix F: Food Diary Form
Dear _____

Thank you again for agreeing to participate in this research and I am looking forward to helping you make some healthy changes! The instructions included here are meant to serve as reminders and as guidelines for the discussion we had in person about keeping a food diary. If you have questions regarding your food diary please do not hesitate to contact me at 087-340-2090, m.brahm1@nuigalway.ie.

Meghan
Meghan M. Brahm, M.A., BCBA
Board Certified Behaviour Analysts
Ph.D. Candidate, School of Psychology,
National University of Ireland, Galway

Food Diary

What is a food diary?

- A food diary is simply a “food journal” you keep with you and fill out through your day. It is where you will record detailed descriptions of all food and beverages you consume. Food diaries are typically kept for 3 full days. Optimally 2 weekdays and 1 weekend day although you are welcomed and encouraged to include more days, if it suits.

- Important Information:
  - Please do not change your eating habits while keeping this food diary
  - Record food as you eat, do not wait to record later
  - Only record the portion of food you actually consume
  - When you record an item that consists of a combination of foods, please break it down into individual components:
    - E.g. Ham and cheese sandwich- 2 slices whole wheat bread, 2 slices ham, ¼ cup cheddar cheese, 1 tablespoon mayonnaise

- What kinds of information will I need to include on my food diary?
  - The general information you will be asked to list on your food diary is:
- Name and Type of Food/Beverage
- Alternative Makeup of product- e.g., diet, sugar-free, 2%, fat-free, low-sodium, gluten-free, etc.
- Brand Name- e.g. Kellogg's, Heinz, Tayto, etc.
- Preparation Methods- e.g. Grilled, boiled, fried, baked, roasted, steamed, microwave. Please include marinades, oil, seasonings, & condiments
- Quantity/Amounts- e.g Cups, Ounces, Grams, Lbs., mL, “baseball sized”, “deck of cards size”, etc.
- Social and Emotional Context- e.g. How you were feeling BEFORE you ate, how you felt AFTER you ate, where you were eating, etc.
- Details about each time you eat and what you eat are vitally important so please include as many details as you can!
Determining Portion Size
Recommended methods:
1. Weighing food on a food scale
2. Measuring with cups or spoons
3. Taking Dimensions with measuring tape or a ruler
4. Reading the Nutrition Labels for individual or pre-packaged items

5. If you cannot weigh or measure a food item, try and estimate your portion Size:

www.nhs.uk
www.pre-diabetes.com
www.prevention.com
<table>
<thead>
<tr>
<th>Meal/ Snack/ Drink</th>
<th>Feeling pre- See list.</th>
<th>Time Start &amp; End</th>
<th>Location/ Context- e.g. work, party, home with kids, etc.</th>
<th>Food Eaten- list all consumed food and beverages and if a special product.</th>
<th>Quantity / Amount- Grams, Ounces, Number/count, “golf ball size”, etc.</th>
<th>Feeling post- See list.</th>
<th>Outcome post- examples from meeting</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

307
• Resentful
• Discouraged
• Shaky
• Worn out
• Inadequate
• Excited
• Rebellious
• Blue
• Jittery
• ad
• Uneasy
• Irritated
• Jealous
• Worried
• Frustrated
• Lonely

• Furious
• On edge
• Confused
• Nervous
• Angry
• Guilty
• Bored
• Helpless
• Upset
• Happy
• Excited
• Other____________________________

Adapted from the Emotional Eating Scale
Appendix G
Matched Stimuli Preference Assessment and Goal setting
**Matched Stimuli Preference Assessment**
The purpose of this questionnaire is to learn which foods you like and dislike. Please tick any foods you would prefer to eat or would buy at the grocery store.

**Dairy**

<table>
<thead>
<tr>
<th>Skim milk</th>
<th>1% milk</th>
<th>2% milk</th>
<th>Chocolate milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy milk</td>
<td>Plain low-fat yogurt</td>
<td>Fruited low-fat yogurt</td>
<td>Cottage cheese</td>
</tr>
<tr>
<td>Swiss cheese</td>
<td>Cheddar cheese</td>
<td>Sliced cheese</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Protein**

<table>
<thead>
<tr>
<th>Beef</th>
<th>Chicken</th>
<th>Turkey</th>
<th>Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork</td>
<td>Ham</td>
<td>Bacon</td>
<td>Sausage</td>
</tr>
<tr>
<td>Eggs</td>
<td>Tuna fish</td>
<td>Peanut butter</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Soy meat</td>
<td>Black beans</td>
<td>Pinto beans</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Starch**

<table>
<thead>
<tr>
<th>Bagel</th>
<th>Pancakes</th>
<th>Corn</th>
<th>White or wild rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>English muffin</td>
<td>Waffles</td>
<td>Potatoes</td>
<td>Pasta</td>
</tr>
</tbody>
</table>

**Fruits**

<table>
<thead>
<tr>
<th>Apple</th>
<th>Blueberries</th>
<th>Peaches</th>
<th>Apple juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applesauce</td>
<td>Cantaloupe</td>
<td>Pears</td>
<td>Orange juice</td>
</tr>
<tr>
<td>Banana</td>
<td>Watermelon</td>
<td>Strawberries</td>
<td>Grape juice</td>
</tr>
<tr>
<td>Orange</td>
<td>Muskmelon</td>
<td>Mango</td>
<td>Mixed berry juice</td>
</tr>
<tr>
<td>Mandarin orange</td>
<td>Pineapple</td>
<td>Dried fruit</td>
<td>Cranberry juice</td>
</tr>
<tr>
<td>Grapes</td>
<td>Plum</td>
<td>Canned fruit</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vegetables**

<table>
<thead>
<tr>
<th>White or wheat bread</th>
<th>French toast</th>
<th>Peas</th>
<th>Popcorn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pita bread</td>
<td>Granola</td>
<td>Sweet potato</td>
<td>Pretzels</td>
</tr>
<tr>
<td>Crackers</td>
<td>Squash</td>
<td>Flat bread</td>
<td>Chips</td>
</tr>
<tr>
<td>Dinner roll</td>
<td>Taco shells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereal (hot and cold):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crisps (potato, tortilla, etc.):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asparagus</td>
<td>Cucumber</td>
<td>Mushroom</td>
<td>Iceberg lettuce</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>----------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Green beans</td>
<td>Sweet peppers</td>
<td>Romaine lettuce</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Brussels sprouts</td>
<td>Mixed vegetables</td>
<td>Leaf lettuce</td>
</tr>
<tr>
<td>Celery</td>
<td>Onion</td>
<td>Roasted vegetables</td>
<td>Spinach</td>
</tr>
<tr>
<td>Carrots</td>
<td>Tomato</td>
<td>Oriental vegetables</td>
<td></td>
</tr>
</tbody>
</table>

**Other:**

**Condiments and dressings**

<table>
<thead>
<tr>
<th>Butter</th>
<th>Creamy salad dressing</th>
<th>Salsa</th>
<th>Guacamole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margarine</td>
<td>Curry Sauce</td>
<td>Guacamole</td>
<td>Hummus</td>
</tr>
<tr>
<td>Cream cheese</td>
<td>Spaghetti sauce</td>
<td>Sour cream</td>
<td>Sweet chili</td>
</tr>
</tbody>
</table>

**Other:**

**Favourite restaurants/menu selection**

List your top three restaurant/menu selections:

1. ____________________________
2. ____________________________
3. ____________________________

Please list any additional information about your food preferences that you think would help:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

**Physical activity preference:**

Physical activity while pregnant can be difficult but it is a vitally important part of health in pregnancy. This assessment will help us to better understand what type of activity you prefer and have experience in. Please list your most to least preferred activities from 1-10 in the boxes below. If you have additional types of physical activity that you enjoy, please list them in other and give them a rank order as well.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Reference Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking/Hiking</td>
<td></td>
</tr>
<tr>
<td>Running/Jogging</td>
<td></td>
</tr>
<tr>
<td>Yoga/Pilates</td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
</tr>
<tr>
<td>Cycling</td>
<td></td>
</tr>
<tr>
<td>Aerobics</td>
<td></td>
</tr>
<tr>
<td>Weight Training</td>
<td></td>
</tr>
</tbody>
</table>


Goal Setting:
What are your top 5 goals that we can work on together!

1. _________________________________________________________
   _________________________________________________________
   _________________________________________________________
   _________________________________________________________

2. _________________________________________________________
   _________________________________________________________
   _________________________________________________________
   _________________________________________________________

3. _________________________________________________________
   _________________________________________________________
   _________________________________________________________
   _________________________________________________________

4. _________________________________________________________
   _________________________________________________________
   _________________________________________________________
   _________________________________________________________

5. _________________________________________________________
   _________________________________________________________
   _________________________________________________________
   _________________________________________________________
Appendix H
My Fitness Pal Examples
**Weekly nutrient intake success**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Calories</th>
<th>Nutrients</th>
<th>Macros</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>69</td>
<td>35</td>
<td>-34g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>155</td>
<td>131</td>
<td>-24g</td>
</tr>
<tr>
<td>Fiber</td>
<td>16</td>
<td>7</td>
<td>-9g</td>
</tr>
<tr>
<td>Sugar</td>
<td>40</td>
<td>25</td>
<td>-15g</td>
</tr>
<tr>
<td>Fat</td>
<td>64</td>
<td>32</td>
<td>-33g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>15</td>
<td>10</td>
<td>-5g</td>
</tr>
<tr>
<td>Polyunsaturated Fat</td>
<td>5</td>
<td>-</td>
<td>-5g</td>
</tr>
<tr>
<td>Monounsaturated Fat</td>
<td>13</td>
<td>-</td>
<td>-13g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0</td>
<td>0</td>
<td>0g</td>
</tr>
</tbody>
</table>

**Daily goal intake by micro and macro nutrient.**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Calories</th>
<th>Nutrients</th>
<th>Macros</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>69</td>
<td>35</td>
<td>-34g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>155</td>
<td>131</td>
<td>-24g</td>
</tr>
<tr>
<td>Fiber</td>
<td>16</td>
<td>7</td>
<td>-9g</td>
</tr>
<tr>
<td>Sugar</td>
<td>40</td>
<td>25</td>
<td>-15g</td>
</tr>
<tr>
<td>Fat</td>
<td>64</td>
<td>32</td>
<td>-33g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>15</td>
<td>10</td>
<td>-5g</td>
</tr>
<tr>
<td>Polyunsaturated Fat</td>
<td>5</td>
<td>-</td>
<td>-5g</td>
</tr>
<tr>
<td>Monounsaturated Fat</td>
<td>13</td>
<td>-</td>
<td>-13g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0</td>
<td>0</td>
<td>0g</td>
</tr>
</tbody>
</table>

**Tailored reminders**

<table>
<thead>
<tr>
<th>Meal</th>
<th>Reminders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>Snacks</td>
<td></td>
</tr>
<tr>
<td>Dinner</td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I
Acceptability Questionnaire
Appendix I - Acceptability Questionnaire

Name:__________________________
Date:_____________

1. How easy was the treatment procedure to follow?
   1 2 3 4 5 6 7
   Not easy at all Extremely easy

2. How disruptive did you find the treatment procedure to be?
   1 2 3 4 5 6 7
   Not disruptive at all Extremely disruptive

3. How time consuming did you find the treatment procedure to be?
   1 2 3 4 5 6 7
   Not time consuming at all Extremely time consuming

4. How helpful has the treatment procedure been in helping you change your eating patterns?
   1 2 3 4 5 6 7
   Not helpful at all Extremely helpful

5. Indicate the percentage of time you followed the treatment procedure as instructed.
   0-10% 11-20% 21-30% 31-40% 41-50%
   51-60% 61-70% 71-80% 81-90% 91-100%
Appendix J:
Self Designed Demographic Survey
and Intake Screening for Pre-Pregnant
Women
Participant Survey
The Use of Behaviour Change Procedures to Support Health Behaviours

- Respondents Information
  - What is your marital status?  
  - Single/never been married
  - Married
  - Separated
  - Divorced
  - Widowed
  - Partnership
  - Including yourself, how many people live in your house?________________
  - What is your gross annual household income?  
  - Less than €10,000
  - €10,000 to €29,999
  - €30,000 to €49,999
  - €50,000 to €69,999
  - €70,000 to €99,999
  - €100,000 or more
  - What is the highest level of education you have completed?  
  - Primary school
  - Secondary school
  - Third level
  - If you have completed Third level education, what did you earn?  
  - Certificate
  - Diploma
  - Degree
  - Masters
  - PhD.

- Medical History
  - What is your date of birth?________________________________
  - Have you ever been diagnosed with an eating disorder? Yes □ No □  
    If yes, please specify the diagnosis___________________________
  - Are you concerned you might have an eating disorder? Yes □ No □
  - Are you taking any vitamins? Yes □ No □
  - Are you taking folic acid supplements? Yes □ No □
  - Are you taking Vitamin D? Yes □ No □
  - Do you currently smoke cigarettes? Yes □ No □
  - Do you consume any amount of alcohol on a weekly basis? Yes □ No □  
    If yes please estimate how much/often__________________________
  - Do you used illicit drugs? Yes □ No □
  - What is your current weight in pounds?________________________
  - What is your current height in feet and inches?____________________
  - Are you aware of the recommended healthy weight range for your height?
  - Are you aware of your current BMI?_______________________________
  - What is your employment status?  
  - Employed
  - Out of work and looking for work
  - Out of work but not looking for work
  - A student
  - Housewife
  - Unable to work and receiving disability
  - Other___________________________
  - If employed, what is your occupation?____________________________
    ____________________________________________________________
    ____________________________________________________________
Family Medical History

What is your race/ethnicity?
- Asian or Asian Irish
- Chinese
- Any other Asian background
- Black or Black Irish
- African
- Any other Black Background

What was your country of birth?

Please indicate, by ticking, if you have a history of any of the following:

- Autism Spectrum Disorder (ASD)
- Anxiety Disorder
- Attention Hyper Activity Disorder (ADHD)
- Auto-immune Disease (e.g. rheumatoid arthritis, lupus, thyroid disease)
- Bipolar Disorder
- Depression
- Eating Disorder (e.g. anorexia, bulimia)
- Gastrointestinal disorders (e.g. celiac disease, Crohn’s disease, Ulcerative colitis)
- Fragile X, or been told that you are a carrier for fragile X
- Intellectual Disability (IQ <70)
- Learning Disability (e.g. dyslexia, dyspraxia)
- Major Mood Disorder
- Personality Disorder (e.g. antisocial personality, borderline personality disorder)
- Schizophrenia
- Seizure Disorder/Epilepsy
- Sleep Disorder (e.g. insomnia, dyssomnia)
- Speech delay or impairment
- Other psychiatric disorder
- Metabolic conditions (e.g. diabetes, hypertension)
- Down Syndrome
- Other Chromosomal abnormality

√
Appendix J: Demographic Survey

- **Do you have any biological children?**  Yes  No
  - If yes, please list their gender and dates of birth
    - ________________________________
    - ________________________________
    - ________________________________

- **Do you have any adopted children?**
  - Yes  No  No
  - If yes, please list their gender and dates of birth

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**Recruitment Intake**

Behavioral Intervention to Support Healthy Behaviours

Name:_____________________________________

Age:________________________________________________________________________

Previous Pregnancies :_________________________________________________________

If so, start and end of pregnancy weight:________________________

Current weight:________________________________________________________________

Date of weight take:____________________________________________________________

History of an eating disorder?____________________________________________________

Diabetes?_____________________________________________________________________

Nutritional compilations?________________________________________________________

Specialized diet?________________________________________________________________

Eligible?______________________________________________________________________
Appendix K:
Chapter 4 & 5 Participant Information Sheet
The use of behaviour change procedures to support health behaviours.

Information Sheet:

Dear Participant,

My name is Meghan Brahm, I am currently undertaking a PhD. in Applied Behaviour Analysis (ABA) at the National University of Ireland, Galway (NUIG). As part of my doctoral research, I am conducting a study and would like to invite you to take part in it. Before you agree, it is important for you to understand why this research is being done and what it will involve, this information sheet will tell you about the study. I am happy to answer any questions you may have at any time so feel free to contact me (my contact details are provided at the end). Please take as much time as you need to read this document and if you are happy to agree to participate, a consent form is attached for you to sign.

Introduction and Purpose:

Obesity and/or overweight has become a significant health concern globally. Of particular concern is increased weight impacting pregnancies at high rates. Recently, there have been many advances surrounding healthy weight behaviours for women pre-pregnancy, with the aim of setting women up for the healthiest pregnancy they can have. The research you are being invited to participate in aims to support women in identifying and changing behaviors which may be impacting their health and weight pre-pregnancy. Specifically, the research is looking to determine if behavioural supports and nutrition education will help women to manage their weight related behaviors in a healthy way.

Duration of Study and What Participation Involves:

The project is expected to begin within the next few weeks will last approximately 12 weeks. Participation includes:

- Firstly, completing an interview, conducted by me, and a questionnaire about food intake and eating. Secondly, you will be asked to complete a food and exercise diary over a seven-day period, which I will set up for you and teach you how to complete. Using the interview and diary information, we will work together to develop a personalized health plan which will support you through the duration of your participation, and hopefully beyond.

- After the initial interview and seven-day food diary, you and I will work together to target specific behaviors for change across the next 10 weeks. Each week I will provide you with goals, instructions and supports for the week to come. A component of this will also be entering your food into a phone application so we can track your progress.
• You will also be invited to participate in weekly lessons about changing health knowledge and behavior. Lessons will focus on increasing your nutrition knowledge and supporting you through your health journey. I will be conducting all of the lessons, if you choose to partake, and helping you to follow your individual plan.

After the research is complete, my supervisor, Dr. Geraldine Leader and I, will publish the results in an academic journal. Should you agree to participate, I can send you the article when it is published. You will not be identified in anyway within the publication.

Possible Risks and Inconveniences:

There are no health or safety risks in this study. I have received a diploma in personal nutrition, have extensive experience in behaviour change procedures and will be working with you to ensure maximum support the whole way through.

Potential Benefits:

It is our hope that this research will aid in supporting you to become as healthy as possible, and that the knowledge you gain throughout the process will help you to continue healthy habits in the future. We also hope to aid in the advancement of pre-pregnancy healthcare and education in Ireland as well as internationally through the completion of this research.

Your Rights:

If you do decide that you wish to take part, you will be given this information sheet to keep and be asked to sign the attached consent form. Participation is voluntary. You are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time will not affect your rights in any way.

Confidentiality:

All information concerning your participation in this study is private and confidential and will not be shared with anyone outside of the study team. The personal information, which may be gathered for this project, includes age, gender, weight and medical records. Any results or information gathered will be securely stored in a way that protects your identify. Participants will be identified with a number and your details will be documented separately to all data collected. No participant will be identified in any publication.

Complaints:

I would like to remind you that you are entitled to change your mind about your participation in this study at any time during the course of the study without disadvantage or penalty to you. If you feel a need to make a complaint at any point during or after the study is conducted, I will be at hand to address the issue.

Further Information:

If you would like further information, please do not hesitate to contact me at any time. If you have any concerns about this study and wish to contact someone independent and in confidence, you may contact the Chairperson of the NUI Galway Research Ethics
Committee, c/o Office of the Vice President for Research, NUI Galway, ethics@nuigalway.ie.

Please contact me to clarify any points on which you remain unclear:
Meghan M. Brahm, M.A., BCBA
Address: NUI Galway Psychology Office, Arts Millennium Building Extension, Galway, Ireland.
Email: m.brahm1@nuigalway.ie
Telephone: 087-340-2090

You will be given a copy of the Participant Information Sheet and a signed Consent Form to keep for your own records. Thank you very much for participating in this study.
Appendix L:
Weekly Instruction Sheet Example
The use of behaviour change procedures to support health behaviours.

Week 1

Dear Cathy,

Thank you again for participating in this research study. We are so excited to begin this health venture with you. We at the National University of Ireland, Galway’s psychology department have been working to go over all of the data that you collected for us. Now that is complete and we are ready to start the next phase!

Each week you will receive a new goal from us to work on and a lesson plan to help you with your journey to health. Remember this is NOT a diet, we are trying to establish lifelong health behaviours and knowledge of what healthy actually is.

For this week we have a few pieces of homework for you:

1. Download the MyFitnessPal© application (it is free).
2. Enter all of your calories into the app BEFORE consuming them. Entering before eating is a crucial step in the self-management and habit breaking process. If we continue to reflect on what we eat after consuming it, our behaviour will not change.
3. The lead researcher, Meghan Brahm, BCBA, will be contacting you via MyFitnessPal© to give you reminders about entering your food, encouragement in the process and to remind you of what an awesome job you are doing!
4. Begin tracking your steps every day! The goal for this week is to walk at least 3,500 steps every day. Be sure to check your step count periodically during the day and get moving!

Another part of working on your health is to motivate yourself! After giving us a list of your favorite (non-food related) thing, each week we will designate a reward for hitting all of your goals that comes from your list.

This week you are working to get a mani/pedi! So remember, no mani/pedis unless you meet the 4 goals set for you above. If you feel at all that you are unable to meet the goals, do not forget to contact Meghan and she will help you in any way she can.

Please let us know if there is anything we can do for you in getting ready to start on Monday and we will help however we can. Can’t wait to hear how the week goes.

You can do this!

NUIG Psychology Research Team

Health is a journey, not a destination.