THE ROLE OF DIET IN ALLEVIATING GASTROINTESTINAL AND BEHAVIORAL SYMPTOMS IN CHILDREN WITH AUTISM

By

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DEDICATION:

I would like to dedicate this thesis to my sister, Christine Rose Wylie. Christine is determined, strong, and inspiring. I am proud of the independent woman she has become. I would also like to recognize my mother, Rebecca Wylie. Raising a child with autism is no small feat, but your strength and compassion never wavered. You have set an example that I will continually strive to emulate.

ABSTRACT:

Six mothers of children with autism were interviewed and asked to complete an Aberrant Behaviors Checklist (ABC) to analyze their child's diet, gastrointestinal symptoms, and behavioral symptoms. The results showed the children on a gluten-free, casein-free (GFCF) diet had fewer behavioral symptoms and symptoms of less severity (average behavioral score of 22.35) than the children who were either on a casein-free, egg-free diet (CFEF) (average behavioral score of 80), or not adhering to any exclusionary diet (average behavioral score of 69.5). Behavioral symptoms decreased with age, the youngest participant of age 4 had an average score of 72 while the oldest participants of age 7 had an average score of 35. Based on this data, GFCF dieting seems to improve ASD children's GI and behavioral symptoms, however the mechanism and effectiveness is still under debate. Parents should be aware of the nutritional detriment that this diet may have on their child before excluding gluten and casein.

INTRODUCTION:

The connection between diet and autism has been a topic of debate among researchers, dieticians, and physicians. The most common diet adopted by families with autism is the gluten-free casein-free diet (GFCF). This thesis will work to understand the physiology behind why diet influences the appearance and severity of gastrointestinal and behavioral symptoms in children with autism.

The Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) defines autism spectrum disorder (ASD) as:

A. Chronic social impairment affecting the patient in multiple aspects of life
B. Repetitive tendencies throughout daily tasks, a restricted lifestyle, stereotypical mannerisms
C. The patient may present with symptoms of ASD during early childhood or symptoms may be masked until demands exceed the patient's capabilities.
D. Patient's symptoms hinder areas of his/her daily life to a clinically significant degree (American Psychiatric Association, 2013).

ASD is a clinical diagnosis based on the DSM-5 criteria. Pediatricians are trained in surveillance, screening, and evaluation to identify children at risk for ASD (AAP guidelines). The recommendations are to complete developmental surveillance at every medical visit, including looking for concerns for ASD. At the 18- and 24-month well-child visits, primary care providers complete formal screenings specifically for ASD. Children who are identified from either surveillance or screening are referred for full developmental evaluation and diagnosis.

In 2012, the Centers for Disease Control (CDC) estimated that approximately 14.6 per 1000 (1 in 68) children who were age 8 years old met the diagnostic criteria for ASD (Christensen et al., 2012).

Autism and the Gastrointestinal System

Gastrointestinal (GI) issues are common in individuals with ASD with studies showing that children with ASD are three times more likely to experience GI symptoms than their peers exhibiting typical development (Chaidez, Hansen, & Hertz-Picciotto, 2014). Approximately 20-70% of children with ASD experience GI symptoms, such as diarrhea and constipation, depending on the definitions of the symptoms and the study parameters (Hyman, 2013). Current research has been unable to confirm if children with ASD experience GI symptoms as a result: a) of abnormal physiology directly associated with ASD; b) a comorbid condition; or c) symptoms that are independent of ASD and primarily driven by environmental (dietary) factors (Buie et al., 2010).

Common GI Symptoms:

The GI symptoms that children with ASD experience span a wide range of severity and type. This thesis will focus on the three most common chronic symptoms identified in current research: chronic constipation, diarrhea, and gastrointestinal pain.

- Constipation:
    - Definition: Fewer than three bowel movements a week
        - Bowel movements with stools that are hard, dry, and small, making them painful or difficult to pass
    - Behaviors indicating constipation include: arching of the back, pressing on the abdomen, and clenched teeth.

- Diarrhea:
    - Definition: Loose, watery stools three or more times a day
        - Acute diarrhea: a common problem that typically lasts 1 or 2 days and goes away on its own
        - Persistent diarrhea: lasts longer than 2 weeks and less than 4 weeks
        - Chronic diarrhea: lasts at least 4 weeks, chronic diarrhea symptoms may be continual or periodic
- Gastrointestinal Pain:
    - Behaviors indicating pain include: pressing on the abdomen, bloating, bent over posture, and contraction of abdominal muscles

Overview of the Immune System

While there are multiple factors that can lead to GI distress, this thesis focuses on the hypothesis that GI symptoms develop due to a chronic immune response that causes an inflammatory response. In order to understand this hypothesis, insight into the inflammatory response of the immune system will be included here.

Reactive Oxygen Species:

Reactive oxygen species (ROS) play a prominent role in the innate immune system where it primarily attacks fungal and bacterial pathogens. ROS also functions as a signaling molecule via paracrine action. However, when cells are exposed to high amounts of ROS, oxidative damage can occur leading to necrosis. Abnormally high levels of ROS can disrupt cellular behavior by damaging cellular materials such as lipids, proteins, and DNA as seen in Figure 1. It can also disrupt membrane and enzyme function, protein crosslinking, enzyme transport, protein synthesis, and ion transport,

along with damaging other cell functions and communication mediums (Ray, Huang, & Tsuji, 2012).

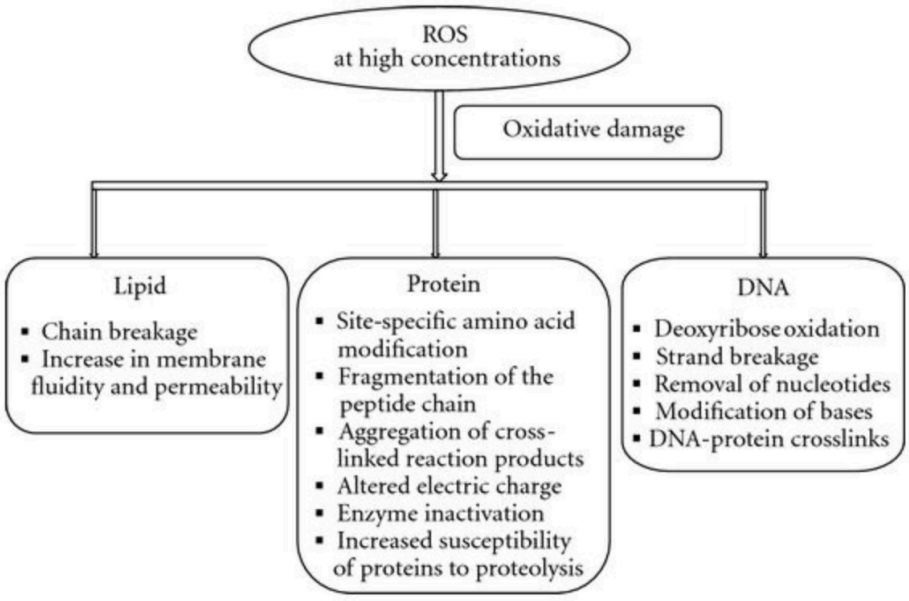

Figure 1: Some of the detrimental effects of high concentrations of ROS (Sharma, Jha, Dubey, & Pessarakli, 2012).

Antibody Mediated Damage:

When the body is initially exposed to foreign proteins, an innate immune response will take place, attacking and destroying the antigen. However, the antigen also initiates a response in the adaptive immune component creating a longer-term memory to combat the antigen. In this response, the proteins will bind to the previously created anti-gluten or anti-casein antibodies that the immune system generated when first exposed to the foreign proteins. The fragment crystallizable region (Fc) of immunoglobulin G (IgG) antibodies will bind to Complex 1 (C1) and activate the classic complement pathway. The complement cascade consists of an array of complexes that ultimately results in lysis of the cell that has incorporated the marked antigens via the formation of a membrane

attack complex (MAC). MAC is a series of proteins that form a hole in the cell membrane of the foreign material. Due to the higher osmolarity in the cell, water will rush in and the foreign cell will swell and burst with the sudden influx of water. Macrophages, ROS, and other cytokines are recruited to initiate the cleanup of the lysed cell, resulting in an increase in extracellular fluid and inflammation (Nimmerjahn & Ravetch, 2010).

The Inflammatory Response to Gluten and Casein

While some scientists believe that GI distress in children with ASD is an inflammatory response to gluten and casein, there is discussion regarding how the inflammatory response occurs. Two hypotheses are outlined below:

1. The inhibition of methyltransferase (MTase) causes an increase in reactive oxidative species (ROS) leading to potential intestinal damage and chronic inflammation (James, 2003).
2. Changes in the physiology of the intestine result in increased intestinal permeability. This increased permeability allows proteins such as gluten and casein to exit the intestinal lumen after consumption and initiate an antibody mediated immune response resulting in chronic inflammation upon subsequent consumption of these proteins (Navarro et al., 2014).

Physiology of the MTase Blockage:

Adenosine deaminase (ADA) is the enzyme that facilitates adenosine breakdown. ADA is located throughout the body, but in the intestines ADA is bound to dipeptidyl peptidase-4 (DPP-IV), the enzyme responsible for gluten and casein breakdown.

Abnormalities in DPP-IV may result in inability to properly digest gluten and casein, as well as decreased ability of adenosine deaminase to break down adenosine (Jepson & Johnson, 2007). If DPP-IV is ineffective, the ADA enzyme bound to DPP-IV could also be disrupted and unsuccessful in completing adenosine breakdown efficiently. This leads to an accumulation of adenosine within the cell. The increase in adenosine pushes the reaction in the reverse direction via Le Chatelier's Principle, making more S-adenosylhomocysteine (SAH). High concentrations of adenosine also inhibits S-adenosylhomocysteine hydrolase (SAHH), exacerbating the accumulation of SAH. S-adenosylmethionine (SAM) is the methyl donor in the methyl transferase reaction. With high levels of SAH, SAM is inhibited and thus unable to donate a methyl group to the methyltransferase (MTase), altering cellular reactions. Glutathione is a downstream product in the methionine transsulfuration pathway. However, due to the increase in SAH and inhibition of SAHH, the reaction is unable to proceed in the forward direction to produce glutathione. The decrease in glutathione is coupled with an increase in oxidized glutathione, thus causing an increase in oxidative stress within the cell (James, 2003). This increase in oxidative stress could possibly disrupt normal GI mechanisms such as absorption and secretion, cause damage to the intestinal epithelium, and lead to chronic inflammation resulting in GI symptoms.

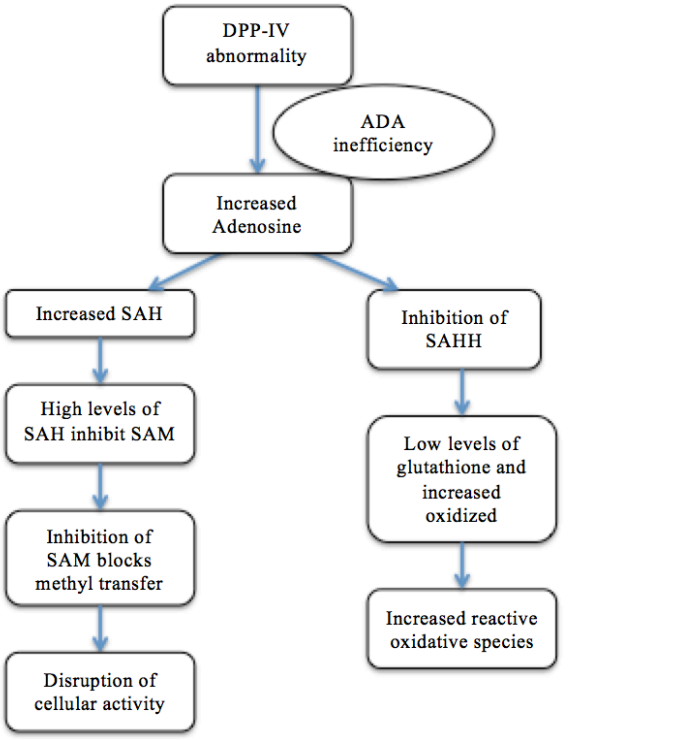

Figure 2: Disruption of the methyltransferase pathway (James, 2003).

Physiology of Increased Intestinal Permeability Hypothesis:

Other researchers have hypothesized that children with autism have increased intestinal permeability to proteins such as gluten and casein. It has been postulated that there is a defect in the intestinal tight junctions, allowing proteins to leak out of the intestinal lumen and enter the blood. (See Figure 3) Once in the blood, gluten and casein proteins can be recognized as free antigen. B cells will engulf the free-floating proteins and present the proteins to T follicular helper cells on MHC Class II. T follicular helper cells will then activate B cells to make antibodies to gluten and casein antigen. Therefore, when the child ingests gluten and casein again, it will leak into the blood stream, and bind to anti-gluten or anti-casein IgG antibody. Antibody plus antigen complexes can activate

the complement system leading to macrophage activation, destruction of "self" cells, and an immune response involving reactive oxidative species release (Navarro et al., 2014).

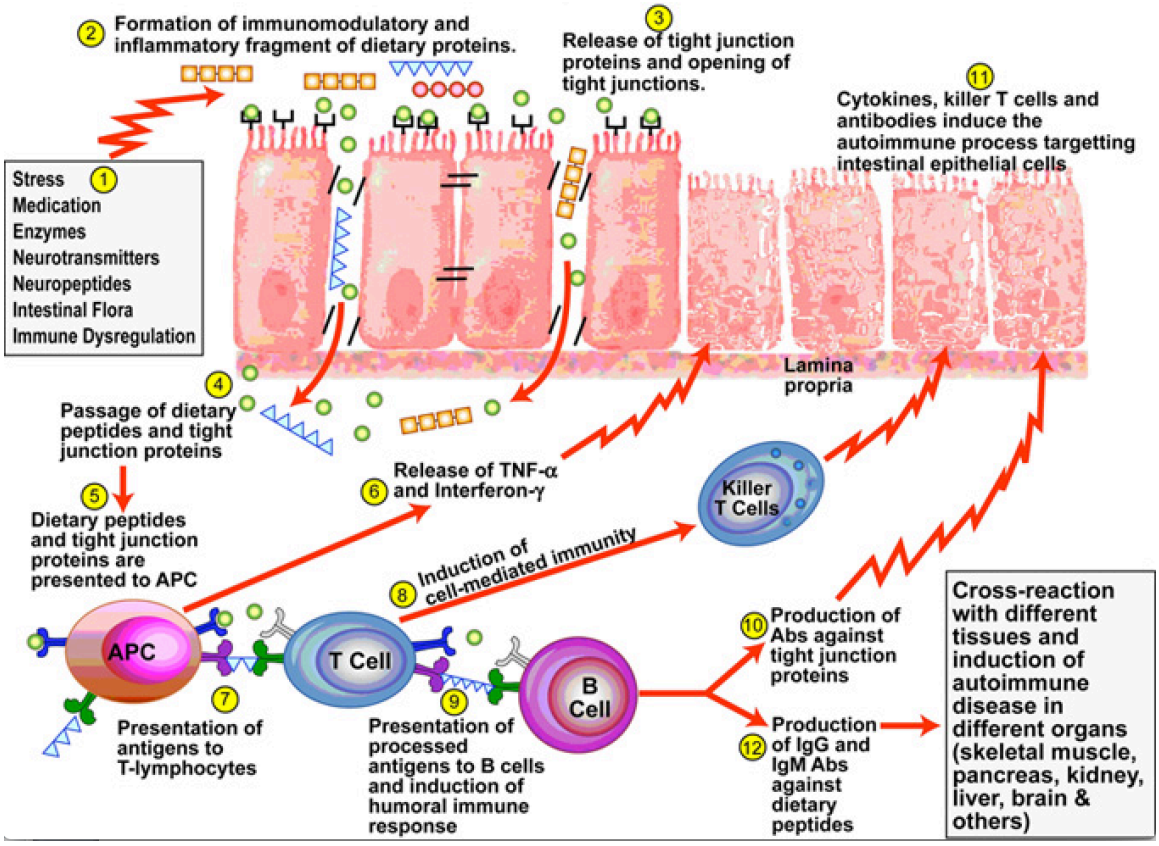

Figure 3: Illustration of the immunological response to proteins exiting the intestinal lumen via ineffective tight junctions (Vojdani, Pollard, & Campbell, 2014).

Pathophysiology Underlying Gastrointestinal and Behavioral Disorders:

This exaggerated immune response has been hypothesized to cause the GI symptoms of diarrhea, constipation, and abdominal pain. However, the exact mechanism of how this occurs is still unclear and being investigated. Inflammation may initiate a cascade of events that eventually lead to abnormalities in the autonomic nervous system, which in turn affect digestion. (See Figure 4) While the inflammatory response has not yet been proven to have any direct effect on behavioral symptoms, it has been hypothesized that behavioral symptoms are exacerbated by chronic inflammation,

discomfort and pain. Inflammatory cytokines such as IL-6, IL-1β, and TNF-α, can cause disruption in other neurotransmitters such as serotonin that regulate mood and behavior that could potentially cause behavioral symptoms in children with autism (McNamara & Lotrich, 2012). The research focused on understanding the mechanism of the behaviors seen in children with autism is limited because there are many pathways that could possibly be involved including the brain-gut connection, chemical and hormone levels, or simply physical discomfort.

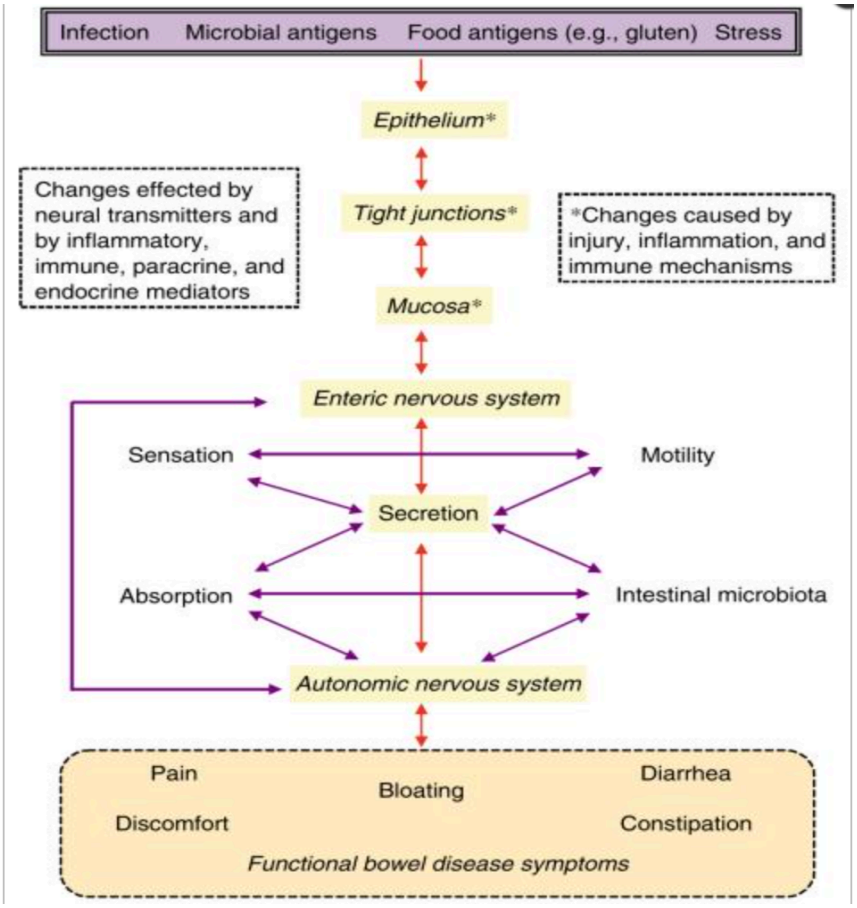

Figure 4: Factors underlying the pathophysiology of GI symptoms related to a gluten inflammatory response (Verdu, Armstrong & Murray, 2009).

METHODS:

This thesis focuses on the potential correlation between diet and behavioral symptoms utilizing a newly developed set of interview questions to query parents of children with autism. The interviews were conducted in a clinical trial room, giving mothers a safe place to analyze their child's symptoms in relation to diet. This interview method uses pointed questions that allow research conclusions to be drawn both quantitatively via the Aberrant Behaviors Checklist (ABC) and qualitatively in relation to how mothers feel their child has responded to diet intervention.

The mothers participating in this study were parents of the children who were being seen as patients at the Pediatric Neurology clinic. Mothers were contacted and asked if they were willing to participate in a 30-minute interview and survey at the clinic.

All mothers were the primary caregiver of a child with autism who was age 3-7 years at the time of the interview. All children involved in this study must have experienced at least one GI symptom or have a severely restricted diet which consisted of ten foods or less. All mothers enrolled in the study were required to be native English speakers in order to ensure question clarity and understanding.

Upon entering the clinic, mothers were given the consent form to review and sign. After reviewing the form, they were asked to complete the Aberrant Behaviors Checklist (ABC), a measure to compare their child's behaviors to the behaviors of a healthy peer. The ABC form lists behaviors for which mothers could bubble in one of four options: 0= not a problem at all, 1= the behavior is a problem but in a slight degree, 2= the problem is moderately serious, 3= the problem is severe in degree. The higher the total score on this assessment, the more severe the overall behavioral symptoms. The Aberrant Behavior

Checklist, Second Edition was used for this study. Upon completion of the ABC form, mothers then participated in an approximately 20 minute verbal interview. Questions related to their child's diet, gastrointestinal symptoms, and behavioral symptoms were asked and are given in Appendix I.

RESULTS:

All mothers reported that their children had at least one behavioral symptom. The most common symptoms were: tantrums, moodiness/irritability, self-harm, social isolation, and ignoring directions. (See Figure 5)

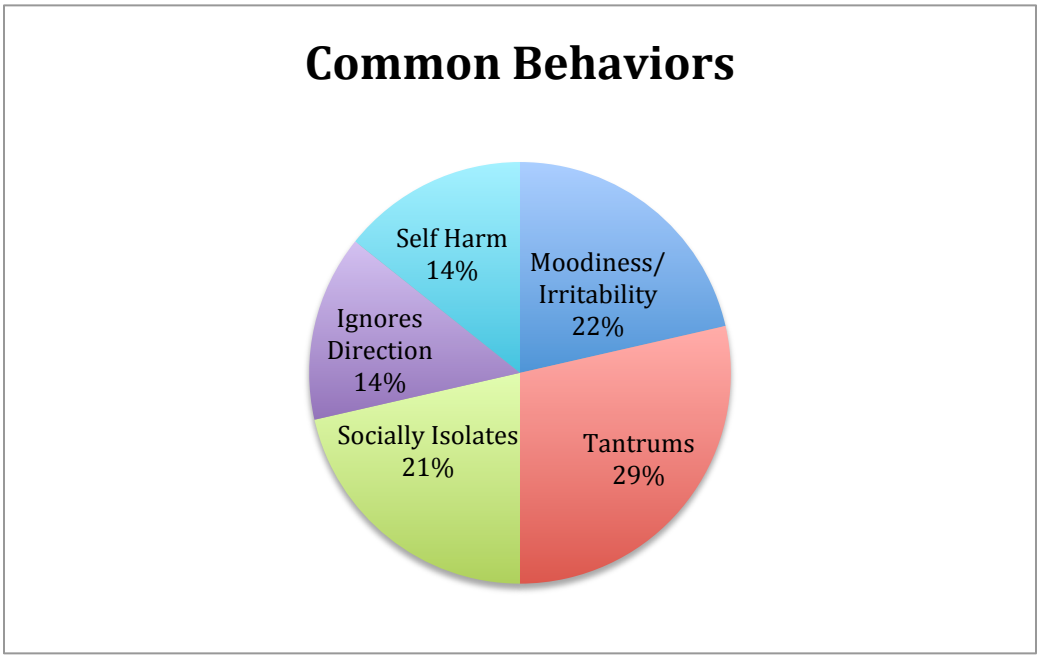

Figure 5: Common behaviors reported by mothers (% of a total number of 7 children)

Two out of the three mothers with children on the GFCF diet reported that the diet seemed to improve their child's behavioral symptoms within a few days of starting of the diet, then the improvement plateaued within a week a two, as indicated by the following sample comments during the interviews:

> *B: "Three days later, he was talking, you could see the fogginess go away, and he was verbal. He was coming out of his room every morning much better. Whereas he used to come out being very fearful and hesitant. He would, there was just such a difference, in just days."*

R: "I would say initially when we first did it (the GFCF diet), it seemed like there was a quick change right away like within the first few days we noticed something, like a better improvement with his behaviors and stuff. But then it just kind of leveled off like nothing really changed after that."

With respect to age, the general trend showed improvement of behavioral symptoms with age. (See Table 1 in Appendix II) The youngest participant, age 4, had an average behavioral score of 72 while the 2 oldest children, age 7, had an average behavioral score of 35. (See Figure 6)

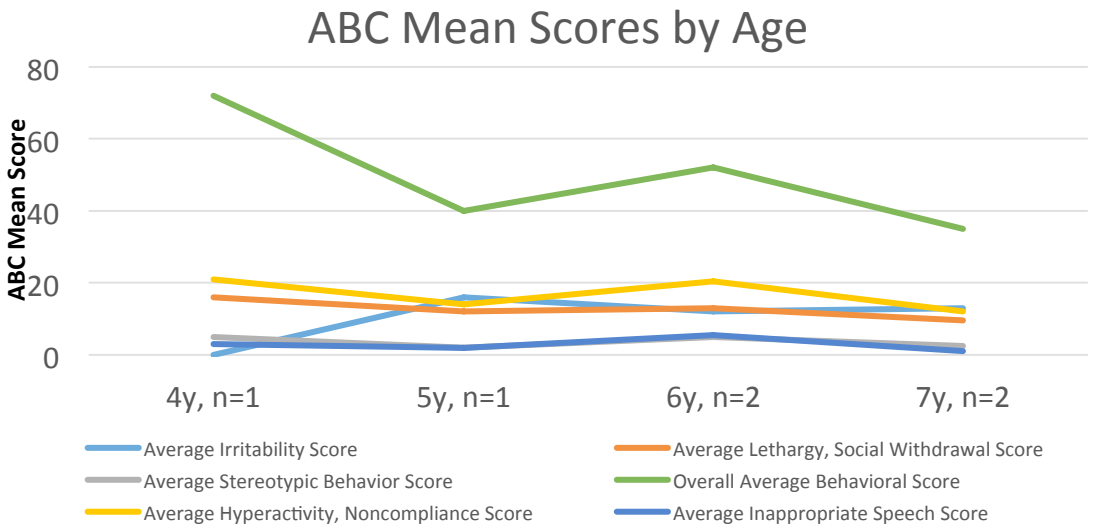

Figure 6: ABC mean scores with reference to age

Of the six participating mothers, three had children who were on a gluten-free casein-free (GFCF) diet, one was on a casein-free, egg-free diet (CFEF), and two were not on any type of exclusionary diet. Using the ABC analysis, data across the different diet types were compared. Results are shown in Table 2 in Appendix II. Children on the GFCF diet had the lowest average behavioral score of all the dieting groups of 22.335. The score supports the claim that children on a GFCF diet typically have fewer

behavioral symptoms, and when they do have symptoms they are of lesser severity than their ASD peers. The child on the CFEF diet had a score of 80 while the children on no specific diet had an average score of 69.5.

All mothers who had their children on the GFCF diet reported improvement in their child's GI symptoms. The child on the CFEF diet also experienced a decrease in GI symptoms due to his diet, however since this child has a true allergy to casein and eggs, this data is not significant to this study because the decrease in symptoms is likely due to the absence of the allergen in his diet. The proposed mechanisms of GI dysfunction are related to an inflammatory response, however this inflammatory response is not linked to allergies, but to proteins escaping the intestinal lumen or due to abnormalities in digestive enzymes. The other children had no documented allergies to gluten or casein. The children without allergies were started on the diet due to a physician's referral (n=1) or because they heard that it had been beneficial to some children with autism previously (n=4). The children adhering to no specific diet served as a control because no conclusions could be drawn based on their symptoms in relation to diet.

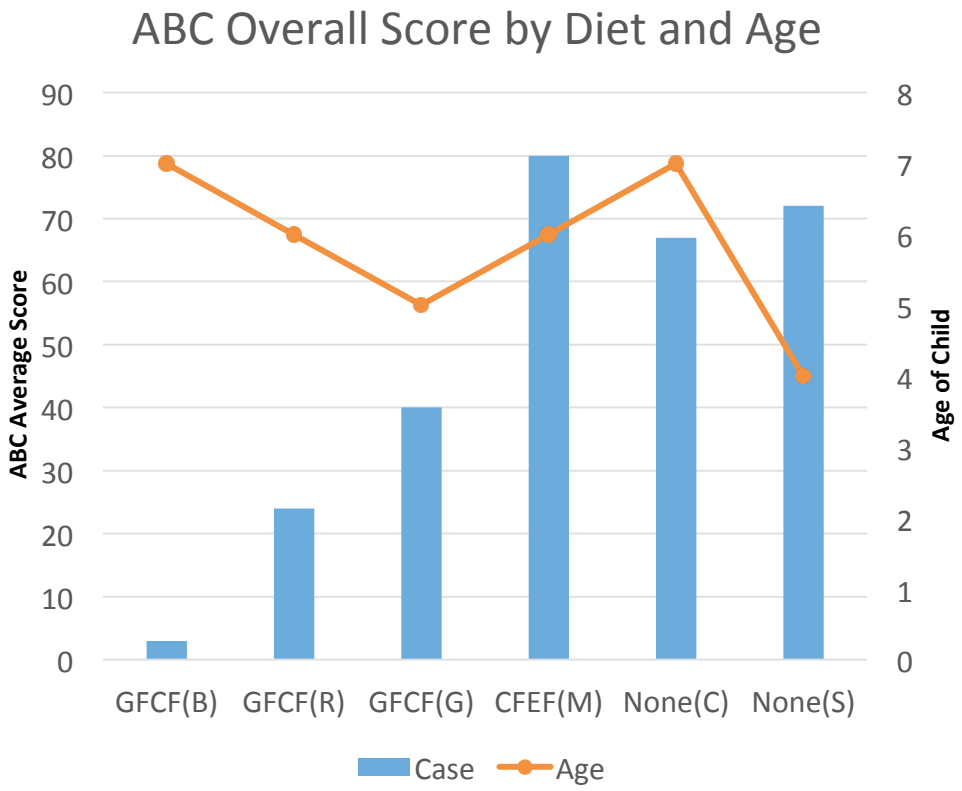

Figure 7: ABC score in relation to diet and age

Of the six children, four experienced at least one GI symptom. In agreement with the literature review above, the most common GI symptoms include constipation, diarrhea, and pain. (See Figure 8) However, it is difficult to distinguish whether GI symptoms of children are due to an increased intestinal permeability, a methyltransferase block, or some other unknown mechanism. Within this study's parameters, no conclusions can be drawn on the physiological mechanism in which the symptoms occurred.

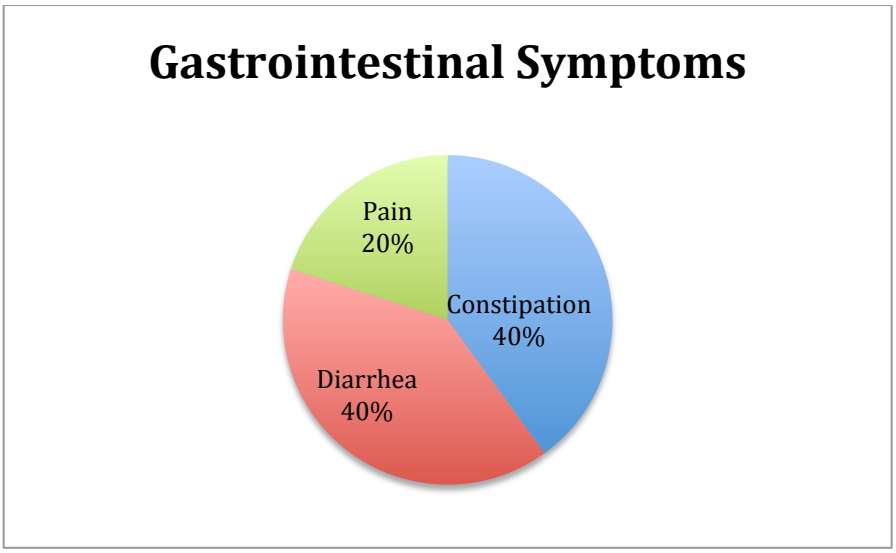

Figure 8: Common gastrointestinal symptoms reported by mothers (% of a total number of 7 children)

Of the children on the GFCF diet, two had moderately low adherence to the diet. Mothers reported that they would try to buy GFCF products, but would allow child to eat gluten or casein on a weekly basis. The other child on the GFCF diet had a moderate adherence in which the child did not consume gluten, but did have casein approximately once every other week. The child on the CFEF diet had a strict adherence to that diet due to the child's anaphylactic allergies to casein and egg products.

Five out of the six mothers described their children as picky eaters. Mothers all said their child's pickiness began at age three, when the child was able to communicate what he/she wanted. Two mothers reported that their child preferred snacking throughout the day rather than having a full sit down meal. This trend could be due to the children having slow gastric emptying, in which it takes a longer amount of time for the food to pass through the stomach to the intestine.

DISCUSSION:

The data from this study suggests that the GFCF diet tends to decrease the number and severity of children's behavioral and GI symptoms. However, there are several limitations involved in this study that impact its significance. First, it is important to note that with age, children are undergoing more treatments and therapies throughout their lifetimes. Therefore, the trend that age decreases behavioral symptoms and symptom severity may be a consequence of increased interventions or therapies rather than solely maturation or duration of dieting. In addition, the study is based on a small sample size of six mothers and there are no parameters set to ensure adherence to the diet. Also, the data is based on a mother's perception of their child, which could lead to bias. No matter the underlying physiological mechanism involved, it is difficult to determine if behavioral symptoms and potential improvement are a direct result from diet. The measure used in this study is parental evaluation, a very subjective measurement that is easily swayed by personal desire related to the parent's optimism or hope for their children. Therefore, great attention should be paid to the type and specificity of the questions for these evaluations.

The two proposed mechanisms within the literature review above are the most common hypotheses behind GFCF dieting. However, neither of these hypotheses have been proven and there is still much debate over both the mechanism and effectiveness of the diet. If given the opportunity to advise a family about starting their child with ASD on a GFCF diet, it would be important to note the variety of foods and amount of protein that child will consume if placed on the diet. If gluten and casein are the central sources of protein in the child's diet, removing these proteins could cause a nutritional deficiency

that could be much more detrimental to the child than the potential benefits of the diet. One mother (G) commented on this, *"We tried to do the whole no dairy thing, but she (their pediatrician) did tell us that we could slowly introduce it back into his diet so we do let him have a little bit of dairy because sometimes I feel that that's the only protein he'll get is in like yogurt or cheese."* Therefore, if the child does have a wide variety of foods and protein sources in his/her diet, this study would support the idea of trying a GFCF diet to see if that child could decrease his/her GI or behavioral symptoms.

REFLECTION:

I have always known that there is a wide range of severity when it comes to autism. However, growing up in a small town, with few people to compare my sister's ASD severity to, my family felt isolated and unsure of how my sister compared to others with ASD. After conducting these interviews, I have a better idea of the range of autism. I have grown to better understand my sister's behavioral symptoms, and become grateful for the symptoms she does not experience. I have expanded my understanding of the biochemistry and physiology of the gastrointestinal system, and I've become more aware of how dysfunction in the intestine can affect the ASD population's daily life. I hope ASD research will continue to identify and study factors that affect the ASD population in hopes of improving their quality of life.

Appendix I: Interview Questions

Opening:

1. How old is your child?
2. What is your child's sex?
3. When was your child diagnosed with autism?
4. Is your child considered to have mild, moderate, or severe autism?

Dieting:

5. How long has your child been on his/her diet?
6. Can you describe your child's typical diet? Does he/she gravitate towards any types of foods?
7. Do you think this diet is helping your child?
8. Have you tried this diet previously?
9. How strictly does your child adhere to his/her diet?
10. Why did your family decide to try this diet?
11. Have you noticed any general changes in your child since he/she has started the diet?
12. What age did your child become a picky eater?
13. What are your mealtime routines?
14. Does your child help you cook?

Gastrointestinal Symptoms:

15. What are your child's gastrointestinal symptoms? Which symptoms are most common/prominent?

16. Have you noticed any gastrointestinal symptoms change while on the diet? When did these changes occur?
17. How often does your child experience gastrointestinal symptoms or discomfort?

Behavioral Symptoms:

18. Have you noticed any behavioral symptoms change while on the diet? When did these changes occur?
19. What are your child's behavioral symptoms? Which symptoms are most common/prevalent?
20. Has this diet affected your family's stress level?

Appendix II: Tables of ABC Scores

Table 1: ABC Scoring Categorized by Age Group

	Age 4, n=1 Diet: None	Age 5, n=1 Diet: GFCF	Age 6, n=2 Diet: CF (1), GFCF (1)	Age 7, n=2 Diet: GFCF (1), None (1)
Irritability				
Injures self on purpose	3	0	0	1
Aggressive to other children or adults (verbally or physically)	1	1	1	0
Screams inappropriately	2	1	0	0
Temper tantrums/outbursts	3	1	1	1
Irritable and whiny	0	2	0.5	0.5

Yells at inappropriate times	2	1	0.5	0
Depressed mood	0	0	0	0.5
Demands must be met immediately	1	1	1	1
Cries over minor annoyances or hurts	2	1	1.5	0.5
Mood changes quickly	0	1	1	1
Cries and screams inappropriately	2	0	0	1
Stamps feet or bangs objects or slams doors	2	0	0	1
Deliberately hurts himself/herself	3	0	0	1
Does physical violence to self	3	0	0	0.5
Has temper outburst or tantrums when he/she does not get own way	3	1	1.5	1
Lethargy, Social Withdrawal				
Listless, sluggish, inactive	0	0	0	0.5
Seeks isolation from others	2	2	2	1
Preoccupied, stares into space	1	1	1	1
Withdrawn; prefers solitary activities	2	1	2	0.5

Fixed facial expression; lacks emotional responsiveness	0	0	0	1
Does nothing but sit and watch others	0	0	0.5	0.5
Resists any form of physical contact	2	0	0	0
Isolates himself/herself from other children or adults	2	2	1	1
Sits or stands in one position for a long time	0	0	1	0
Unresponsive to structured activities (does not react)	0	0	0.5	1
Is difficult to reach, contact, or get through to	1	1	0.5	1
Prefers to be alone	2	1	2	1
Does not try to communicate by words or gestures	0	1	0.5	0
Inactive, never moves spontaneously	0	0	0	0
Responds negatively to affection	2	1	1	0.5
Shows few social reactions to others	2	2	1	0.5
Stereotypic Behavior				

Meaningless, recurring body movements	0	1	1.5	0.5
Stereotyped behavior; abnormal repetitive movements	2	1	1.5	1
Odd, bizarre in behavior	2	0	1	0
Moves or rolls head back and forth repetitively	0	0	0	0
Repetitive hand, body, or head movements	0	0	1	0.5
Waves or shakes the extremities repeatedly	0	0	0	0.5
Rocks body back and forth repeatedly	1	0	0	0
Hyperactivity, Noncompliance				
Excessively active at home, school, work, or elsewhere	1	0	1.5	0.5
Boisterous (inappropriately noisy and rough)	2	1	1.5	0.5
Impulsive (acts without thinking)	1	1	1	1
Restless, unable to sit still	1	2	1.5	1
Disobedient; difficult to control	1	1	0.5	0.5
Disturbs others	2	1	1.5	1
Uncooperative	1	1	0.5	0.5

Does not pay attention to instructions	1	1	1.5	1
Disrupts group activities	1	1	1	0.5
Does not stay in seat (e.g., during lesson or training periods, meals, etc.)	1	1	1.5	1
Will not sit still for any length of time	0	1	1	1
Easily distractible	1	1	2.5	1
Constantly runs or jumps around the room	3	0	1	1
Pays no attention when spoken to	1	0	1.5	0.5
Tends to be excessively active	2	1	1.5	0.5
Deliberately ignores directions	2	1	1.5	0.5
Inappropriate Speech				
Talks excessively	0	0	0.5	0.5
Repetitive speech	2	1	2	0
Talks to self loudly	0	0	1	0
Repeats a word or phase over and over	1	1	2	0.5
Average Irritability Score	27	10	8	10
Average Lethargy, Social Withdrawal Score	16	12	13	9.5

Average Stereotypic Behavior Score	5	2	5	2.5
Average Hyperactivity, Noncompliance Score	21	14	21	12
Average Inappropriate Speech Score	3	2	5.5	1
Overall Average Behavioral Score	72	40	52.5	35

Table 2: ABC Scoring Categorized by Different Diets

	Gluten-Free Casein-Free, n=3	Casein-Free Egg-Free, n=1	None, n=2
Irritability			
Injures self on purpose	0	0	2.5
Aggressive to other children or adults (verbally or physically)	0.667	1	0.5
Screams inappropriately	0.333	0	1
Temper tantrums/outbursts	0.667	1	2.5
Irritable and whiny	0.667	1	0.5
Yells at inappropriate times	0.333	1	1
Depressed mood	0	0	0.5
Demands must be met immediately	0.333	2	1.5
Cries over minor annoyances or hurts	0.667	2	1.5

Mood changes quickly	0.333	2	1
Cries and screams inappropriately	0	0	2
Stamps feet or bangs objects or slams doors	0	0	2
Deliberately hurts himself/herself	0	0	2.5
Does physical violence to self	0	0	2
Has temper outburst or tantrums when he/she does not get own way	0.667	2	2.5
Lethargy, Social Withdrawal			
Listless, sluggish, inactive	0	0	0.5
Seeks isolation from others	1	3	2
Preoccupied, stares into space	1	1	1
Withdrawn; prefers solitary activities	0.667	3	1.5
Fixed facial expression; lacks emotional responsiveness	0.333	0	0.5
Does nothing but sit and watch others	0	1	0.5
Resists any form of physical contact	0	0	1

Isolates himself/herself from other children or adults	0.667	2	2
Sits or stands in one position for a long time	0	2	0
Unresponsive to structured activities (does not react)	0	1	1
Is difficult to reach, contact, or get through to	0.333	1	1.5
Prefers to be alone	0.667	3	2
Does not try to communicate by words or gestures	0.333	1	0
Inactive, never moves spontaneously	0	0	0
Responds negatively to affection	0.667	1	1.5
Shows few social reactions to others	1	1	1.5
Stereotypic Behavior			
Meaningless, recurring body movements	0.333	3	0.5
Stereotyped behavior; abnormal repetitive movements	0.667	3	1.5
Odd, bizarre in behavior	0	2	1

Moves or rolls head back and forth repetitively	0	0	0
Repetitive hand, body, or head movements	0	2	0.5
Waves or shakes the extremities repeatedly	0	0	0.5
Rocks body back and forth repeatedly	0	0	0.5
Hyperactivity, Noncompliance			
Excessively active at home, school, work, or elsewhere	0.333	2	1
Boisterous (inappropriately noisy and rough)	0.667	2	1.5
Impulsive (acts without thinking)	0.667	1	1.5
Restless, unable to sit still	1	2	1.5
Disobedient; difficult to control	0.333	1	1
Disturbs others	0.667	2	2
Uncooperative	0.333	1	1
Does not pay attention to instructions	0.667	2	1.5
Disrupts group activities	0.667	1	1
Does not stay in seat (e.g., during lesson or training periods, meals, etc.)	0.333	2	1.5

Will not sit still for any length of time	0.333	2	1
Easily distractible	1	3	1.5
Constantly runs or jumps around the room	0	2	2.5
Pays no attention when spoken to	0.333	2	1
Tends to be excessively active	0.667	2	1.5
Deliberately ignores directions	0.667	2	1.5
Inappropriate Speech			
Talks excessively	0	1	0.5
Repetitive speech	0.667	3	1
Talks to self loudly	0	2	0
Repeats a word or phase over and over	0.667	3	1
Irritability Sum	4.667	12	23.5
Lethargy, Social Withdrawal Sum	6.667	20	16.5
Stereotypic Behavior Sum	1	10	4.5
Hyperactivity, Noncompliance Sum	8.667	29	22.5
Inappropriate Speech Sum	1.334	9	2.5
Overall Behavioral Sum	22.335	80	69.5

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