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Philadelphia College of Osteopathic Medicine

School of Professional and Applied Psychology

SLEEP, COMMUNICATIVE ABILITY, AND DIET AS PREDICTORS OF AGGRESSION IN AUTISM SPECTRUM DISORDER

Rafat Omar

Submitted in Partial Fulfillment of the Requirements for the Degree of

Doctor of Psychology

June 2019

DISSERTATION APPROVAL

This is to certify that the thesis presented to us by Rafat Omar

on the 21 day of May, 2019, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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Abstract

Aggression is a common behavioral issue in children with autism spectrum disorder (ASD). Aggression is often treated with evidence-based behavioral treatments, such as applied behavioral analysis and functional communication training. Another form of intervention that has grown in popularity is to alter the child's diet. The most popular dietary intervention, the autism diet, has been used as a form of behavior management by parents and guardians for children diagnosed with ASD to address aggressive behavior; however, its use has not been strongly supported by research. The authors proposed that a more beneficial way of understanding aggression in ASD is to understand aggression through the lens of the frustration-aggression hypothesis. According to the frustration-aggression hypothesis, aggressive acts can stem from aggression-activating affect caused by such factors as physical pain, irritation, and psychological discomfort. It is proposed that children with ASD turn to aggressive behavior when experiencing these irritants as a result of the communicative challenges they face as a part of ASD. This study examined the use of the autism diet, sleep disturbance, and communicative ability as predictors of aggression in children diagnosed with ASD. Use of the diet and lower communicative ability were significantly and positively correlated with aggressive episodes, while sleep disturbance was not. These findings did not find support for use of the autism diet in reducing aggression; however, they should be interpreted with caution because of the retrospective nature of the data.

Table of Contents

List of Tables

INTRODUCTION

Statement of the Problem

Children with autism spectrum disorder (ASD) present with a variety of challenging behaviors. One of the most common behavioral challenges caregivers face is aggression (Davis, Dominick, Lainhart, Tager-Flusberg, & Folstein 2007; De Giacomo et al., 2016). Despite the prevalence of aggression within this population, research on the causes of aggression in children with ASD has been limited (Kanne, Mazurek, & Wodka, 2013). A number of factors that have previously been associated with higher rates of aggression in the general population, such as gender, have not been found to be significant predictors of aggression in children with ASD (Aman & Farmer, 2011; Hill et al., 2014; Kanne et al., 2013). Some factors believed to contribute to aggression in children with ASD which have been studied include impaired communicative ability, sleep disturbances, and gastrointestinal (GI) issues (Berkowitz, 1989; De Giacomo et al., 2016; Mazefsky, Schreiber, Olino, & Minshew, 2014). Delayed language development and difficulties with emotional regulation and impulse control in children with ASD may explain why predictors of aggression differ from predictors for neurotypical children (Kanne & Mazurek, 2011).

ASD has no cure, often resulting in parents attempting a number of interventions to reduce problematic behaviors, including aggression. While applied behavioral analysis and other behavioral-intervention methods are effortful and have empirical support, they are not perfect, leading caregivers to attempt other interventions that often have little or ambiguous empirical support. One method of intervention that has become popular is to alter the child's diet. The most widely used method of dietary intervention is the gluten-

free, casein-free diet, also known as the *autism diet* (Winburn et al., 2014). Gluten refers to a group of proteins found in wheat that help foods maintain their shape (What is gluten?, n.d.). Symptoms that individuals with gluten intolerance may experience include abdominal pain, headaches, irritability, and heartburn. In theory, this intervention would accomplish the following: (a) eliminate gluten and casein intake, thereby reducing or eliminating the symptoms associated with gluten intolerance, and (b) reduce aggressive behavior by preventing peptides from crossing the blood-brain barrier, which is believed to produce changes in brain functioning, leading to aggressive behavior (Amidon, 1994; Catassi et al., 2013). However, in reality, specialized diets can be difficult to implement and produce limited results (Sathe, Andrews, McPheeters, & Warren, 2017; Mari-Bauset, Zazpe, Mari-Sanchis, Llopis-Gonzalez, & Morales-Suarez-Varela, 2014; Winburn et al., 2014).

The researchers purpose an alternative perspective for a more fruitful inquiry into understanding aggression in ASD through the frustration-aggression hypothesis. The frustration-aggression hypothesis may be more helpful than traditional models of aggression in understanding aggression in children with ASD, as traditional models often include factors that do not apply to individuals with ASD because of the cognitive and communicative deficits associated with ASD. The frustration-aggression hypothesis may also provide a framework to help understand why some reductions in aggressive behavior have been observed in studies using the autism diet.

The authors contend that as opposed to aggression directly resulting from diet-induced neurotransmitter activity, aggression could be caused by irritants. Thus, elevated GI issues in ASD may be related to aggression because of their impact as a distressor.

Children with ASD may experience GI difficulties, but as a result of difficulties in communicative ability, they may express their distress through aggressive actions. This line of reasoning is supported by studies of functional communication training (FCT) that find that communicative ability can decrease aggression (e.g., Brown et al., 2000; Falcomata, Roane, Feeney, & Stephenson, 2010; Mancil, 2006; Wong et al., 2015). Given the relationship between GI issues and sleep disturbance, as well as sleep disturbance and aggression, sleep disturbances may be an important factor to consider in addition to diet and communicative ability.

This study explored the possible link between diet and aggressive behavior. Specifically, this study examined the role that diet plays in predicting aggressive behavior in children who have been diagnosed with ASD. Further, this study investigated whether several variables (i.e., dietary intervention, sleep disturbances, and communicative ability) predicted aggressive behavior in children with ASD. The study hypothesized that sleep disturbances and children's abilities to communicate their needs are better predictors of aggression than is use of the autism diet. To lay the groundwork for this study, a discussion of ASD characteristics and history is followed by discussions of aggression, dietary intervention, GI issues, and sleep disturbances.

Literature Review

Autism Spectrum Disorder (ASD)

Prevalence. According to the Centers for Disease Control and Prevention (CDC; 2018), 1 in 59 children has been identified as having ASD, which occurs across all racial, ethnic, and socioeconomic groups. ASD occurs in 1 in 37 boys compared to 1 in 151 girls

(CDC, 2018). The CDC has estimated that roughly 1% of the world's population has ASD (CDC, 2018).

One of the major changes that the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5;* American Psychiatric Association, 2013) made to the diagnoses of ASD is the removal of Pervasive Developmental Disorder (PDD) and Asperger's diagnoses, which have been replaced with the umbrella term *Autism Spectrum Disorder.* The removal of Asperger's syndrome was met with resistance from individuals who had been diagnosed with it because of such factors as the potential stigma associated with ASD and concern that access to medical and social services may be lost if the individual lost his or her diagnosis (Wing, Gould, & Gillberg, 2011). Defining the boundaries of any subgroup can be difficult, especially given the variety of presentations of ASD. Part of the difficulty with these subgroups is that many individuals have a mix of features across all of the subgroups, making their accurate placement difficult (Wing et al., 2011). Individuals formerly diagnosed with Asperger's syndrome continue to struggle with the loss of the label. A contingent of individuals and families remain dissatisfied with the change and hope to see the diagnosis return in the next iteration of the *DSM* (Barahona-Corrêa & Filipe, 2015).

Key features. The core components of ASD include stereotyped and repetitive behaviors, communication difficulties, and social-skill deficits. ASD is known for the social and communicative deficits; however, these deficits can also be seen in other disorders. In order to make the correct diagnosis of ASD, one must understand what sets ASD apart from other disorders that cause social and communicative issues, such as language disorder and social communication disorder (American Psychiatric Association,

2013). The characteristics that differentiate ASD from other developmental disorders are the presence of rigid, stereotyped behaviors; strict adherence to routine or insistence on sameness; and unusual interests, such as an obsessive interest in a particular type of machinery or obscure activity. One should note that the stereotyped behaviors must be present at the time of diagnosis in order to qualify because symptoms change as an individual ages (American Psychiatric Association, 2013).

One challenge that parents typically face is the rigid thinking and insistence on sameness of their children with ASD. This often appears in the form of a restricted diet. Children with ASD tend to be very selective about the foods they are willing to eat, in extreme cases as few as five foods (Cermak, Curtin, & Bandini, 2010). This level of food restriction raises concerns about the nutritional adequacy of their diets. A review of relevant literature on nutritional adequacy and food selectivity in children with ASD revealed a number of sensory-related causes for the selectiveness of the children's diets, including adverse reactions to textures, smells, colors, and temperatures (Cermak et al., 2010).

Etiology. The root cause of ASD has been debated since the inception of the diagnosis. Researchers have not been able to ascertain a definitive answer regarding the cause of the disorder. A number of theories have arisen throughout the years, ranging from parenting to genetics to vaccinations. Researchers continue to develop and test new theories in hopes of unlocking the mystery surrounding the origins of ASD. The most popular theories regarding the etiology of ASD are the idea that ASD is rooted in biology and the theory that ASD is caused by vaccinations.

***Genetic theory*.** While the etiology of ASD has not been agreed upon, the consensus among researchers is that some combination of genetic and environmental causal factors is at play (Autism Spectrum Disorder fact sheet, 2018). Some genes have been identified as possibly contributing to the development of ASD; however, research on those genes is in the preliminary stage, with no definitive results found to date (Autism Spectrum Disorder fact sheet, 2018). Recent literature suggests that advanced maternal age may be a predictor of ASD (Autism Spectrum Disorder fact sheet, 2018).

Theory related to mitochondria. Naviaux et al. (2013) conducted a study on a mouse model of ASD. This study revealed a possible method of reversing signs of ASD. This study examined mitochondria and the abnormal functioning of warning signals within them. The warning signals in the subject mouse were blocked through the use of suramin, a substance known to suppress particular neurological processes (Naviaux et al., 2013). When the signals were blocked, autistic symptoms decreased in the mouse, and social preference increased. The findings of this study were preliminary, and the researchers cautioned that these results did not guarantee any success in treating humans; however, this research has generated another viable theory regarding the etiology of ASD.

A number of large studies have found evidence to suggest the existence of inherited risk factors for ASD (Buxbaum et al., 2012). Specifically, advanced paternal age has been identified as one factor associated with genetic inheritance in ASD (Goh et al., 2014). A recent study suggested that DNA methylation, which involves methyl groups being added to DNA, in paternal sperm may lead to increased risk of ASD (Feinberg et al., 2015). Semen samples were collected from 44 fathers who were part of a

cohort of families who had a child diagnosed with ASD. The cohort was known as the Early Autism Risk Longitudinal Investigation (EARLI; Feinberg et al., 2015). The methylation rates were compared with reports from other studies. The researchers found that methylation rates were substantially higher in their cohort when compared to the rates in other reports. While this study was limited by small sample size, it did suggest a possible risk factor for ASD.

Environmental factors. One recent theory regarding the causes of ASD focuses on the impact of pathogens, such as exposure to lead, ethyl alcohol, and mercury (Landrigan, 2010). It is believed that children are exposed to as many as 3,000 synthetic chemicals per year and that exposure to these synthetic chemicals contributes to the development of ASD (Landrigan, 2010). Recent literature has also suggested that exposure to thalidomide, misoprostol, and valproate and rubella infection during pregnancy may play a role in the development of ASD (Landrigan, Lambertini, & Binbaum, 2012). Of all of the environmental factors implicated as causes of ASD, valproate has had the most empirical support (Bromley et al., 2013; Roullet, Lai & Foster, 2013).

Valproate has a variety of uses, including as an anticonvulsant and mood stabilizer (Roullet, Lai & Foster, 2013). When taken during pregnancy, valproate can cause a condition known as *fetal valproate syndrome* by crossing the placenta, possibly causing a variety of physical and neurodevelopmental difficulties in the child (Roullet, Lai & Foster, 2013). In their 2013 study, Bromley et al. compared the prevalence of neurodevelopmental disorders in children who were exposed to antiepileptic drugs in a cohort of 415 children from birth to 6 years old. Children exposed to valproate displayed

a higher risk of being diagnosed with a neurodevelopmental disorder when compared to a control group. ASD was the most common diagnosis. Research regarding potential brain injury caused by exposure to neurotoxins during pregnancy and in early childhood is ongoing, and the implication of more chemicals in the development of ASD and other neurodevelopmental disorders is anticipated (Grandjean & Landrigan, 2014; Roullet, Lai & Foster, 2013).

Vaccination theory. While the idea that vaccines cause ASD is not tied to any biological theory, any discussion of the etiology of ASD requires acknowledgment of this theory because of its impact on the population. The antivaccine movement made famous by actress Jenny McCarthy has been the most prolific development in the claim that environmental factors cause ASD. The antivaccine movement is an important part of the past, present, and future of ASD. The vaccination theory stems from a study published in *The Lancet* conducted by Andrew Wakefield in 1998 in which he claimed that the measles mumps rubella (MMR) vaccine caused ASD based upon the observation of 12 children who developed behavioral symptoms of PDD after receiving the MMR vaccine (Wakefield et al., 1998).

The vaccination theory has been thoroughly refuted by new research on the subject. A meta-analysis was conducted in 2014 that included five cohort studies with a total of 1,256,407 participants and five case control studies involving 9,920 children (Taylor, Swerdfeger, & Eslick, 2014). This meta-analysis concluded that no connection exists between vaccines and ASD or between the components of the MMR vaccine and the development of ASD. The case-control studies found no increased risk of developing

ASD from exposure to thermisol or mercury, which are commonly found in vaccines (Taylor et al., 2014).

Parents in the United States continue to express concern over vaccinating their children despite the fact that the original study by Andrew Wakefield was found to have several conflicts of interest. The discovery of these conflicts led to the revocation of his medical license in the United Kingdom (Ziv, 2015). This debate has been gaining attention as public concern for the safety of children grows.

One result of the concern over vaccinating children has been the resurgence of previously eradicated diseases. One recent example was the 2015 measles outbreak in California. The return of such diseases as measles has been directly linked to fears that parents have regarding the potential link between vaccines and ASD, making educating the public about research on the subject vital (Taylor et al., 2014). The fallout from the measles outbreak is ongoing as the debate about whether or not to pass legislation requiring vaccinations has intensified in recent months, with California considering a bill to eliminate personal-belief exemptions for vaccinations (Medina, 2015). Beliefs about environmental factors causing ASD that are not supported by research can be dangerous. The widespread availability of misinformation can lead to parents attempting their own often harmful interventions. Refusal to vaccinate children against deadly diseases is one of the more serious examples of the impact of misinformation.

Gastrointestinal Issues and ASD

GI issues are common in ASD. Children with ASD are three times as likely to have GI issues in general and seven times more likely to have GI inflammation than the general population (Robson, 2013). One of the main causes of GI inflammation in

children with ASD is dietary allergy (Robson, 2013). It has been posited that avoiding dietary allergies while strengthening the GI system with probiotics reduces pain and discomfort, thereby reducing frustration and consequent aggressive behaviors (Hsiao 2014). While this connection would further support the belief that links exist between diet and the behavior of children with ASD, it still does not directly address the idea of gluten specifically as a cause of aggressive behavior.

Recent research conducted by the University of Missouri-Columbia (2017) suggests that some children with ASD suffer from GI issues caused by an increased reaction to stress. Increased stress reactions can have an impact on a child's social and emotional functioning. Sensory overreactivity and symptoms of anxiety appear to be linked (Mazurek et al., 2013). This sensory overreactivity is especially relevant to the ASD population because sensitivity to sensory stimuli is a core component of ASD. Also, children with higher rates of intestinal and abdominal pain present higher levels of anxiety when compared with the general population (Mazurek et al., 2013).

Dietary concerns and immune abnormalities have been shown to exacerbate the core symptoms of ASD (Hsiao, 2014). The gut-brain connection helps to explain the impact of GI issues on ASD symptoms. The brain and stomach communicate through the gut-brain axis bilaterally to regulate functional processes, creating a direct-line connection (Hsiao, 2014). This pathway also helps to explain the potential effectiveness of interventions that target GI issues in the treatment of ASD.

The idea that GI issues exacerbate the symptoms of ASD suggests that providing relief of GI symptoms can be used to enhance treatment outcomes. Preliminary research on fecal transplants in children with ASD have produced promising results (Del Rosario,

2017). The process involves inserting microbiobes from healthy donors into the GI tract of the recipient. Introducing the healthy sample helps to replenish the probiotics that have been suppressed or killed by overuse of antibiotics (Del Rosario, 2017). In a study of 18 children, participants displayed improvements in stomach health and overall behavior for as long as 8 weeks after fecal transplant treatment, according to parental reports. These uncontrolled findings provide some support for the idea that behavioral improvement in children with ASD can be obtained by identifying and alleviating their physical ailments.

A child who is experiencing GI conditions but is unable to effectively communicate that suffering is likely to become frustrated. Such frustration is often expressed through aggressive behaviors (e.g., punching, pinching, and shaking others), suggesting that the communication difficulties associated with ASD interacting with inflammation may result in aggression.

Sleep Difficulties and GI issues

While sleep issues are not a core feature of ASD, they are common among children with the diagnosis (Klukowski, Lebensztein, & Wasilewska, 2014; Mazurek & Petroski, 2015). Approximately 40 to 80% of children with ASD have sleep disturbances compared to 25 to 40% of children in the general population (Delahaye et al., 2014). Common sleep issues that impact children with ASD include increased bedtime resistance, insomnia, parasomnia, sleep-disordered breathing, morning rise problems, and daytime sleepiness (Klukowski et al., 2014; Mazurek & Petroski, 2015). The details of the relationship are not fully understood; however, the researchers believed that several factors, including such sensory issues as sensitivity to temperature and sounds and GI problems, play a role (Mazurek & Petroski, 2015). While the link between sleep issues

and GI problems has not been studied thoroughly, this relationship has some empirical support. Vomiting, acid reflux, chronic diarrhea or constipation, intestinal bloating, and abdominal pain have been associated with causing sleep disturbances in children with ASD (Adam, Fabes, Hubbard, & Liu, 2006; Klukowski et al., 2014).

Communicative Issues and ASD

Communication impairment is a part of the diagnostic criteria for ASD. However, the presentation of these impairments varies from child to child. A variety of profiles exist among children who develop language ability. One of the most common communicative problems in ASD is echolalia, which is the tendency to repeat words that the child has heard (Autism Spectrum Disorder: Communication Problems in Children, 2018). Echolalia can occur immediately after the child hears the words or after a delay. In some instances, the child can answer a question by repeating the question, making determining the child's wants or needs difficult (Autism Spectrum Disorder: Communication Problems in Children, 2018).

Recent literature has found that within the ASD population are children with language skills that are close to those of same-aged peers who do not have ASD (Tek, Mesite, Fein, & Naigles, 2014). Higher functioning children may exhibit only mild impairments, such as difficulty answering who, what, where, and why questions, while others may not develop language at all (Lord et al., 2000; Tek et al., 2014). For children who develop language abilities, expressive language appears to be the strongest predictor of future language development in children beyond preschool years (Lord et al., 2000). Expressive language may be the strongest predictor due to the fact that it impacts most forms of social communication. Expressive language dictates a child's ability to express

wants and needs, impact play, and convey meaning to others, making expressive language imperative to the development of social-communication ability (Speech-Language Definitions, 2017).

Aggression and ASD

Aggression is defined in a number of ways because of the variability in its presentation; however, the term is typically defined as a behavior, physical or verbal, that is threatening or likely to cause harm (Fitzpatrick, Srivorakiat, Wink, Pedapati, & Erickson, 2016). Verbal aggression generally includes shouting, cursing, and threatening to hit others. Common acts of physical aggression in children include biting, punching, kicking, shoving, and throwing objects (Fitzpatrick et al., 2016). Physical aggression appears to be particularly problematic within the ASD population (Card & Little, 2006; Zahn-Waxler, Park, Essex, Slattery, & Cole, 2005; Kanne, Mazurek, & Wodka, 2013). The disparity between physical and verbal aggression is believed to be the result of a number of factors, including lower verbal IQ, social and communicative deficits, and severity of ASD symptoms (Domenick et al., 2007; Jang, Dixon, Tarbox, & Granpeesheh, 2011; Kane & Mazurek, 2011)

While aggression does occur within the general population, it is much more common in children with ASD. Kanne and Mazurek (2011) reported that 68% of parents reported that their children with ASD displayed physically aggressive behavior compared to 52% of children without an ASD diagnosis (Alink et al., 2006). Physical aggression has been shown to decrease in children in the general population around age 3 years; it is believed that it is replaced by verbal forms of aggression as the child's verbal ability improves (Alink et al., 2006). Reductions in aggression with age do not always occur in

children with ASD. In Kanne and Mazurek's 2011 study, children with ASD between the ages of 6 and 8 years were found to have higher rates of aggression than younger children in the study. Communicative and developmental delays in children with ASD may help to explain why these reductions are not commonly seen within that population.

Aggression has been identified as one of the most common behavioral problems found in children with ASD (Davis et al., 2007; De Giacomo et al., 2016). The same link was not found with other disabilities that impact a child's development and cognitive functioning (Davis et al., 2007). Studies that have included ASD and intellectual disabilities have shown that ASD cooccurring with intellectual disabilities is a risk factor for aggression (Farmer et al., 2015). Children with ASD have also been associated with greater risk of behavioral, emotional, and conduct problems when compared to children with intellectual disabilities (Farmer et al., 2015; Totsika, Hastings, Emerson, Lancaster, & Berridge, 2011). These data suggest that ASD's core symptoms contribute to the prevalence of aggression, highlighting the need for continued research to further clarify the mechanisms underlying this link.

Applying traditional models of aggression to children with ASD is often unhelpful because of the communicative and developmental impairment common to ASD. For example, the general aggression model (GAM) states that aggression is influenced by one of two classes of input variable: situational and individual (Anderson & Bushman, 2002). Individual variables include attitudes toward the use of aggression, impulsivity, and personalizing behavior (Anderson & Bushman, 2002). Situational variables include a variety of social cues, such as insults, provocations, and the appearance of frustration (Anderson & Bushman, 2002).

Some of the individual factors listed in the GAM do fit well with ASD. For example, children with ASD are often impulsive and have an underdeveloped understanding of the impact that aggressive behavior has on others because of delays in their development of understanding cause and effect, making the impulsivity and attitudes toward the use of aggression factors relevant to the ASD population (Steijn, et al., 2012). While some of the individual factors of the GAM may be applicable to the ASD population, the situational-variables piece may not. Many children with ASD struggle to identify and understand social cues. Additionally, individuals with ASD often cannot correctly identify emotions or nonverbal cues that others are displaying and often are unaware that others are teasing or insulting them; thus, explaining any aggressive behavior by a situational variable is unlikely in most cases (Zeedyk, Rodriguez, Tipton, Baker, & Blacher, 2014). The inability to fully apply the GAM to ASD underscores the need for a more fruitful way of viewing aggression within the ASD population.

A more helpful theory to explain aggressive behavior in children with ASD is the frustration-aggression hypothesis. This hypothesis states that such factors as physical pain and discomfort and psychological discomfort, which can include GI discomfort and impaired function resulting from sleep disruption, both commonly found in ASD, create aggression-activating affect and ultimately instigate aggression (Berkowitz, 1989; Conrad, Kahn-Greene, Kamimori, Killgore, & Lipizzi, 2006). This framework may be a more helpful way of understanding aggression in children with ASD, as it does not include cognitive components that are limited by the difficulties faced by children with ASD.

Young children with ASD often display frequent maladaptive behaviors when faced with negative feelings or internal states (Boulter, Freeston, South, & Rogers, 2014; Hartley, Sikora, & McCoy, 2008). In their 2008 study, Hartley et al. investigated the prevalence and risk factors of maladaptive behavior in young children with ASD. Risk factors that were examined included gender, low expressive-language ability, and anxious mood. Of 169 children between the ages of 1 and 6 years, one third exhibited clinically significant levels of maladaptive behavior. Low expressive-language ability was found to be the biggest predictor of aggressive behavior. These findings are in line with studies on the effectiveness of FCT, which found that improving language and communicative ability helped to decrease aggression (e.g., Brown et al., 2000 Falcomata et al., 2010; Mancil, 2006; Wong et al., 2015).

Children with ASD often contend with a range of cooccurring issues that influence the rate of their aggressive behaviors. GI issues, sleep abnormality, and sensory-processing issues have all been implicated in increasing rates of aggression (Kanne et al., 2013). Previous studies have found a connection between emotional dysregulation and social competency, particularly in expressive and receptive language in both children and adults with ASD (Samson, Huber, & Gross, 2012; Hutchins & Prelock, 2014). One potential explanation for this prevalence is that the aggression is a maladaptive response resulting from a lack of ability to regulate emotions in response to negative feelings. Related to difficulty with effectively regulating one's emotions may be the ability to effectively communicate wants and needs (Geller, 2005; Hutchins & Prelock, 2014; Samson, Hardan, Lee, Phillips, & Gross, 2015). In their 2015 study, Samson et al. examined emotional dysregulation and the core symptoms of ASD. This

study included 31 individuals with ASD and 28 typically developing individuals between the ages of 8 and 20 years. Participants and their parents were asked to complete questionnaires that assessed for cognitive coping skills and emotional-regulation ability. Compared to their typically developing peers, the children with ASD used adaptive coping skills less consistently, a characteristic associated with negative emotional experience and increased dysregulation.

Aggression can be caused by a number of factors. The triggers of aggression in children with ASD often impact and influence one another, at times causing significant distress and making the identification of triggers difficult. The multifactorial nature of aggression can confuse and frustrate parents, leading them to desperation. In their desperation for a way to reduce the disruptive behavior, parents may turn to unproven methods, such as dietary intervention.

Dietary Interventions

One of the earliest and most widely cited theories for use of dietary intervention arose from concerns about the release of peptides and opioid activity in the intestines and increased intestinal permeability in individuals with ASD, known as the *leaky gut theory* (Amidon & Lee, 1994). The theory states that incomplete breakdown of foods that contain gluten and casein causes an excess of opioid peptides in the stomach. These peptides are able to cross the intestinal membrane, enter the bloodstream, and cross the blood-brain barrier, thereby impacting neurotransmitters in the nervous system and thus altering behavior (Catassi et al., 2013). Various GI problems, including diarrhea, celiac disease, irritable bowel syndrome, and milk protein allergy, are associated with increased intestinal permeability (Navarro et al., 2015). Literature on this theory has been

inconclusive, contributing to the ongoing uncertainty regarding the effectiveness of the autism diet (De Magistris et al., 2010).

In an effort to test the leaky gut hypothesis, De Magistris et al. (2010) sought to compare the intestinal barriers of children with ASD and of their first-degree relatives with those of neurotypical families. Their study included 90 children with ASD and 146 first-degree relatives, as well as 60 neurotypical children and 146 adult relatives. The researchers found that 36.7% of children with ASD and 21.2% of their relatives had higher-than-average intestinal permeability, compared to 4.8% in the other families. These findings may offer some support to the leaky gut theory in ASD; however, they may really indicate that the higher impermeability rate may be a result of genetics within the family. These findings underscore the need for continued inquiry into the gut-brain connection in ASD and the leaky gut hypothesis.

The autism diet has been reported to reduce aggressive behaviors based on anecdotal evidence from caregivers (Cormier & Elder, 2007). However, few controlled studies have examined the effectiveness of dietary changes as an intervention for ASD. Research on the subject has been mixed and has neither firmly supported nor refuted the claim that the diet has any impact on behaviors associated with the core deficits of ASD, including hyperactivity, aggression, anxiety, and depression (Marti, 2014).

Child health professionals are reluctant to recommend these interventions because of the lack of empirical support for their efficacy (Winburn et al., 2014). A review of recent literature determined that the evidence for use of the autism diet is limited and weak, highlighting the need for continued research of dietary interventions as a means of improving behavior (e.g., Sathe et al., 2017; Mari-Bauset et al., 2014). Despite the lack of

support, caregivers are implementing this dietary intervention, thus highlighting the need for continued research in order to ensure that children are receiving safe and effective treatment. Recent literature estimates that 1 in every 5 preschool children with ASD has used a dietary intervention (Bradley et al., 2018). For the purposes of this review, the authors summarized the available literature regarding the effectiveness of dietary and other natural interventions in humans and animal models.

The reliance on routine and repetition that often accompanies ASD can be frustrating and discouraging for caregivers. Changes to a diet can be very disruptive to a child with ASD, particularly if a child's diet is already limited by their food preferences. Perhaps the most popular form of dietary intervention is the autism diet. This diet consists of removing all food items that contain gluten and/or casein (a slow-acting whey protein typically found in milk) from an individual's diet (Elder et al., 2006). Elder et al. (2006) studied the impact of the autism diet on verbal and nonverbal communication and social skills in a group of 15 children with ASD aged between 2 and 16 years. Caregivers reported some improvements; however, the researchers reported that the findings in this study were not statistically significant.

Whiteley et al. (2010) suggested that dietary intervention may positively impact developmental outcomes for some children with ASD. In a study of 72 children aged 4 to 10 years, the researchers randomly assigned children to a diet intervention group in which they used the autism diet and a group that received no intervention. Nutritionists oversaw the participants' diets to ensure adherence to the diet and were aware of which children were in the diet group while all other members of the study group were blinded, including the assessors. Participants were tested at baseline, 8 months, and 12 months using the

Autism Diagnostic Observation Schedule (ADOS) and Gilliam Autism Rating Scale (GARS). Upon retest, significant improvements in both the ADOS and GARS scores were found within the diet group, suggesting that the use of the diet can have a positive impact on children's behaviors. One limitation of this study was that the researchers did not control for intervention outside of the diet and were therefore unable to disqualify impact that any other interventions being implemented may have had. Other interventions might need to be implemented in conjunction with the diet because of the difficulty that children with ASD have when faced with changes to their expected routine.

In a noncontrolled study conducted by Winburn et al. (2014), parents reported "significant improvements" when their children took part in the autism diet. Specifically, the parents reported seeing these improvements in a number of symptoms, including concentration and attention, communication, and social interactions. While this study showed promising results, it was not without limitations. The lack of a control condition prevented the researchers from ruling out the influence of factors other than dietary interventions. The ability to rule out outside influences is imperative to identifying the potential effectiveness of dietary interventions. Ruling out these influences is especially important because the researchers did not exclude children who were receiving other types of treatment during the testing period.

Robson (2013) examined the effectiveness of natural approaches to treating ASD by conducting a review of literature on naturopathic remedies used in treating children with ASD. One pattern found in the literature was a vitamin/mineral deficiency resulting from a limited diet. Another significant theme that emerged from this research was the impact of GI issues on children's behavior. Children with more GI issues (i.e., abdominal

pain, chronic diarrhea, and/or constipation) displayed more undesirable behaviors than their peers (Robson, 2013). The acknowledgement of these issues has helped to provide increased understanding of the relationship between physical discomfort and behavior. The impact that food has on the relationship between GI pain and behavior should be examined further to enhance the research between dietary intervention and aggression.

Ruskin et al. (2013) studied the impact of the ketogenic diet on mice. The ketogenic diet is a high-fat, low-carbohydrate diet that has been used to treat epilepsy (Ruskin et al., 2013). This particular diet was chosen because of the high comorbidity of seizures with ASD and the diet's success in reducing seizures in individuals with epilepsy. The mice in this study were a strain of mouse that has been found to display the core deficits of ASD that are found in humans: repetitive behaviors, poor socialization, and reduced communications. After being on the ketogenic diet for 3 to 5 weeks, the mice showed improvements in all three core deficits of ASD. The subjects spent less time engaging in repetitive behaviors, spent more time in contact with other mice, and showed an increase in social behaviors when given the opportunity. This study provided support for the idea that diet can have an impact on the behaviors associated with ASD. Given the potential of the ketogenic diet in improving the lives of those with ASD, further research should be conducted to study the viability of this intervention in humans (Ruskin et al., 2013).

A recent study by Lee et al. (2018) suggested that a modified version of the autism diet with elements of the ketogenic diet can help to alleviate the core symptoms of ASD. In an open-label clinical trial, 15 participants between 2 and 17 years of age displayed improvements of up to 30% in their ADOS and Childhood Autism Rating

Scales (CARS-2) scores after a 3-month trial on the diet. Participants were tested at baseline and then retested using both instruments after 3 months. Improvements were found in the participants' overall ADOS-2 scores. Overall ADOS-2 scores improved by an average of 20.7%, while social-affect scores improved by an average of 19.9%. CARS-2 scores related to social functioning (i.e., relating to others, fear, and imitation) were also improved when retested. These findings show promise that a dietary intervention could be effective; however, one should note that the small sample size and lack of a control group were limitations of the study. Also worth noting is that, on average, placebo conditions produce a 25% effect, which could account for most of the improvement seen in this study (Howick et al., 2013).

Adams et al. (2018) conducted a study on nutritional and dietary intervention in 67 individuals with ASD between 3 and 58 years of age. Participants with ASD were randomly assigned to treatment and nontreatment groups. The treatment group completed the nutritional and dietary intervention while those in the nontreatment group were asked not to make any significant changes to their current treatment regimen. The nutritional and dietary design group were placed on the autism diet and given a vitamin and mineral supplement regimen that included essential fatty acids, Epsom salt baths, carnitine supplements, and digestive enzyme supplements. The vitamin and mineral supplements were staggered, with the dietary intervention beginning after all vitamin and mineral supplements were put into place. This study was a single-blind design in which the researchers were blind to which group the participants were in, but the participants were not. This 12-month trial included the restriction of gluten, casein, and soy from the participants' diets while also providing vitamin and mineral supplements.

The treatment group displayed significant increases in nonverbal IQ, a reduction of core symptoms of ASD, and advancement of developmental age when compared to the control group. The largest gains were found in measures of interpersonal relationships and social skills, with participants showing a 22% average increase in scores on CARS-2 items in the treatment group compared to 14% improvement in the nontreatment group and a 59% average increase on the Vineland interpersonal relationship subscale compared to only a 2% increase in the nontreatment group. The outcomes found in this trial suggest that with further refinement and expansion, dietary interventions may improve the lives of individuals with ASD; however, a number of vitamin supplements were also used as an intervention, making unclear the intervention to which the improvements responded. One should note that the researchers were not blind to the group assignments, thus creating the potential for biased results.

Despite these few studies with encouraging findings, a literature review conducted by Mahmoud, Al Saadi, and Matthews (2018) indicated a lack of studies on the effectiveness of dietary intervention. The authors conducted a search for literature on dietary intervention and ASD and found 55 items with varying results. The studies published included few randomized control designs and several studies of parental reports on the effectiveness of the diet; however, the Adams et al. (2018) randomized control study was not a part of this review. Mahmoud et al. (2018) concluded that the empirical evidence was insufficient to make any determination about the effectiveness of dietary interventions. Additionally, the reviewers identified a need for large, randomized, well-controlled trials that include clinical measures to quantify the reductions of symptoms. They also suggested that measures be created to assess the restrictiveness of

the diet in order to fully inform caregivers of potential challenges they may face in implementing the diet. These findings were consistent with prior reviews of the literature, highlighting the need for continued research in order to fully understand the potential benefits and drawbacks of dietary intervention.

Parents of children with ASD tend to have beliefs about alternative treatments for their children of which health professionals may not be aware (Harrington, Rosen, Garnecho, & Patrick, 2006). Information and connection to others are easily accessible through the Internet, leading many parents of children with ASD to consult with each other. The danger of this level of connectivity and ease of access is the distribution of unproven ideas that are misrepresented as evidence based. These potentially harmful ideas make the education of psychologists and parents about empirically supported treatment methods vital.

Winburn et al. (2014) surveyed parents of children with ASD and child health professionals about their attitudes toward dietary interventions. The authors specifically inquired about a gluten- and casein-free diet because of its popularity. Parents reported that their children displayed fewer aggressive behaviors and improved mood overall when gluten and casein were removed from their diets (Winburn et al., 2014). Of note, in previous studies the diet received high efficacy ratings among parents in self-report measures but showed little success in modifying behavior when any other measure was used to collect data (Cass et al., 2008; Goin-Kochel, Mackintosh, & Myers, 2009). A number of factors can influence the behavior of a child with ASD, thus making difficult a determination of the cause of the disparity between parental reports and other measures.

The self-report could be inaccurate; however, the presence of an observer may have also altered the children's behaviors.

In contrast to parents, the majority of the professionals surveyed by Winburn et al. (2014) stated that they did not believe evidence was sufficient to make a determination that the autism diet is effective. Nineteen percent of professionals responded by stating that they would advise against the autism diet, suggesting that no medical evidence supports the idea that this diet is effective (Winburn et al., 2014). Medical professionals pointed out that no reason exists to conclude that gluten and casein have any impact on an individual's behavior from a physiological standpoint (Winburn et al., 2014). The results gathered by Winburn et al. (2014) showed a disparity between parental and professional opinions, specifically highlighting the possibility of a placebo effect influencing results. This disparity, coupled with lack of other empirical support for dietary interventions, calls into question the effectiveness of these interventions. These findings suggest that other factors associated with aggression in children with ASD, such as GI issues and sleep disturbances, need to be considered as possible causes of the reported behavioral changes.

GI Issues and Aggression

GI issues have been associated with emotional-regulation issues in children with ASD (Carr & Owen-DeSchryver, 2007; Mazefsky et al., 2014). One study of 95 children aged 7 to 19 years explored the emotional and behavioral impact of GI issues on children with high-functioning ASD (Mazefsky et al., 2014). The Child Behavior Checklist was used to quantify emotional and behavioral issues. The GI Symptom Inventory was used to measure GI symptoms. This inventory collects data from the previous 3 months,

including abdominal pain, bloating, “not feeling hungry after eating very little,” and other symptoms not otherwise specified, such as nausea, constipation, and diarrhea. Of the children involved in the study, 61% reported at least one GI issue, which was higher than the prevalence of GI problems for the entire population (i.e., 47%). The children with higher scores on the GI SymptomIinventory were also found to have higher scores on the Child Behavior Checklist. These findings speak to the prevalence of GI issues in the ASD population, as well as the connection between GI issues and behavioral issues in children with ASD.

The connection between GI issues and emotional problems was further supported in a study by Chiadez, Hansen, and Hertz-Picotto (2014). A total of 960 children between the ages of 2 and 5 years were included in the study. The children were divided into three groups: children with ASD, children with other developmental disorders, and typically developing children. Participants were administered a gastrointestinal history (GIH) questionnaire. The GIH scale examined symptoms from the previous 3 months. The Aberrant Behavior Checklist (ABC) was also administered. Problematic behaviors were assessed based on the total of the five ABC subscales: irritability, lethargy/social withdrawal, stereotypy, hyperactivity, and inappropriate speech. The ABC and GIH scale items are both rated on 4-point Likert scales. Four of the five ABC subscales (i.e., irritability, social withdrawal, stereotypy, and hyperactivity) were significantly higher in children with ASD with gaseousness, abdominal pain, diarrhea, and constipation. These findings add to the support for the link between GI issues and emotional issues.

Sleep Disturbances and Aggression

In addition to GI issues, sleep disturbances have been linked to behavioral dysregulation, decreased quality of life, and several behavioral problems, including physical aggression in children with ASD; however, this link is not completely understood (Kotagal & Broomall, 2012; Mazurek & Sohl, 2016; Cohen, Conduit, Cornish, Lockley, & Rajaratnam, 2014; Delahaye et al., 2014; Kanne et al., 2013). Common sleep disturbances in children with ASD include insomnia, inability to fall and stay asleep, and frequent waking throughout the night (Mazurek & Sohl, 2016). Research on the prevalence of sleep problems suggests that between 40 and 80% of children with ASD experience an issue with sleep, particularly insomnia (Cohen et al., 2014, Cortesi, Giannotti, Ivanenko, & Johnson, 2010). Recent literature has suggested that sleep problems exacerbate core deficits of ASD, including social and communication difficulties (Hoffman, Tudor, & Sweeney, 2012). While the relationship between sleep disturbance and behavioral problems, such as aggression, has been well documented, the etiology behind this relationship remains unknown (Mazurek & Sohl, 2016).

Disturbances in sleep have been linked to physical aggression in children with ASD. One study of 400 children with ASD aged 2 to 18 years explored the prevalence and correlates of physical aggression (Hill et al., 2014). Aggressive behaviors were derived from the child's score on the Child Behavior Checklist's aggressive behavior subscale, which includes such items as "gets into fights," "hits others," and "physically attacks others." Items that pertained to the child's behavior were recorded on a 3-point Likert scale and summed to create a total score. Sleep disturbances were recorded using the Children's Sleeping Habits Questionnaire. The questions were answered on a 3-point

scale across eight domains: bedtime resistance, sleep onset latency, sleep duration, anxiety around sleep, night awakenings, sleep-disordered breathing, parasomnias, and morning waking/daytime sleepiness. Sleep disorders were found to be strongly correlated with aggressive behavior, with no significant differences in sociodemographic variables.

Another study sought to compare the levels of aggression in children with ASD and those of typically developing children with sleep disturbances (Chen et al., 2017). This study included 577 typically developing children and 490 children with ASD, all aged between 4 and 6 years old. A modified version of the Overt Aggression Scale (OAS) was used to assess the level of aggression of the participants. The scale assessed the following domains: Verbal Aggression Toward Others, Verbal Aggression Toward Self, Physical Aggression Against Other People, Physical Aggression Against Objects, and Physical Aggression Against Self. Responses were entered on a 3-point Likert scale. The Children's Sleeping Habits Questionnaire was also used to assess sleeping habits in this study. Sleep disturbances were significantly associated with all of the OAS domains. These findings were consistent in both groups. Both of these studies add to the body of literature endorsing sleep disturbances as a significant predictor of aggression. One potential explanation for the link between sleep disturbance and aggression is that children cannot effectively communicate their negative emotions and experiences and therefore turn to aggression to communicate their discomfort.

Communicative Ability and Aggression

Language delays have been associated with higher rates of aggression in children with ASD, as well as in the general population (Domenick et al., 2007; Mazurek & Sohl, 2016). Approximately between 20 and 50% of children with ASD fail to develop spoken

language (Schreibman & Stahmer, 2014). Owing to the number of children with ASD who fail to develop spoken language, language acquisition has been the primary focus of treatment intervention (Schreibman & Stahmer, 2014). A recent review of literature on language and conduct issues revealed that delays in the development of expressive language have been connected with the development of conduct issues, including temper tantrums and aggression, in children between the ages of 3 and 5 years (Doyle, Falissard, Girard, Pingault, & Tremblay, 2016). One should note that this connection has not been thoroughly studied in children with ASD, highlighting the need for continued research. While studies have found expressive-language delays to be a predictor of increased physical aggression in children with ASD, little literature has examined this link specifically (Domenick et al., 2007; Doyle et al., 2016).

Expressive language is a broad term that describes the way people communicate their wants and needs (Speech-language definitions, 2017). Expressive language includes a number of verbal and nonverbal abilities, including facial expressions, gestures, and semantics (Speech-language definitions, 2017. One study that included 107 children between the ages of 4 and 14 years found that children with ASD with higher levels of aggression also had lower levels of expressive language (Domenick et al., 2007). Domenick et al. (2007) used a custom measure called the Abnormal Behavior Patterns Questionnaire (ABPQ) to collect data about the children's aggressive behaviors and the Expressive Vocabulary Test for expressive-language development. The researchers found verbal IQ, expressive language, and receptive language to be significant predictors of aggression within this sample.

Doyle et al. (2016) sought to examine the longitudinal relationship between language and conduct problems. Conduct problems in this study included tantrums and physical aggression. The study included 14 children between the ages of 3 and 5 years. Conduct problems were measured using the Strengths and Difficulties Questionnaire (SDQ), which includes items pertaining to fighting with other children, hostility toward adults, and temper tantrums. Language was assessed using the British Ability Scale. The researchers found that children with lower levels of expressive language exhibited higher rates of conduct issues. These findings further imply a connection between expressive language and behavioral problems and further illustrate the need for continued exploration of this connection. One should note that this study was limited by its small sample size and did not include children diagnosed with ASD.

The connection between communicative ability and aggression has been further supported by studies that have found reductions in aggression through the use of treatment methods that build a child's ability to communicate (Mancil, 2006; Wong et al., 2015). FCT has been supported by literature as an effective treatment method in reducing aggression for children with ASD from preschool age through high school (Brown et al., 2010; Falcomata et al., 2010; Mancil, 2006; Wong et al., 2015). FCT posits that many young children and children with ASD have difficulty with abstract thinking and the way that they verbally conceptualize and express their distress; they may turn to reactive aggression as a response to pain or discomfort as a maladaptive response resulting from the lack of ability to regulate emotions in response to negative feelings. FCT continues to be studied and modified to modernize its implementation through the use of technology and telehealth services.

FCT is a form of treatment that seeks to address children's behavioral and communication difficulties (Mancil, 2006; Wong et al., 2015). FCT focuses on identifying the function of the inappropriate behavior and teaching the child an appropriate replacement (Carr & Durand, 1985). This model helps children to improve their ability to communicate their wants and needs through appropriate channels, resulting in the children having their needs met and increasing the likelihood of the appropriate behavior being displayed (Carr & Durand, 1985).

FCT has received a substantial amount of empirical support. One study involving 103 children aged 6 years and younger showed that FCT helped to reduce aggressive behavior by as much as 96% from baseline assessment (Wacker et al., 2017). Of those 103 children, 25% were diagnosed with ASD. Only one of the participants did not display a reduction in disruptive behaviors. Wacker et al. (2017) reported across four studies, each spanning 4 years beginning in 1992 and concluding in 2010. FCT was provided either in the child's home or via telehealth. Participants received treatment for as long as 10 months. Parents were provided with education about the function of behavior and were coached to respond to and fulfill the child's need only when the child used the communication skills that were taught by the researchers. Immediate reductions in aggressive behaviors were seen when the techniques were implemented successfully. One should note that destructive behavior returned if the parent did not quickly respond to the child's request, suggesting that fulfillment of the need may have prevented the destructive behavior.

Another skill-based communication treatment is the use of the Picture Exchange Communication System (PECS). PECS uses laminated picture cards with a variety of

activities, objects, and requests. The child carries a board containing these pictures and is taught to use the pictures to communicate wants and needs. PECS was developed by the Delaware Autistic Program using a six-element program to teach children functional communication skills (Heflin & Simpson, 1998). PECS is common in classroom settings, as it has been found to be an effective tool in teaching children to communicate their wants and needs appropriately (Hefflin & Simpson, 1998). In some cases, implementation of a picture exchange has been found to eliminate aggressive behavior entirely (Frea, Arnold, & Vittimberga 2001; Hu & Lee, 2018).

PECS has been used in conjunction with FCT. In one study, FCT was used with PECS to train a nonverbal child with ASD (Torelli et al., 2016). The child participated in 5 hours of therapy per week over a span of 2.5 months. In these sessions, the child was given two Apple IPads: one used for play and the other, which contained picture exchange software, used for communication. The researchers used FCT to encourage use of the picture exchange software in order to reduce aggressive behaviors, which Torelli et al. (2016) defined "as forceful physical contact between the subject, or an object controlled by the subject, and another person including hitting, throwing, etc." (p. 2). Removing access to a preferred reinforcer and placing a demand on the child elicited aggressive behavior. The researchers addressed the aggression by teaching the subject to complete the request and use the communication picture exchange software to request the reinforcer. At baseline, the child displayed more than three aggressive responses per minute when attempting to gain access to a tangible reinforcer. At the end of treatment, his responses had been reduced to fewer than one per minute. While the rate of aggression was still high, the results of this study are promising given the reduction of

aggressive behavior in a short period of time. This research is limited in that it is a single-case study; however, it does provide limited support for the use of FCT with children with ASD who use communicative devices. Additional research should be conducted to further support the use of FCT within that population.

Behavioral treatments have helped to reduce aggression by building communication skills and indirectly support the link between aggression and language. Being unable to communicate can be frustrating for children, with that frustration often leading to aggression. Teaching children effective ways to communicate their thoughts, feelings, wants, and needs helps to alleviate their frustration and, in turn, to reduce levels of aggression (Sallows & Graupner, 2005). The frustration-aggression hypothesis states that the interruption or blocking of goal-oriented behavior can create an aggressive inclination (Berkowitz, 1989). This hypothesis may help to explain why expressive-language difficulties have been found to be predictors of aggressive behavior.

Reviewing the relevant literature highlights the lack of studies aimed at identifying the predictors of aggressive behavior in children with ASD. While some progress has been made, a need continues for further exploration into the multitude of factors that can trigger aggression in children with ASD. Questions also remain about the relationship between diet and aggression. As a first step, this study sought to explore the relationship between some of the most common variables associated with children with aggression in children with ASD: sleep disturbance and communicative ability, as well as the use of the autism diet as an intervention for decreasing aggressive behavior.

RESEARCH QUESTIONS AND HYPOTHESES

Q1: Does past or current use of a dietary intervention significantly predict frequency of aggression in children with ASD?

H1: Use of the autism diet will not be a significant predictor of aggression.

Q2: Does communicative ability significantly predict frequency of aggression in children with ASD?

H2: Communicative ability will be a significant predictor of rate of aggression.

Q3: Does the presence of sleep disturbances predict frequency of aggression in children with ASD?

H3: Presence of sleep disturbances will be a significant predictor of rate of aggression.

Q4: Does the ability to communicate wants and needs as measured by particular items on the Social Communication Questionnaire (SCQ) predict aggression in children with ASD?

H4: The ability to communicate wants and needs as measured by particular items on the Social Communication Questionnaire (SCQ) will predict lower levels of aggression.

It is hypothesized that factors other than dietary intervention, specifically sleep disturbance and communicative ability, will be better predictors of aggressive behavior than the autism diet. It is expected that participants who have higher communicative ability as measured by the SCQ will display fewer incidents of aggression. It is believed that children who have high SCQ scores will be more likely to express themselves verbally rather than through aggression. The presence of sleep difficulties is believed to be related to the rate of aggression. Sleep disturbances have been shown in research

literature to be related to emotional dysregulation and gastrointestinal (GI) symptoms. It is anticipated that the presence of sleep disturbances will be a predictor of aggression in this sample. Lastly, it is believed that children who are able to communicate needs in a prosocial manner will display fewer instances of aggression. A child who is able to identify wants and needs should be less anxious and less frustrated about problems they encounter and therefore less aggressive. It is believed that the function of aggressive behavior is communicative; therefore, it is anticipated that children who are better able to identify and communicate wants and needs will be less aggressive. This hypothesis is exploratory.

METHODS

Study Design

This quantitative, correlational study used archival data. The data were collected from a local community mental-health agency. All of the data examined in this study were taken from information collected prior to the implementation of treatment at the agency. The information was gathered during intake assessments aimed to determine the need for mental-health services.

Participants

Participants were 111 children (26 female and 85 male) diagnosed with ASD between the ages of 4 to 8 years (M = 5 years, 9 months; SD = 1.32) whose families sought services for them in a large multisite agency located in the northeastern region of the United States between 2015 and 2018. A power analysis determined that a sample size of 77 would be required to complete a multiple regression with a power of .80, a .05 error probability, and a moderate effect size. In order to be included in the study, (a) the parent must have completed the Social Communication Questionnaire (SCQ) during the intake process, (b) the evaluator must have asked whether or not the child had ever used the autism diet, and (c) the family needed to have indicated whether or not the child was experiencing a sleep disturbance at the time of intake. Children were excluded if they had been involved in prior treatment. Six potential participants were excluded from the study because of partially completed SCQ forms.

Recruitment

The data were obtained from an agency providing mental-health services to children in Philadelphia, PA. Clients at this agency can be self-referred, referred by another mental-health provider, or referred by the child's school. The agency provides assessment services that screen for autism spectrum disorder (ASD) and connect families to resources for treatment. The assessment consists of a structured clinical interview, at least one behavioral observation in the child's home, at least one observation in the child's school or daycare setting (if applicable), and several parental report measures that assess the child's communication ability and social skills. The data used were collected from these assessments with permission from the agency.

Measures

Structured Clinical Interview

As part of the intake process, all patients complete a structured clinical interview with a psychologist. The interview included questions about the child's behavioral, medical, developmental, social, and academic histories. Questions in the interview asked parents to describe any past or current treatment received, to disclose whether or not the family had ever used the autism diet, and to disclose whether or not sleep disturbances were present. Demographic information collected at intake included age, gender, race, current school placement, current residence, and with whom the child currently resided.

Behavioral Observation

As part of the intake process, clinicians gathered observational data on children in their home and school settings (if applicable). The children were observed for either 8 or 10 hours, depending on whether the child was of school age. Only the first 8 hours of

observation were used in this study to ensure consistency in the data. These observations were conducted in at least two sessions by a master's-level clinician. Clinicians must have completed functional behavior analysis (FBA) training through the agency. This training is a 2-day, 16-hour training that involves watching videos and interactive activities to teach accurate observation and interpretation of behavior. Prior to receiving certification, clinicians must watch a sample behavior video and count the number of target behaviors displayed in the video. Their count must be accurate within one instance of the trainer in order to receive certification. The clinician records the frequency, intensity, and duration of any problematic behaviors that are shown. These observations were used to estimate the child's rate of aggression for this study. Included in the data set are categorical classifications of the level of aggression based on frequency. Mild/moderate refers to children with one to six daily incidents of aggression while children who display seven or more incidents are classified as severe. These classifications are used within the agency from which these data were derived.

Social Communication Questionnaire

Following the interview, the parents completed the Social Communication Questionnaire - Lifetime form (SCQ; Bailey, Lord, & Rutter, 2003). The Lifetime form focuses on an individual's behavior throughout his or her development while the current form focuses solely on behaviors over the previous 3 months (Bailey et al., 2003). The SCQ is a 40-item assessment instrument that measures an individual's ability and interest level in engaging others socially. This instrument is employed when assessing a child for ASD (Chandler et al., 2007). The SCQ includes items that assess a child's ability to identify wants and needs, interest in engaging with others, spontaneous sharing, verbal

ability, and conversation skills. The total score represents the child's ability to communicate with others effectively. Discrepancies between the scores of children with ASD and those without ASD have been found, supporting the validity of the SCQ as a screening tool for ASD (Chandler et al., 2007).

The SCQ was developed using the Autism Diagnostic Interview-Revised (ADI-R; Le Couteur et al., 1989). The measure was designed to explore three core areas of functioning typically seen in children with ASD: reciprocal social interaction, language and communication, and repetitive and stereotyped patterns of behavior (Ung et al., 2016). The SCQ Lifetime form varies from other empirically supported communication measures, such as the Autism Diagnostic Observation Schedule (ADOS) and the Vineland Adaptive Behavior Scales, in that it examines communication ability throughout the child's lifespan. The questionnaire consists of 40 yes-or-no questions that a parent completes for his or her child. The questionnaire's primary use is to support a diagnosis of ASD. It is scored by assigning one point for every "yes" response and zero points for every "no" response. Children with scores of less than 15 are considered likely to have ASD (Bailey et al., 2003). The SCQ has been shown to be a reliable screening measure for discriminating children with ASD and pervasive developmental disorder (PDD), as well as other developmental disorders, particularly in 3- to 5-year-olds (Allen, Silove, Williams, & Hutchins, 2007). Internal consistency as measured by Cronbach's alpha was found to be 0.89 (Avcil, Baykara, Baydur, Münir, & Emiroğlu, 2015). The questionnaire has also been found to be a valid screening tool when used to identify children who require ASD-specific diagnostic assessment (Allen et al., 2007). Specifically, the SCQ showed a sensitivity of 0.90 and specificity of 0.80 when

discriminating between ASD and non-ASD cases (Chandler et al., 2007). Findings were not impacted by parental education or child IQ (Chandler et al., 2007).

Procedure

Access to the data set was provided by the behavioral health services agency by providing the researcher with supervisory access to its electronic medical record. This method allowed the researcher to access patient data without having to save any documents with a patient's name to protect privacy. At intake, a comprehensive biopsychosocial evaluation was conducted with a psychologist; the evaluation was typed, signed by the evaluator, and then uploaded into the electronic medical record. A filter within the electronic record's software was used to identify clients who received an extended assessment. The researcher first identified the child's age to determine eligibility. Once eligible participants were identified, their evaluations were read to identify the presence of sleep disturbance and use of the autism diet. Information about the presence of sleep disturbances was taken from the biopsychosocial evaluation report based on the parent's response to the following prompt: "Is your child having any difficulty sleeping? This would include things like problems falling asleep, waking up in the middle of the night, or having nightmares." Use of the autism diet was determined by the parent's response to the following question: "You may have heard about natural remedies or strategies to help manage your child's behavior. I'm going to ask you about some of them. Is your child on any special diet? If so, which one? If not using at present, have you used one in the past?" Parents also completed a number of self-report measures, including the SCQ, which rates the child's ability to communicate effectively with others. The total score from the SCQ was used to determine the child's communication ability.

RESULTS

Overview of Data Analysis Plan

Once the data were collected, descriptive and frequency analyses were performed to describe the sample. Correlational analyses of the relationship between the dependent and independent variables were examined. Finally, multiple linear regression was conducted to identify the potential relationship between use of the autism diet and aggression, as well as to test main effects for sleep disturbances and communicative ability.

Correlations were measured using Pearson *r* and the point-biserial correlation coefficient. Pearson *r* is used for two continuous variables, while the point-biserial correlation coefficient measures the strength of association between a continuous variable and a binary variable (Statistics Solutions, 2017). Like other correlations, the strength of association ranges from -1 for a negative association to +1 for a positive association. A zero indicates that no association exists. The assumptions of normal distribution of the continuous variable and homoscedasticity must be fulfilled (Statistics Solutions, 2017).

Multiple linear regression assesses the relationship among a set of predictor variables on a criterion variable. In this instance, the independent variables included use of the autism diet, sleep disturbances, and communicative ability. The dependent variable was aggression, which was measured by the frequency of aggressive behaviors based on observation. Variables were evaluated by what they added to the prediction of the dependent variable, which is different from the predictability afforded by the other predictors in the model. The *F* test was used to assess whether the set of independent variables collectively predicted the dependent variable.

The assumptions of multiple regression—linearity, homoscedasticity, and multicollinearity—were assessed. Linearity assumes a straight-line relationship between the predictor variables and the criterion variable, and homoscedasticity assumes that scores are normally distributed about the regression line. Linearity and homoscedasticity were assessed by examination of a scatter plot. The absence of multicollinearity assumes that predictor variables are not strongly related. Multicollinearity was assessed using variance inflation factors (VIFs). VIF values greater than 10 would suggest the presence of multicollinearity (Statistics Solutions, 2013).

Findings

This study included 4 hypotheses: (a) The use of the dietary intervention would not be a significant predictor of aggression, (b) Communicative ability would significantly predict aggressive behavior, (c) The presence of sleep disturbance would predict aggression, and (d) An exploratory hypothesis that higher scores on items on the Social Communication Questionnaire (SCQ) pertaining to the communication of wants and needs would predict lower levels of aggression.

To test the research questions and hypotheses, a series of analyses were conducted using SPSS. First, a series of correlations were used to test Hypotheses 1 through 3. A point-biserial correlation indicated that diet was significantly and positively correlated with aggressive episodes, $r_{pb} = .226$, $p = .017$. That is, use of the diet was associated with more frequent aggressive episodes. A similar method was used to test whether sleep disturbance was associated with aggressive episodes; however, no significant relationship was found, $r_{pb} = .004$, $p = .969$. Finally, the relationship between scores on the SCQ and aggression was tested using Pearson *r;* results again indicated a positive relationship, $r =$

.345, $p < .001$. This analysis indicated language impairment was associated with higher levels of aggression.

To examine the influence of sleep, diet, and communicative ability simultaneously, a multiple regression analysis was conducted. Given that sleep was not associated with aggression at the univariate level, an initial regression was used to test if it contributed once diet and communicative ability were accounted for in the model. The results of this initial analysis showed strong predictive ability overall, $F(3,107) = 6.768$, $p < .001$, $R^2 = .159$; however, consistent with previous analysis, sleep was not related to aggression, $\beta = -.075$, $p = .409$ (see Table 1 for full results). Thus, sleep disturbance was removed from the model, and it was reestimated.

Prior to analyzing the results of the final multiple regression, the model was examined to ensure it met the necessary statistical assumptions. Linearity and homoscedasticity were examined using a series of plots. The results indicated that the relationship between aggression and communicative ability appeared linear. Further, the assumption of homoscedasticity using a plot of the residuals versus predicted values showed no clear pattern, indicating homoscedasticity. The presence of multicollinearity, which would violate an assumption of independence, was tested by examining the VIF. In the current model, the VIF was 1.014, which is far below the usual cutoff of 10. Thus, no evidence of multicollinearity was present. Lastly, the normality of the dependent variability was assessed by examining skewness, kurtosis, and distribution of values. Once again, this assumption was met, as both the skewness and kurtosis values were low relative to their standard errors, and the values appeared to be normally distributed when graphed.

As the model met the assumptions of multiple regression, the results could now be interpreted. The model indicated strong fit to the data, $F(2,108) = 9.837$, $p < .001$ (see Table 2 for full results). The R^2 for the model was .154, indicating that 15.4% of the variance of aggression could be accounted for by use of a dietary intervention and score on the SCQ. The results indicated that scores on the SCQ, $\beta = .323$, $p < .001$, as well as use of the autism diet, $\beta = .289$, $p = .036$, significantly predicted aggressive episodes.

Finally, an exploratory analysis was conducted to examine Hypothesis 4, which focuses on items from the SCQ indicating the ability to communicate needs. To examine this question, each of the items was correlated, using point-biserial, with aggression scores. Further, a composite score (created by summing the three items) was used to examine aggression. The results of this analysis revealed no significant relationship between items 10, 23, and 32 of the SCQ with aggression (r_{pb} values were -.110 [$p = .251$], -.007 [$p = .940$], and -.019 [$p = .847$], respectively). Additionally, no relationship was found between the composite score and aggression, $r = -.057$, $p = .553$.

Table 1

Summary of Multiple Regression Including All Predictors

Variable	*B*	*SE B*	*β*	*t*	*p*
Constant	2.775	1.682		1.650	.102
SCQ	.327	.088	.338	3.711	.000
Diet	2.036	.951	.191	2.140	.035
Sleep	-.804	.971	-.075	-.829	.409

Note. SCQ = Social Communication Questionnaire.

Table 2

Summary of Multiple Regression Including Significant Predictors

Variable	*B*	*SE B*	*β*	*t*	*p*
Constant	2.521	1.651		1.527	.130
SCQ	.312	.086	.323	3.624	.000
Diet	2.012	.949	.289	2.119	.036

Note. SCQ = Social Communication Questionnaire.

Table 3

Means and Standard Deviations

Variable	*Mean*	*SD*	*N*
Aggression	9	5.110	111
SCQ	18.48	5.283	111

.

Table 4

Correlations

	1	*2*	*3*	*4*
1. SCQ	-	.116	.203	.345
2. Diet	.116	-	.054	.226
3. Sleep	.203	.054	-	.004
4. Aggression	.345	.226	.004	-

Note. SCQ = Social Communication Questionnaire

DISCUSSION

This study assessed the use of a dietary intervention, the presence of sleep disturbance, and social communication ability as predictors of physical aggression in children with autism between the ages of 4 and 8 years. The data were collected at a community mental health agency located in the northeastern region of the United States. Higher scores on the Social Communication Questionnaire (SCQ), which indicate a higher likelihood of autism and lower communicative ability, and parental report of the use of the dietary intervention were both found to be predictors of aggressive behaviors in this sample. The presence of sleep disturbance was not associated with aggression. An analysis of particular items on the SCQ pertaining to the child's ability to communicate wants and needs was conducted and it was determined that the child's ability to communicate wants and needs also did not predict aggressive behavior. One should note that the population being studied included mostly children of lower socioeconomic status. These populations tend to be underserved and underrepresented in the research.

Some of these findings were consistent with those of previous studies while others were not. One area in which this study's outcome differed from previous research was related to sleep disturbance. Previous literature has found sleep disruption to be a significant predictor of aggressive behavior in children with autism (Broomall &Kotagal, 2012; Chen et al., 2017; Mazurek & Sohl, 2016). One key difference between this study and previous literature on sleep disturbances and aggression is the specificity of the disturbance. This study measured sleep disturbance in the general sense using a yes-or-no question and did not take into account the nature of the disturbance, while previous studies used measures that identified specific sleep disorders. One possible explanation

for this difference is that some sleep disturbances may be associated with increased aggression while others may not. A more detailed account of the disturbances being experienced would be required to fully understand and explain the differences between the findings of this study and others that included sleep disturbance.

Higher rates of aggression were positively correlated with decreased communicative ability in this study. This finding was consistent with previous literature on emotional regulation and communicative ability and aggression in children with autism (Domenick et al., 2007; Hutchins & Prelock, 2014; Mazurek & Sohl, 2016; Samson et al., 2012). Previous studies have found expressive language to play a key role in both social-communication skills and emotional regulation (Armstrong, Cole, & Pemberton, 2010; Doyle et al., 2016). These findings suggest that building expressive-language skills in children may increase their emotional-regulation ability, thereby possibly decreasing aggressive behavior. Building language skills is especially important for children with autism given the high rate of language impairment in the population.

Use of the autism diet positively correlated with frequency of aggression. One potential explanation for this finding may be that the children studied generally had high levels of aggression and misbehavior, leading parents to become desperate and to attempt more interventions, including the autism diet. This finding does not support use of the autism diet as related to decreasing aggression in children with ASD. The authors advise that these findings be interpreted with caution because of the retroactive nature of the data collection method. One should also note that the results of this study are consistent with some of the previous literature, strengthening the validity of the results.

Strengths and Limitations

The results of this study help to identify predictors of aggressive behavior, an important first step to reducing these behaviors in treatment. Another strength of the research was that the availability of a large enough sample allowed for a sample size greater than the minimum determined through the power analysis. An additional strength of this study was the ecological validity found within the sample. Using a sample composed of clinical cases may be more representative of the general population than samples recruited in research laboratories, thereby possibly increasing the generalizability of the results. Also, this study involved aggression, sleep disturbance, and communicative ability, variables that were common and relevant to the population being studied.

Limitations to this study also should be noted. This study examined archival data that did not allow for follow-up about the ways data were collected. While the data were collected in a standardized interview, no rater or interrater reliability data were available. Another limitation of this study was the inability to recruit families because this dataset was drawn from a sample of convenience. A more balanced sample may have been obtained by actively recruiting families who have tried dietary interventions for their children.

Another limitation to this study was the use of parental reports in the communication questionnaire, as well as in the clinical interview. Anecdotal measures can often be inaccurate, and thus possibly provide skewed data. Goin-Kochel et al. (2009) endorsed that placebo effects are often found in parental reports. Goin-Kochel et al. surveyed 479 parents or caregivers of children with autism about the effectiveness of the autism diet and two types of psychopharmacological treatments. The researchers found

that improvements were reported by a majority of the participants, even if the treatment method in question had been proved ineffective by previous research, thus suggesting that placebo effects may play a role in parental reports about intervention effectiveness. Also, the way the use of the diet was measured in the data set presented a limitation for this study. Participants were included if they had ever used the diet, not accounting for a number of changes that may have occurred with the child since ceasing use of the diet.

A number of factors, such as age, that may have moderated the relationship between frequency of aggression and use of the autism diet were not examined in this study. However, one should note that rates of aggression in children with ASD have been impacted less by these variables compared to typically developing children. Lastly, the settings of the behavioral observations were a variable that was not controlled for. The variability between home and school settings may have influenced the results.

Implications

The findings of this study indicated that higher rates of aggression were found in children in this sample who had used the autism diet. These findings illustrate the need for further research into the diet's potential impact on behavior. We are advising that parents refrain from using the diet until a stronger research base has been established. One important consideration is that parents may still feel inclined to attempt the intervention. If so, clinicians must ensure that the parents are consistent in their implementation of the diet. If a child on the spectrum has communication difficulties and frustration levels rise, inconsistent application of any intervention could exacerbate the situation, leading to higher rates of aggression.

The results of this study are consistent with those of previous studies about communicative ability predicting lower rates of aggression. These findings when taken with those of existing studies support the idea that teaching children with autism more functional ways to communicate and rewarding them for their use of these new skills may help reduce challenging behaviors, such as aggression. Of note, these ideas are not limited to verbal communication, as nonverbal children can be taught to use the Picture Exchange Communication System (PECS) and assistive devices to enhance these skills.

Future Directions

Conducting a randomized control trial may be helpful in advancing research on the impact that diet has on aggressive behavior. The ability to control for a greater number of confounding variables, such as inconsistent implementation of the autism diet, would allow for greater insight into the specific role that diet may or may not play in aggressive behavior. Given that this study examined behavior at baseline, examining the impact that treatment has on communication ability should also be beneficial. Another potential future direction would be to examine whether or not other diets impact aggression in children with autism behaviors.

Use of the autism diet was found to be a significant positive predictor of aggression in children with autism in this study; therefore, future research should still be conducted to investigate the connection further. These studies should examine sleep disturbances and gastrointestinal (GI) issues as variables that may mediate or moderate the relationship between use of the autism diet and aggressive behavior. Exploring the interaction between these variables will help to elucidate the relationship between the autism diet and aggression.

Despite the frequency of aggression in children with ASD, the subject has not been widely researched. Continued research into the causes of aggression in children with ASD is crucial to improving treatment outcomes for this population. Given the cognitive and social deficits that children with ASD present with and the multifactorial nature of aggression, the development of a complex model of aggression that takes the multidimensional nature of aggression and the challenges faced in ASD into account would help to advance the development of treatment options in children with ASD.

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