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Examining the Dunning-Kruger Effect in Autism Knowledge, Information Sourcing, and Endorsement of Vaccination Policy

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EXAMINING THE DUNNING-KRUGER EFFECT IN AUTISM KNOWLEDGE, INFORMATION SOURCING, AND ENDORSEMENT OF VACCINATION POLICY

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DISSERTATION APPROVAL

This is to certify that the thesis presented to us by _____Alexandra Reed_____

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acceptable in both scholarship and literary quality.

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ABSTRACT

The purpose of this study was to further examine the Dunning-Kruger effect as it relates to knowledge of autism, source of information, and endorsement of vaccination policy. Specifically, the study assessed the relationship between confidence in autism awareness and the belief that vaccines cause autism. It also examined the relationship between the source of information regarding autism and vaccines and vaccination attitudes. Last, it assessed whether individuals with higher confidence levels in the internet would be more likely to have both anti-vaccination attitudes and lower awareness of autism facts. Adult participants (N = 199) were surveyed on various social media outlets using five self-report measures. First, it was predicted that anti-vaccination individuals would show higher confidence in their knowledge and lower knowledge of autism compared to pro-vaccination individuals. Second, it was predicted that anti-vaccination individuals would be more likely to rely on the internet than physicians compared to pro-vaccination individuals. Last, it was hypothesized that vaccination stance would differ on confidence in source between physician and internet. The findings confirmed that anti-vaccination individuals were more confident in their knowledge of autism and vaccines compared to pro-vaccination individuals. Further, pro-vaccination individuals were shown to be more likely to obtain information from physicians whereas source was equally distributed between internet and physician for anti-vaccination individuals. Last, those pro-vaccination individuals displayed higher levels of confidence in the internet overall and lower levels of confidence in physicians compared to anti-vaccination individuals in whom the opposite pattern was found. Implications are further discussed.

CHAPTER 1: INTRODUCTION

Statement of the Problem

In the age of the internet, keeping up with the rapid-fire spread of misinformation can be overwhelming. In fact, false information is 70% more likely to be spread than accurate information on the internet (Soroush et al., 2018). A relevant example of the misinformation that continues to be diffused despite an abundance of evidence to the contrary is the link between the measles-mumps-rubella (MMR) vaccine and autism (Kata, 2012; Lewandowsky et al., 2017). The dissemination of the link between autism and vaccines is linked to a fraudulent case study of 12 children, conducted by Andrew Wakefield and colleagues in 1998, which has had complicated and enduring implications (Wakefield et al., 1998). While the study was partially retracted from the *Lancet* in 2004 and completely retracted by 2010, and while Wakefield was found guilty of ethical violations, scientific misrepresentation, and deliberate fraud, a drop in vaccinations and a rise in measles outbreaks were nonetheless reported in the years after the publication was retracted (Rao & Andrade, 2011; World Health Organization, 2019).

Despite large epidemiological studies that attempted (and failed) to replicate the findings from the Wakefield study, trials held to bring the authors to justice, and the scientific community continuing to spend enormous resources refuting the effects of this small case study, “fake news” spread faster than any efforts to counter it (Poland & Spier, 2010). A significant plurality of parents continues to report a hesitation to immunize their children because of fear of various repercussions, including autism (Opel et al., 2013).

Ironically, studies show that the lower their knowledge regarding autism and vaccines, the more confident people are that they know more than the experts on the

topic, thus affecting attitudes toward vaccinations (Motta et al., 2018). This effect, known as the Dunning-Kruger effect, has been implicated in a series of findings demonstrating that relatively unknowledgeable or unskilled individuals are afflicted with a form of illusory superiority of knowledge wherein they mistake their levels as far higher than average (Dunning, Johnson, Ehrlinger & Kruger, 2003). The authors attribute this phenomenon to the inability of such individuals to be aware of their misinformation - or a miscalibration of metacognition (*meta-ignorance*) - which they term the *unknown of unknowns* (Dunning, 2011). The implications of this cognitive bias burden individuals in two ways: it is not only that individuals have incomplete and misguided knowledge, but it is those very two shortcomings that in turn prevent them from being aware of the mistakes they are making or seeing the wisdom of the (informed) choices of others (Dunning, 2011).

While it is evident that a significant portion of the population continues to be misinformed on the facts regarding autism and vaccines, what remains unclear is the confidence individuals have in various sources of information and how this informs their endorsement of anti-vaccination platforms. Evidence shows that those with highest confidence in the internet as a source of health information tend to be lowest in health literacy (Alcock, 2016). Studies also point to the internet as a source rife with anti-vaccination propaganda and an emerging anti-vaccination movement, defined as “an amorphous group holding diverse views that nevertheless shares one core commonality: an opposition to vaccine” (Kata, 2012, p. 3778). It stands to reason, therefore, that those who obtain more information regarding autism and vaccinations from the internet, as opposed to from a reputable source, such as a physician, would be more likely to both

endorse an anti-vaccination stance and rate the internet as a highly credible source for such information. More research is therefore needed to explore the effect of sources on the link between autism and vaccination endorsement, as well as people's confidence about their source of choice.

Purpose of the Study

The purpose of this study was threefold. First, it sought to assess correlations between confidence in autism awareness and the belief that vaccines cause autism. Second, this study also sought to examine the relationships between the source of individuals' information regarding autism and vaccines and their anti-vaccine attitudes. Research suggests that those who seek health information mainly from the internet tend to report the lowest health literacy and might suggest that those receiving information regarding autism and vaccines from the internet would be more likely to hold anti-vaccination positions (Alcock, 2016). Third, this study sought to explore whether individuals with higher confidence levels in the internet as a source of information would be more likely to have both anti-vaccination attitudes and lower awareness of autism facts. These results aim to raise awareness about the importance of making informed decisions in health care, as well as to explore the role of various sources in the dissemination of pivotal information about vaccinations.

Research Questions and Hypotheses

Research Questions

Does vaccination stance have differential impacts on confidence in and knowledge of vaccines and autism?

Do the sources of information on vaccines and autism and confidence in the sources differ based on vaccination stance?

Hypotheses

1. Individuals who are anti-vaccination will show significantly higher confidence in their knowledge and lower knowledge of autism compared to individuals who are pro-vaccination.
2. Individuals who are anti-vaccination will be significantly more likely to obtain information from the internet than from physicians, whereas individuals who are pro-vaccination will be significantly more likely to obtain information from physicians than from the internet.
3. 3a) Individuals who are anti-vaccination will show significantly higher confidence in the internet than in physicians, and individuals who are pro-vaccination will show significantly higher confidence in physicians than in the internet.

   3b) Individuals who are anti-vaccination will show significantly higher confidence in the internet than that shown by individuals who are pro-vaccination, and those who are pro-vaccination will show significantly higher confidence in physicians compared to individuals who are anti-vaccination.

CHAPTER 2: REVIEW OF THE LITERATURE

Brief History of Autism

Throughout the history of recorded mental illness, autism has emerged as a complicated and controversial diagnostic category. The term *autistic* first appeared in modern times in a 1944 assessment by Swiss psychiatrist, Eugen Bleuler, while referring to the thought patterns of his patients with schizophrenia (Silberman, 2015). The term was subsequently borrowed by Austrian pediatrician, Hans Asperger, who studied boys with high intelligence and social deficits, a condition that he termed an *autistic psychopathy* (Donvan & Zucker, 2016). His postgraduate thesis, "Die 'Autistischen Psychopathen' Im Kindesalter," which eventually led to the now defunct diagnostic category of Asperger's syndrome, would remain overlooked for 4 more decades (Donvan & Zucker, 2016).

Leo Kanner, an Austrian psychiatrist who immigrated to the United States years before the outbreak of World War II, is responsible for the more current conceptualization of autism (Olmsted & Blaxill, 2016). After assuming the position as head of the department of Child Psychiatry at Johns Hopkins Hospital, he was credited with coining the term and defining the disorder that would be called *Autistic Disturbances of Affective Contact* or *Kanner's syndrome* (Jacobsen, 2010). Along with his crafting the diagnostic category of autism, Kanner believed that autism developed as a result of lack of genuine maternal warmth. He is also, therefore, credited with the derivation of the term *refrigerator mother,* referring to a substantial lack of maternal and infant bonding responsible for eliciting autistic symptoms, or even eliciting autism proper (Solomon, 2012). The refrigerator mother philosophy served as autism's first fake news

controversy and spiraled into various treatment models put forth by the infamous child psychologist, Bruno Bettelheim. Bettelheim was the founder of the Sonia Shankman Orthogenic School, a highly unorthodox residential treatment center created with the express purpose of nurturing autistic children who, it was assumed, spawned from mothers who preferred they did not otherwise exist (Silberman, 2015).

A year before the publishing of the American Psychiatric Association's (1980) *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.; *DSM-III*), Judith Gould, a psychologist, and Lorna Wing, a psychiatrist, writer, and parent of an autistic daughter, challenged the notions that the extent of a mother's love could create such profound symptoms in her own children. After scrupulous review of the existing data, the duo published groundbreaking data describing autism as existing along a spectrum (originally, *continuum*) and having epigenetic origins (Carrington, et al., 2015). This description was in stark contrast to the predominating view of the time, propagated largely by Bettelheim's "The Empty Fortress," in which he continued to implicate Kanner's philosophy about parents' love in the development of their children's disorder (Donvan & Zucker, 2016).

Wing fought tirelessly against Bettleheim's conceptualization of autism teaching, speaking, lecturing, and publishing books and articles in academic journals in order to promote the concept of an autism spectrum and, in 1984, was asked to draft the revised criteria for autism in the American Psychiatric Association's (1987) *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.-Revised; *DSM-III-R;* Donvan & Zucker, 2016). Massive shifts in the diagnostic criteria in the *DSM-III-R* (1987) were noted for both autism and pervasive developmental disorder (PDD), a now obsolete catch-all

clinical category for neurodevelopmental delay (APA, 1987). The *DSM-III-R* (1987) required identification of eight symptoms, two of which related to reciprocal social interaction (e.g., lack of awareness of the existence or feelings of others; no, or abnormal social play); one related to impairment in verbal and nonverbal communication (e.g., no mode of communication, or marked abnormal nonverbal communication) and last, one related to restricted repertoire of activities (e.g., stereotyped movements, persistent preoccupation with objects).

Wing would also be responsible for defining, organizing, and measuring the cluster of symptoms Asperger had described decades earlier (Donvan & Zucker, 2016). The inclusion of Asperger's syndrome in the American Psychiatric Association's (1994) *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*) was not without controversy during its lifespan in the *DSM*. The hesitation surrounding its existence was perhaps less about its relevance and more about Asperger himself. Asperger's Austrian origins and previous cryptic journal entries in the delicate era of mental health care in World War II had led to accusations of sympathetic Nazi tendencies by some in the field (Martin, 2016). Wing worked to clear his name for the purposes of validating his diagnostic category. That year, Asperger's syndrome was one of only two new disorders (of 94 proposed) included in the *DSM-IV* (APA, 1994; Martin, 2016). In a dramatic shift of diagnostic categories, the current iteration of the *DSM-5* (2013) collapsed Asperger's, Pervasive Developmental Disorder, Retts Disorder, Childhood Disintegrative Disorder, and Autism into a single Autism category and allowed, for the first time, a comorbid diagnosis with Attention Deficit/Hyperactivity Disorder that previously had been contraindicated (APA, 2013).

Etiological Perspectives

In the year 2000, one in 150 children had been identified with autism (Centers for Disease Control [CDC], 2018). By 2020, this rate rose to one in 54 (Centers for Disease Control [CDC], 2020). While changes in the diagnostic categorization of autism and increasing awareness of symptoms have served as the main two propositions for the alarming rise in identified individuals with autism spectrum disorder (ASD), alternative theories abound (Wright, 2017). The propagated causes for autism have ranged from old wives' tales to extensively researched and compelling genetic findings, and yet, unfortunately, a definitive answer remains unclear. Frustrated families desperately seeking answers have led the charge for increased empirical research on the topic and have been credited with a complete dismantling of the previously reigning theories, such as emotionless mothering (Brewer, 2018). Psychologist and parent of an autistic child, Bernard Rimland, proposed the first pieces of evidence against a psychogenic nature to autism, stating that, instead, it appeared to have a neurobiological nature (Mandy & Lai, 2016). Today, the attribution of autism onset to genes continues to dominate. Extensive twin and genetic studies have vindicated Rimland's theory by demonstrating a reliable moderate-to-high genetic vulnerability (Frazier et al., 2014; Hallmayer et al., 2011). Biological factors, such as the age of the father independent of the age of the mother, complications during pregnancy, or psychiatric history for either parent, have been among the strongest biological predictors of autism onset, with a four times greater risk for men older than 55 years of age producing a child with autism (Hultman et al., 2011).

Environmental factors have also been implicated in autism onset, although to a much lesser degree. A recent meta-analysis has linked a deficient zinc concentration in

blood plasma in utero to autism onset in infancy, prompting consideration of prenatal zinc supplementation recommendations (Babaknejad et al., 2016). Highly fluoridated amniotic fluid and exposure to valproate, used to control epilepsy during pregnancy, have also been linked to autistic symptoms (Christensen et al., 2013; MacArthur, 2016). Emerging studies have also begun to link prenatal pesticide levels and risk of autism (Sagiv et al., 2018; Schmidt et al., 2017). Use of antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs) during the first trimester, has also been shown to increase autism incidence (Boukhris et al., 2016; Frazier et al., 2014). Last, both a small study linking the anaerobic gut bacteria genus *Clostridium* to late-onset autism, and an elevated cerebral spinal fluid levels of cytokines, have been hypothesized to cause a permanent state of immune dysregulation, contributing to the appearance of autism symptoms (Keşli et al., 2014; Patterson, 2009). The consensus among researchers today on the topic of autism etiology is generally that of an interplay between environmental and genetic, or epigenetic, factors that continues to warrant a considerable amount of further study (Mandy & Lai, 2016).

Autism Post-Truth

Unfortunately, many unfounded etiological explanations continue to proliferate. Rumored causes for autism have run the spectrum from bad parenting to the will of God to unspecified lingering “toxins” (Bazzano et al., 2012; Goin-Kochel et al., 2015). Of all the misunderstandings surrounding the etiology of autism, arguably none has had more far-reaching consequences than the one connecting vaccines to autism. The two most circulated and often mistakenly connected links to autism are thimerosal and the administration of the measles-mumps-rubella (MMR) vaccines. As a result of anecdotal

spread of misinformation through the media, the topic of the preservative thimerosal, containing the compound ethyl mercury, often appears in anti-vaccination literature as a legitimate rationale for opting out of early childhood vaccinations (Bazzano et al., 2012). However, this fear is improperly based on one heavily flawed and obsolete study linking autism and thimerosal, which has long been removed from all vaccines given to children under the age of 6 years, with the exception of some inactivated influenza vaccines (Baker, 2008; Bazzano et al., 2012; Geier & Geier, 2003). Many large-scale, longitudinal and international replication studies have found no effect linking the preservative thimerosal or ethyl mercury to autism or neurodevelopmental delays (Hurley et al., 2010). In fact, the prevalence of autism was found to be significantly higher among participants who were administered the thimerosal-free vaccines (95% CI, 62.2–108.0 per 10,000, $p < 0.05$) than patients exposed to thimerosal (59.5 per 10,000; 95% CI, 49.6–70.8 per 10,000; OR, 1.39; 95% CI, 1.01–1.92; $p < 0.05$). The authors concluded thimerosal had no effect on the increasing rates of autism (Hurley et al., 2010).

Most notable, however, is the unrelated but now infamous 1998 Wakefield et al. study, "*Illeal-lymphoid-nodular hyperplasia, non-specific colitis and pervasive developmental disorder in children,*" linking the MMR vaccine to autism. This sparked the robust current anti-vaccination movement and continues to be most heavily implicated in the debate regarding vaccination safety in children (Bazzano et al., 2012; Thorpe et al., 2012;). In 2010, the study was retracted by the publishing journal the *Lancet*, citing flaws, fraudulence, and claims that have since been unequivocally disproved (Godlee et al., 2011). Nonetheless, the seed of doubt was planted (Poland & Spier, 2010).

A significant and growing number of parents continue to report a hesitation to immunize their children because of fear of various repercussions, including autism (Opel et al., 2011). One study noted that 37% of parents polled were reluctant to vaccinate their children and that a significant proportion of those parents (13%) believed that vaccines were the primary cause of autism (Fischbach et al., 2016). Although 95% of research scientists reported genetics to be the major contributor to autism onset, only 55% of parents did as well (Fischbach et al., 2016). This tremendous variance between the knowledge of experts in the field and of parents is alarming and should be cause for concern regarding dissemination of accurate information. This variation in knowledge between physicians and parents may not be surprising. After all, parents have no reason to be as knowledgeable as research scientists regarding the etiology of neurodevelopmental disorders. However, decision-making processes predicated on incomplete or incorrect information is a problem.

Dunning-Kruger Effect

In 1999, social psychologists Justin Kruger and David Dunning published one of the first studies exploring the cognitive bias that came to be known as the Dunning-Kruger effect. This phenomenon is one in which people of lower ability in a given domain mistakenly overrate their ability as higher than average (Kruger & Dunning, 1999). Per this effect, individuals who are incompetent tend to suffer from a dual burden of being both unknowledgeable about the domain while overestimating their ability, as well as of simultaneously being so incompetent that they lack the metacognition necessary to overcome it. This bias has led to more than simply illusory superiority; at stake are unfortunate decision-making processes with highly consequential implications.

The authors recount the story of McArthur Wheeler, who was arrested after robbing two Pittsburgh banks during the daytime without a disguise. He exclaimed to police with incredulity after his arrest, “But I wore the juice!”. Wheeler’s exclamation was based on a misunderstanding of the chemical properties of a lemon juice face mask acting as an invisibility shield (Kruger & Dunning, 1999). The authors labeled this meta-ignorance the *unknown of unknowns* (Dunning, 2011). The lack of awareness of the lack of awareness leaves glaring gaps in knowledge, preventing individuals from recognizing their deficiencies and therefore addressing them.

The Dunning-Kruger effect has been replicated successfully with studies testing perceived academic knowledge, high-level reasoning, emotional intelligence, and grammar skills, as well as in many various non-intellectual contexts (Dunning, 2011; Pennycook et al., 2017). One study confirmed the existence of the effect in wine drinkers who considered themselves erudite consumers, and another in opponents of genetically modified foods who considered themselves more knowledgeable and concerned about the topic than average (Fernbach et al., 2019). In truth, both groups had less knowledge than their counterparts who did not consider themselves so knowledgeable (Aqueveque, 2018; Fernbach et al., 2019).

Recently, one of the first studies of its kind began to explore the relationship between knowledge of autism and attitudes toward vaccination (Motta et al., 2018). The Dunning-Kruger effect was confirmed with individuals’ overconfidence in their knowledge of basic facts about autism and anti-vaccine policy attitudes. More than one third of participants believed they knew more than physicians and scientists about the symptoms and causes of autism yet demonstrated the lowest levels of knowledge.

Paradoxically, this suggests that the more confident people are that they know more than experts on the topic, the lower their knowledge surrounding both autism and vaccines (Motta et al., 2018). This finding is highly problematic, as it pertains to decision making regarding vaccinating. Specifically, it suggests that individuals may make decisions based on erroneous information without even being aware of their knowledge gaps. This lack of awareness has been evident in many domains, including seeking health information.

Anti-vaccination propaganda

Evidence shows that those with highest confidence in the internet as a source of health information tend to be lowest in health literacy (Alcock, 2016). In relation to autism and vaccines, studies point to the internet as a source rife with anti-vaccination propaganda and an emerging anti-vaccination movement (Kata, 2012). Some research has suggested placing the blame on robots (or "bots"), which pose as human but are simply programmed automated accounts with the intention of spreading false information (Broniatowski et al., 2018; Galvin, 2018). Bots function as a deliberate disruption tactic, often by individual actors or sometimes entire nation-states to strengthen the divide between polarized opinions, such as political positions or controversial social positions, such as vaccination policy (Shao et al., 2018). However, recent research has shown that on social media sites, such as Facebook and Twitter, fake news is 70 times more likely to be spread than true information and is more likely to be spread by humans voluntarily sharing sensationalistic headlines than by bots (Soroush et al., 2018). The spreading of misinformation by humans, as opposed to bots, is an important differential, as it suggests a need for behavioral as opposed to technological intervention.

The current state of the internet, with online communities and interactive websites allowing for easy interchange of personal anecdotes, creates a breeding ground for unprecedented sharing of any and all information, including unverified health information. Studies show that greater than 80% of internet users search for health information online (Rice, 2006). Although this active participation in one's own health care can be empowering, the move away from the "white coat ethos" of the experienced physician has allowed for a substantial spread of misinformation and a significant decrease in trust of physicians in an environment where everyone may feel as though they are "experts" (Kata, 2012; Rice, 2006).

The proportion of anti-vaccination websites online varies widely according to reported data by Google, but has been reported to be as many as three quarters of search results, with one study confirming the existence of at least 480 major anti-vaccination websites (Moran et al., 2016). A Google search of the term *vaccination* returned 71% anti-vaccination sites, and the search term *vaccine* returned 25% anti-vaccination sites (Kata, 2009). This finding is important given that 83% of American adults report using Google as their primary search engine for health and general information (Liu et al., 2018; The Pew Research Center, 2012). Of individuals who affirmed searching for personally relevant vaccine information, 70% also reported that their search informed their decision for treatment (Kata, 2012). On anti-vaccine websites, 88% of studies regarding vaccine data and safety have misrepresentations, such as "polio is caused by [inorganic] junk food" or that autism is caused by mercury in vaccines (Kata, 2009). Perhaps surprisingly, the contributor-based, free, online encyclopedia Wikipedia has

largely evaded contamination of false sources, with peer-reviewed, verified, and current studies abounding (Kata, 2009).

Research has also shown that of YouTube videos regarding vaccinations, one third opposed vaccination outright, and these had substantially higher viewer ratings than those of the pro-vaccine clips (Keelan et al., 2007). In addition, prior and repetitive exposure to fake-news headlines has been shown to increase the perceived accuracy of the misinformation (Kaplan, 2017). This includes repetitive suggestions by authority figures, such as Robert Kennedy, Jr., or Donald Trump, who have both publicly raised questions about the connections between vaccines and autism (Kaplan, 2017; Pennycook et al., 2018). More than 20 anti-vaccination documentaries have been championed by celebrities, such as Charlie Sheen, Bill Maher, and Robert DeNiro (Barglow & Schaefer, 2016). Some of these documentaries, such as the anti-vaccination documentary, *Trace Amounts: Autism, Mercury, and the Hidden Truth*, have received film festival awards and high-profile screenings; for example, the documentary just mentioned was presented and screened at the United Nations 2015 NGO Conference (Barglow & Schaefer, 2016).

Apart from anti-vaccination efforts propagated on more mainstream social media sites, a substantial number of independent anti-vaccination websites exist as well. These websites vary with such missions as claiming to serve as neutral watchdog organizations (e.g., the American-based National Vaccine Information Center, which in truth mainly reports anti-vaccination literature), and as anti-vaccination activism organizations (e.g., Generation Rescue [Jenny McCarthy's Autism Organization] or SafeMinds, imploring individuals to reject science in favor of anecdotes and heartbreaking personal tales, Kata, 2012). One study noted that when McCarthy tweets about vaccines, half a million

followers receive notifications regarding her message, which she may use as a platform for autism-related medical advice (Kata, 2012). Other fringe health websites, such as NaturalNews.com, Mercola.com, or Mothering.com, spread general "natural" health-related information, often with extremely questionable or completely unreliable findings and often with disparagement of vaccines. Despite its defunct print magazine, Mothering.com is ranked as the most active online community for parents and currently reports 1.5 million individual visitors per month (Kata, 2012).

Implications of anti-vaccination efforts

The importance of the internet as a tool for information should not be underestimated. When asked where they would turn for information regarding vaccinations, 70% of parents stated that they would look on the internet, and when asked explicitly if they would use the internet for vaccination information, 93% of parents reported affirmatively (Downs et al., 2008). One study reported a relationship between countries with the highest media-based anti-dTap vaccination campaigns and their significantly (as many as 100 times) higher rates of pertussis (Gangarosa, 1998). In a Welsh district where a newspaper ran an anti-MMR vaccination campaign, the vaccine rates for MMR that year were significantly lower than rates in the rest of the country (Mason & Donelly, 2000). In one study from Sweden, 80% of parents who did not choose to vaccinate their children cited the media as their main source of information for their decision (Dannetun et al., 2005).

The spread of misinformation about vaccinations through various forms of media has had profound, measurable impact. However, even coverage in presumably well-reputed mainstream media sources, such as the *New York Times, USA Today,* and

Huffington Post, have been shown to be cautious and even inconclusive in their reportage of causes of autism, placing articles written by physicians alongside those by novelty figures, such as actor Jim Carey, an outspoken critic of vaccines (Zhai, 2017). Data suggest that as a result of contradictory and confusing reports even in reputable sources, parents who may be amenable to vaccinations in general may still be hesitant to vaccinate (Enkel et al., 2018). While the media and internet have incredible potential for disseminating valid information regarding the safety and importance of vaccinations, the anti-vaccine propaganda continues to overshadow any public-health efforts put forth by the Centers for Disease Control and Prevention (CDC), the United States Surgeon General's Office, or any information under the current or past administrations. The repercussions of such aggressive anti-vaccination campaigns against comparatively meager scientific and political efforts to quell them has led to concerning trends in vaccinations worldwide. Infectious disease specialists continue to remind the public that 100 years ago, between 50 to 100 million people (i.e., 3% of the population) died from influenza alone. Despite continued warning of potentially dire consequences, without louder voices from authorities, false information continues to be easily disseminated (Larson, 2018).

Even though overall vaccination rates in the United States remain high, the percentage of currently unvaccinated children has quadrupled since 2001, and America is currently seeing its largest reemergence of previously eradicated diseases at alarming rates in multiple states (CDC, 2019). The CDC estimated that at least 100,000 infants had not received any of the recommended vaccinations in 2019 alone, and the World Health Organization (WHO) ranked vaccine hesitancy as one of the top 10 health threats to the

world in 2019, alongside such diseases as Ebola, dengue, and human immunodeficiency virus (HIV; WHO, 2019). WHO notes that with the human papillomavirus (HPV) vaccine, cervical cancer could be eradicated worldwide, and such diseases as measles that were previously eradicated in many developed and developing countries could remain eliminated with better adherence to vaccination guidelines (WHO, 2019). Vaccinations currently prevent approximately 3 million deaths a year, and an additional 2 million could be avoided with improved adherence (WHO, 2019). Instead, the measles epidemic has been called a "global crisis" and was reported at astonishing rates, with approximately 100 cases in three states in the United States only 20 days into the month of January 2019 (CDC, 2019). Halfway through the year 2019, measles rates in the United States had accelerated to the highest number of outbreaks in nearly 3 decades, affecting over half the country (WHO, 2019). Globally, more than 100,000 cases had been reported, a 300% increase from the previous year (CDC, 2019). This is in light of the existence of a vaccine that provided eradication of the disease nationwide, defined by the WHO as "the complete absence of continuous disease transmission for 12 months or more in a specific geographic area" (WHO, 2010, p. 490).

Vaccine hesitancy

Despite a plethora of findings confirming the safety of all recommended childhood vaccines, hesitancy by parents to vaccinate their children continues to be a topic of great concern (Bianco et al., 2019). Global studies have shown that the top-three-cited reasons for vaccine hesitancy include fear of safety (e.g., side effects); lack of knowledge or awareness of the importance of vaccines; and social issues, including religion, gender, or cultural concerns (Lane et al., 2018). The term *vaccine hesitancy* was

introduced by WHO as an attempt to bridge the divide between the already polarized "anti" and "pro" vaccination camps. Vaccine hesitancy is defined as a delay or refusal of some vaccination services and includes possible causational factors, such as complacency, convenience, and confidence (WHO, 2014). Hesitancy rates in parents with regard to childhood vaccinations have been rising incrementally over the past 20 years, even for parents who ultimately choose to accept some vaccines on schedule, if not all (Bianco et al., 2019). Studies show rates as high as 25% of parents delaying or refusing at least one routine childhood vaccine, and parents who fall into this category cite the influence of pharmaceutical corporations, freedom of choice, and potential consequences of side effects (including autism) as their three primary motives for delaying or refusing (Bianco et al., 2019).

While evidence-based information regarding the importance of vaccines is widely available and evidence is lacking for any relationship vaccines may have to autism, the widespread gravitation toward unconventional sources for vaccine and autism information nonetheless persists. As a next step toward efforts to change public perception about anti-vaccination untruths, it is therefore of imminent importance to understand the source of anti-vaccination information, the confidence levels the consumers of such information have in their sources, and the impact on their own attitudes toward vaccines. The Dunning-Kruger effect, relying on the phenomenon of the unknown of the unknowns, offers an avenue for understanding how individuals become trapped in a maze of misinformation (Dunning, 2011). It can also offer solutions to enlighten people to their own previously unrecognized gaps in knowledge (Ehrlinger et

al., 2008). As Charles Darwin reminded, “Ignorance more frequently begets confidence than does knowledge" (Darwin, 1871, p.141).

Proposed Study

This proposed study was threefold. It first sought to assess how participants’ attitudes toward vaccines and autism related to knowledge and confidence in their knowledge of autism and vaccines. Second, this study also attempted to identify how participants’ attitudes toward vaccines and autism related to their primary source for obtaining information about vaccines and autism. And third, this study sought to identify how participants’ attitudes toward vaccines and autism related to confidence levels in their sources of information regarding autism and vaccines. These results could raise awareness about the importance of screening one’s own base of knowledge before making critical decisions regarding vaccines and could serve as a means to explore the role of various sources in the dissemination and understanding of accurate information about vaccinations.

CHAPTER 3: METHOD

This study is a cross-sectional correlational design seeking to assess group differences in confidence in knowledge of autism, actual knowledge of autism, information sources, and confidence in information sources. A cross-sectional, correlational design was used in order to access information at the current time period. Data were collected using a web-based survey method. This design format allowed for both a large anonymous population sample that targeted a diverse, representative pool, as well as for a sample of convenience. Participants were recruited through the distribution of the survey online through social media sites, including but not limited to Facebook, Twitter, and BabyCenter, to encourage further snowball sampling. The online survey allowed for anonymity for participants who might otherwise feel uncomfortable identifying any related demographic information or revealing knowledge levels or attitudes about autism and vaccines.

Participants

Inclusion and Exclusion Criteria

Eligibility for the study was limited to adults 18 years and older to ensure a standard base of education and competence. Participants must have been a parent or a legal guardian of a child 17 years or younger. Participants must also have indicated their vaccination policy stance of pro-vaccination or anti-vaccination to have been eligible to proceed in the study. A selection of “neither anti-vaccination nor pro-vaccination” resulted in a disqualification of the study. Participation was voluntary, and participants were excluded if they failed to complete all the measures provided.

Screening and Recruitment

A pretest screening measure was administered in order to ensure participants met the inclusion criteria, including being 18 years or older and a parent or legal guardian of a child 17 years old or younger. A willingness to respond to all subsequent measures and a disclaimer about not searching for information while completing the knowledge assessment were required for participation. Those who did not meet the inclusion criteria were not included in the study. Following IRB approval, the study was disseminated in multiple online social media sites in order to maximize participation and to aid in diversification of sample. This survey used a REDCap internet hyperlink for all participants to access and was disseminated online. It was distributed across various pages and groups, including on Facebook, Twitter, BabyCenter, and other media sites, with the invitation to share the information for a snowball sampling effect.

Participant demographics.

Male and female individuals who were 18 years or older and who were parents or legal guardians of children younger than 17 years of age were recruited for the present study. Participants must have chosen a stance regarding vaccination policy, including either in favor of vaccines or against vaccines. They were recruited through various social media sites to reach a diverse audience.

Measures

Demographics

Demographic information was required for participation and included disclosure of sex, race, ethnicity, socioeconomic status, education level, income range, and political ideology.

Autism Survey

To assess general knowledge of autism, a 22-item autism knowledge assessment was implemented. The Autism Survey is comprised of two sections: Part 1, a 22-item assessment seeking to uncover participants' understanding of the etiology of, beliefs about, and general knowledge about autism and Part 2, a two-section assessment concerned with participants' knowledge of the diagnostic criteria required for an autism diagnosis (Helps et al., 1999; Stone, 1987). For the purposes of this study, only the 22-item Part 1 section was used. All 22 questions exist on a Likert scale ranging from 1 (*fully agree*) to 6 (*fully disagree*). A participant with accurate beliefs regarding autism should both agree with true statements and disagree with false statements. Examples of statements include, "*Most children with autism have special talents or abilities*" or "*Autism is a developmental disorder.*" The responses were coded as 1 through 6, with scores of 3 or less indicating disagreement and 4 or more indicating agree with the statement. Items 5, 14, 16, 19, and 21 were reverse coded. Lower scores reflected lowest knowledge, with 22 being the lowest score, and 132 reflected the highest score and therefore the highest level of knowledge. The internal consistency of Part 1 as measured in isolation from Part 2 revealed an internal consistency of the survey with a Cronbach's alpha of .74 (Campbell & Reichle, 1996). The scale exhibited good test-retest reliability (.80), and the intraclass correlation for the survey was .72, also indicating good reliability (Campbell & Reichle, 1996). Validity of the scale was supported, with individuals more experienced in autism (as measured by occupation, years of experience working with individuals with autism, and training in autism) demonstrating significantly higher levels

of knowledge of autism than those with less experience, $F(2, 82) = 7.73$, $p < .001$ (Campbell & Reichle, 1996; Stone, 1987; Stone & Rosenbaum, 1988).

Confidence in Autism Knowledge Scale

In order to measure the level of confidence participants had in their knowledge of autism, a confidence rating for each of the 22 items from the Autism Survey was given. For each autism knowledge belief statement, participants used a 5-point Likert scale from 1 (*not at all confident*) to 5 (*extremely confident*) to indicate their confidence in each autism knowledge belief statement. Range of possible scores included the lowest score of 22 (lowest confidence in their knowledge of autism) to 110 (highest confidence in their knowledge of autism). This confidence rating scale has been previously used to measure confidence in belief as related to gaps between perceived and actual knowledge (Cronbach $\alpha > 0.92$). Expressing belief superiority was significantly correlated with belief confidence (*r*s range: 0.42 –0.50; all *p*s < .001; Aqueveque, 2018; Hall & Raimi, 2018).

Information-Sourcing Question

In order to determine the source from which participants obtain information related to autism and vaccinations, they were asked the following sourcing question and provided with the following response options:

Where do you obtain most of your information on vaccines and autism?

1. *Internet 2. Physician 3. Other*

Participants' responses were coded 1, 2, or 3. For the choice of "Internet," participants were offered an option to specify the website from which they obtain most of their information. If this information was obtained from a reputable source (e.g., peer-reviewed medical journal), it was recoded as "physician." Participants were offered a fill-

in-the-blank option for “other” in order to input other options for source. This fill-in-the-blank category was recoded as reputable or unreputable sources in order to accommodate participants who may not receive their primary information about autism and vaccines from the internet or physicians (e.g., documentaries, governmental medical agencies). An interrater reliability test was conducted for each reputable or unreputable source option.

Trust in Physician Scale

The Trust in Physician Scale is an 11-question measure designed to assess patients’ confidence in their physicians. In order to assess the extent of participants’ confidence in their physicians, respondents were asked to agree or disagree with 11 questions on a 5-point Likert scale with answers coded on a scale from 1 (*strongly disagree)* to 5 (*strongly agree)*. Items 1, 5, 7, and 11 were reverse coded. A higher score indicated higher confidence, with 55 the highest possible score, and a lower score would indicate lower confidence, with 11 the lowest possible score. Examples of the statements include, “*I sometimes distrust my doctor’s opinion and would like a second one*” or “*I trust my doctor’s judgments about my medical care.”* On developmental research and follow-up studies regarding the Trust in Physician Scale, all domains measured demonstrated support for the reliability of the scale (Cronbach’s alpha = .90) and construct validity of the scale. A second replication study demonstrated further reliability and validity of the scale (Cronbach’s alpha = .85; Anderson et al., 2006).

Trust in Internet Scale

Participants were asked to assess their confidence level in information from the internet relating to autism. For this assessment, the Trust in Physician Scale was used,

replacing "*physician*" with "*internet.*" In order to assess the extent of participants' confidence in the internet, respondents were asked to agree or disagree with 11 statements on a 5-point Likert scale with answers coded on a scale from 1 *(strongly disagree)* to 5 *(strongly agree).* Items 1, 5, 7, and 11 were reverse coded. A higher score indicated higher confidence, with 55 as the highest possible score, and a lower score indicated lower confidence, with 11 the lowest possible score. Examples of the statements include, "*I sometimes distrust information on the internet and would like a second opinion*" or "*I trust information I find on the internet about medical care."* The current study is the first to implement a revised version of the Trust in Physician Scale, and therefore, no psychometric data are available. In studies regarding the original Trust in Physician Scale, all domains measured demonstrated support for the reliability of the scale (Cronbach's alpha = .90) and construct validity of the scale. A second replication study demonstrated further reliability and validity of the scale (Cronbach's alpha = .85; Anderson et al., 2006).

Procedures

Information was collected via online survey through the site REDCap, allowing for customization and to ease and maximize dissemination. Participants were asked to complete the eligibility portion first, including their age, their status as parent or caregiver/legal guardian, their vaccination stance, and their commitment to not searching for information or answers ahead of time. If participants did not meet the eligibility criteria, they were redirected to a page that thanked them for their interest. Should individuals have been eligible to continue, they were asked to complete more extensive demographic questions (i.e., education level, gender, race, ethnicity, socioeconomic

status, vaccination policy stance, political ideology, and income range). All of the following questionnaires were administered in random order; however, the Confidence in Autism Knowledge Scale always followed the Autism Survey. Participants were asked to complete the following scales: The Autism Survey assessing their knowledge of autism facts (after each individual question in the Autism Survey, participants were subsequently asked to complete the Confidence in Autism Knowledge Scale in order to assess their confidence in their response to each question pertaining to autism knowledge), The Information Sourcing Question to uncover their primary source of information regarding autism and vaccinations, the Trust in Physician Scale, and the Trust in Internet Scale in order to assess their confidence in source of information.

Participants who completed the survey also had the opportunity to click a provided link that opened a separate tab, not related to the data collection process, to enter a raffle to win a $50 Amazon gift card with the submission of their email address. All responses were assured to be completely anonymous and not tied to participants' identities. After data collection, statistical analyses using the program SPSS were conducted.

CHAPTER 4: RESULTS

Statistical analyses were computed using the Statistical Package for the Social Sciences (SPSS). The survey for the current study was open for 3 days during which time 372 participants initiated the survey. Of the 372 individuals, 49 did not meet inclusion criteria as they did not have a child under 17 years of age, and six additional individuals did not endorse a vaccination stance and, therefore, also did not meet the inclusion criteria. A listwise deletion was performed for participants with missing data, eliminating 118 individuals. This left a sample size of 199 participants for the current study. Of these participants, 83% were female and 97% of participants identified as White. In terms of geographical representation, 46% of the participants identified as being from the eastern, 33% identified as being from the northern, 11% identified as being from the western, and 5% identified as being from the southern United States, as defined by the U.S. Census Bureau (U.S. Census Bureau, 1995). In terms of education, 37% of participants held a 4-year degree, and 25% endorsed having a master's degree. With regard to political stance, 38% of participants identified as liberal, 20% identified as moderate, and 13% identified as conservative. In terms of income, 52% of participants reported an annual income exceeding $100,000. Finally, with regard to vaccination stance, 83% of participants endorsed being in favor of vaccinations while 17% endorsed not being in favor of vaccinations. For a complete demographic breakdown, see Table 1. While these numbers are representative of the population at large, the imbalance of respondents in each category represents a limitation of the study. Table 2 provides the means and standard deviations of the entire sample for the main measures of the study.

Table 1
Sociodemographic Characteristics for Entire Sample

Demographics for Entire Sample		
	n	%
Gender		
Male	33	17
Female	165	83
Other	1	>1
Race		
White	192	97
Black	3	1.5
Asian	2	1
Other	2	1
Hispanic [a]	6	3
Geography		
North	66	33
South	10	5
East	91	42
West	21	11
Education		
High school graduate	7	4
Some college	23	12
2-year degree	20	10
4-year degree	74	37
Master's degree	51	26
Professional school degree	24	12
Political orientation		
Extremely liberal	10	5
Liberal	75	38
Slightly liberal	26	13
Moderate	39	20
Slightly conservative	21	11
Conservative	27	14
Extremely conservative	1	>1
Income		
Less than $20,000	3	2
$20,000-39-999	13	7
$40,000-59,999	18	9
$60,000-79,999	34	17
$80,000-99,999	28	14
$100,000 or above	103	52
Vaccine stance		
In favor of	166	83
Not in favor of	33	17

[a] reflects the number of participants answering "yes" to this question.

Table 2
Descriptive Statistics for Entire Sample

	Vaccination stance	Mean	*SD*	*n*
Autism Scale	In favor of	104.14	9.38	166
	Not in favor of	101.03	14.19	33
	Total	103.62	10.35	199
Confidence in Autism Scale	In favor of	78.07	9.35	166
Knowledge Scale	Not in favor of	83.21	7.02	33
	Total	78.92	9.19	199

To control for Type 1 error, a Bonferroni correction was employed, where all analyses are set at $\alpha = .016$.

Hypothesis 1: A one-way multivariate analysis of variance (MANOVA) was conducted to determine whether individuals who are anti-vaccination would show significantly higher confidence in their knowledge and lower knowledge of autism compared to individuals who are pro-vaccination. In order to use a MANOVA, the following assumptions must be met: a normal distribution, linearity, an absence of multicollinearity, and equality of covariance matrices (Fields, 2013). A normal distribution refers to the assumption that any outliers should be tested before running a MANOVA and that the dependent variables will be normally distributed within the groups. An examination of histograms revealed normally distributed variables. To ensure linear relationships between the pairs of dependent variables in each cell, a scatterplot matrix was conducted between the dependent variables and run separately for each distinct group of the MANOVA. The assumption of absence of multicollinearity was verified by ensuring that the correlation levels between dependent variables did not

exceed .90 (r = .46, p < .01). The equality of covariance matrices assumes that the dependent variables vary in equal measure across the range of independent variables. The Box's M must be nonsignificant to preserve the alpha level at .001. All of the assumptions were met except the equality of covariance matrices. In testing the assumption of homogeneity of covariance matrices, the Box's M test was significant (p < .001), suggesting heterogeneity of variances, a violation of one of the assumptions. Given the large difference in sample sizes between the pro-vaccination and anti-vaccination groups, the Box's M test should be trusted and any significant results from the MANOVA should be interpreted with caution.

Using Wilks's lambda, there was a significant effect of vaccination stance on confidence in knowledge and autism knowledge, $F(1, 197) = 10.71$, $p < .001$, $\Lambda = .901$, $\eta^2 = .099$. Upon further investigation, there were no significant differences between knowledge levels of autism based on vaccination stance, $F(1, 197) = 2.51$, $p = .11$, but a significant difference was found for confidence in knowledge based on autism stance, $F(1, 197) = 8.96$, $p < .01$, $\eta^2 = .043$. Those who endorsed being not in favor of vaccinations were found to be more confident in their knowledge (M = 83.21, SD = 7.02) in comparison to those in favor of vaccinations (M = 78.07, SD = 9.35).

Hypothesis 2: A chi-square test of independence was performed to examine the relationship between vaccination stance and source of information on autism and vaccines (i.e., internet vs. physician). Assumptions of the chi-square test include independence (each subject may contribute to only one cell of the contingency table, and therefore the sum of all frequencies in the table must be equal to the number of subjects included in the study) and expected frequencies (no one cell should have an expected

frequency of less than 5; Fields, 2013). All assumptions for the chi-square analysis were met. The relation between vaccination stance and information source was significant, $\chi 2(1, N = 199) = 7.30$, $p < .001$. Those who endorsed being in favor of vaccinations were shown to be more likely to obtain information from physicians, whereas those who were not in favor of vaccinations were equally distributed between internet and physician as information sources. Specifically, based on the odds ratio, the odds of relying on a physician as a source of information on autism was 2.78 times higher if in favor of vaccinations than if not in favor of vaccinations.

Hypothesis 3: A one-way MANOVA was conducted to determine whether vaccination stance significantly differed on the dependent variables of confidence in source: physician versus internet. The aforementioned assumptions tested in the first hypothesis for the MANOVA were also tested in this hypothesis. The assumptions involving normally distributed variables, linearity between dependent variables, and an absence of multicollinearity between dependent variables ($r = -.38$, $p < .001$, were satisfactorily met. However, the equality of covariance matrices was violated with a significant Box's M test ($p < .001$). Results, therefore, should be interpreted with caution.

Using Wilks's lambda, there was a significant effect of vaccination stance on confidence in physicians and the internet, $F(1, 197) = 55.27$, $p < .001$, $\Lambda = .64$, $\eta^2 = .36$. Upon further investigation, there were significant differences between confidence levels in physicians as a source of information based on vaccination stance, $F(1, 197) = 74.1$, $p < .001$; $\eta^2 = .27$, and there was a significant difference found for confidence in the internet as a source of information based on autism stance, $F(1, 197) = 55.93$, $p < .001$, $\eta^2 = .22$. When examining the means in confidence ratings across internet and physicians

based on vaccination stance, the results are in the opposite predicted direction (see Table 3). Specifically, pro-vaccination participants displayed higher levels of confidence in the internet as an information source and lower levels of confidence in physicians as an information source compared to participants against vaccination. Therefore, hypothesis 3 was not supported. It should be noted that a significant negative correlation between information sources (r = -.38, p < .001) was observed. This suggests that the more confident the participants were in their physicians as a source of information, the less confident they were in the internet.

Table 3
Descriptive Statistics for Entire Sample

	Information Source	Mean	*SD*
In favor of vaccinations	Internet	45.05	5.10
	Physician	24.23	5.93
Not in favor of vaccinations	Internet	36.70	8.79
	Physician	34.58	7.94

Note: SD=Standard Deviation

Due to the limitation of unequal groups with the full sample, the analyses were completed again using a random sample of those in favor of vaccination in order to make the vaccination groups equal in size. For the random sample analysis, 33 randomly selected participants who were in favor of vaccination were included with the 33 participants who were against vaccination yielding a total of 66 participants. Eighty five percent of respondents were female and 97% identified as White. In terms of geographical representation, 36% of the participants identified as from the Northern United States, 36% from the East, 12% from the West and, 10% from the South as defined by the U.S. Census Bureau (U.S. Census Bureau, 1995). In terms of education, 43% of participants held a 4-year degree, and 21% endorsed having a master's degree.

With regard to political stance, 28% of participants identified as liberal, 20% identified as moderate and 14% identified as conservative. In terms of income, 47% of participants reported an annual income exceeding $100,000. For a complete demographic breakdown, see Table 4. Table 5 provides the means and standard deviations of the random sample for the main measures of the study.

Table 4
Sociodemographic Characteristics for Random Sample

Demographics for Random Sample		
	n	%
Gender		
Male	10	15
Female	55	83
Other	1	2
Race		
White	64	97
Other	2	3
Hispanic [a]	3	5
Geography		
North	24	36
South	6	9
East	24	36
West	8	12
Outside the US	4	6
Education		
High school graduate	3	5
Some college	7	11
2-year degree	6	9
4-year degree	29	44
Master's degree	14	21
Professional school degree	7	11
Extremely liberal	5	8
Liberal	19	29
Slightly Liberal	10	15
Moderate	13	20
Slightly Conservative	9	14
Conservative	9	14
Extremely Conservative	1	2
Income		
$20,000-39-999	6	9
$40,000-59,999	3	5
$60,000-79,999	14	21
$80,000-99,999	12	18
$100,000 or above	31	47
Vaccine Stance		
In favor of	33	50
Not in favor of	33	50

Note: *n*=number of participants, [a] reflects the number of participants answering "yes" to this question

Table 5
Descriptive Statistics for Random Sample

	Vaccination Stance	Mean	*SD*	*n*
Autism Scale	In favor of	104.21	8.71	33
	Not in favor of	101.03	14.19	33
	Total	102.62	11.79	66
Confidence in Autism Scale	In favor of	77.72	9.69	33
Knowledge Scale	Not in favor of	83.21	7.01	33
	Total	80.46	8.8	66

Hypothesis 1: To test the hypothesis that individuals who are anti-vaccination would show significantly higher confidence in their knowledge and lower knowledge of autism compared to individuals who are pro-vaccination, a one-way MANOVA was conducted. All assumptions were tested and met except for the Box's M test, which was significant ($p < .001$), suggesting heterogeneity of variances, a violation of one of the assumptions. However, with relatively equal group sizes, as is the case for this analysis where the groups are of equal size, the MANOVA is robust to the violation of this assumption (Field, 2013).

A positive correlation was found between knowledge of autism and confidence in knowledge of autism ($M = 102.62$; $SD = 11.79$). This suggests that as knowledge of autism increases, so does confidence ($r = .284$, $p = .01$). Mirroring the results from the whole-sample analysis, a statistically significant difference was found between vaccination stance across the dependent variables, $F(1, 65) = 5.67$, $p < .01$, $\Lambda = .85$, $\eta^2 = .15$. Upon further investigation, there were no significant differences between knowledge levels of autism based on vaccination stance, $F(1, 65) = 1.20$, $p > .05$, but there was a

significant difference found for confidence in knowledge based on autism stance, $F(1, 65) = 6.93$, $p < .016$, $\eta^2 = .10$. Those who endorsed being not in favor of vaccinations were found to be more confident in their knowledge ($M = 83.21$, $SD = 7.01$) in comparison to those in favor of vaccinations ($M = 77.73$; $SD = 9.69$).

Hypothesis 2: A chi-square test of independence was performed to examine the relationship between vaccination stance and source of information on autism and vaccines (i.e., internet vs. physician). Assumptions for the chi-square test were satisfied; however, the overall test statistic was not significant, $\chi 2(1, n = 66) = .54$, $p > .05$. Hypothesis 2, therefore, was unsupported, as no significant relationship was found between vaccination stance and source of information on autism and vaccines.

Hypothesis 3: A one-way MANOVA was conducted on the random sample to determine whether vaccination stance significantly differed on the dependent variables of confidence in source: physician versus internet. All assumptions were tested and satisfactorily met except for the Box's M test, which was significant ($p < .001$), suggesting heterogeneity of variances, a violation of one of the assumptions. Given the equal sample sizes between the groups in the current analysis, however, the MANOVA is robust to the violation of this assumption (Field, 2013).

A significant effect of vaccination stance on confidence in knowledge and autism knowledge was observed, $F(1, 65) = 19.92$, $p < .001$, $\Lambda = .613$, $\eta^2 = .39$. Upon further investigation, there were significant differences between confidence levels in physicians as a source of information based on vaccination stance, $F(1, 65) = 27.16$, $p < .001$, $\eta^2 = .30$, and there was a significant difference found for confidence in the internet as a source of information based on autism stance, $F(1, 65) = 18.41$, $p < .001$, $\eta^2 = .22$. When

examining the means in confidence ratings across internet and physicians based on vaccination stance, the results are in the opposite predicted direction (see Table 6). Specifically, pro-vaccination participants displayed higher levels of confidence in the internet as an information source and lower levels of confidence in physicians as an information source compared to participants against vaccination. Therefore, replicating the results of the full-sample analysis, Hypothesis 3 was also not supported in the random-sample analysis. Also aligned with the full-sample analysis, a significant, negative correlation was observed between the dependent variables, confidence in physician and confidence in internet, $r = -.35$, $p < .01$. This suggests that the more confident the participants were in their physicians as a source of information, the less confident they were in the internet.

Table 6
Descriptive Statistics for Entire Sample

	Information Source	Mean	*SD*
In favor of vaccinations	Internet	44.42	1.27
	Physician	25.21	1.27
Not in favor of vaccinations	Internet	36.70	1.27
	Physician	34.58	1.27

CHAPTER 5: DISCUSSION

Summary of findings.

Hypothesis 1

The results of this study provide new insight into our understanding of attitudes toward vaccine policy. First, in both the whole- and random-sample analyses, the findings showed that individuals who were not in favor of vaccinations tended to be more confident in their knowledge of autism and vaccines in comparison to those who were in favor of vaccinations. Such was the case in both the whole- and the random-sample analyses despite there being no difference in objective knowledge about autism and vaccines between those who endorsed being in favor of vaccinations and those who did not. This finding suggests that while individuals who are against vaccinations have no difference in levels of objective knowledge from those who are in favor of vaccinations, they are nonetheless more confident in this knowledge. While baseline levels of knowledge about autism and vaccines were high in both groups, confidence wavered based on vaccination position. Individuals who have chosen to be against vaccinations may have also therefore chosen to do much more independent research, as their beliefs diverge from mainstream thought. This is in opposition to individuals who potentially have passively received evidence-based information on the topic and who have not had to go to any further lengths to substantiate their beliefs. As a result, while anti-vaccination and pro-vaccination groups have the same high levels of objective knowledge, anti-vaccination individuals who have had to further substantiate their position might feel more confident as a result of their additional research into the topic. This also raises the

intriguing possibility that evidence-based knowledge of vaccines and autism in and of itself may be insufficient in producing a pro-vaccination stance.

Hypothesis 2

Second, in the whole-sample analysis, the relationship between vaccination stance and information source was significant. Those who endorsed being in favor of vaccinations were shown to be more likely to obtain information from physicians whereas those who were not in favor of vaccinations were equally distributed between internet and physician as information sources. This may help to identify sources of information influencing those holding an anti-vaccination stance. In fact, the odds of relying on a physician as a source of information on autism was 2.78 times higher if in favor of vaccinations. Counter to expectation, those holding anti-vaccination positions are therefore not relying exclusively on the internet for information pertaining to vaccines and autism. However, those holding pro-vaccination positions are relying on physicians to a greater degree. Therefore, a more pronounced reliance on physicians might be needed to help sway individuals' beliefs regarding vaccination stance. Identifying the most trusted and readily accessed sources of information on vaccine and autism misinformation could have important implications regarding efforts to specifically target and screen these sources. Understanding the source of misinformation could help bring attention to a lack of accessible evidence-based information and, importantly, help propagate efforts to counter this increasingly significant concern. In this second hypothesis, the relationship between vaccination stance and information source was significant in the whole-sample analysis, but not in the random-sample analysis, leaving it currently unsupported.

Hypothesis 3

Third, in the opposite predicted direction for both the whole- and random-sample analyses, those in favor of vaccinations displayed higher levels of confidence in the internet overall as an information source and lower levels of confidence in physicians as an information source compared to participants not in favor of vaccinations, where the opposite pattern was found. However, the more confident the participants were in their physicians as a source of information, the less confident they were in the internet. This could possibly be attributed to the fact that those who are in favor of vaccinations access more reputable sources on the internet, thereby giving them a sense of confidence in the information they are consuming. Given the more confident participants were in their physicians as a source of information, the less confident they were in the internet, a confirmation bias effect may be at play. For example, individuals who are not in favor of vaccinations might also intentionally choose health care providers who align with their beliefs, such as alternative medicine providers, depriving themselves of an opportunity to receive substantiated medical advice on vaccinations. As *physician* was not further operationalized in this study, those with an antivaccination stance may have come to view another alternative medical provider who is not aligned with mainstream medical practice as reputable and trustworthy on these matters. Other research suggests that individuals not in favor of vaccinations may have basic cognitive or affective differences that influence their vaccination position (LaCour & Davis, 2020). These individuals may not only be simply seeking out confirmatory information on vaccines but also be cognitively predisposed to attend to many other negative, mortality-related events. This finding suggests that individuals not in favor of vaccines are attending to, and therefore encoding,

biased information more so than others who do not share their beliefs (LaCour & Davis, 2020). Future research is needed to better understand the cognitive mechanisms at play in this phenomenon.

Significance.

Relevance to theory and practice of psychology.

This study is relevant to the theory and practice of psychology as psychologists are in a position of authority to translate research findings to the population they service. Psychologists often serve as important members of interdisciplinary and integrated treatment teams that continue to inform the public at the ground level. Acting as mediators between medical physicians and consumers of health care services, psychologists could ostensibly help with the distribution of objective information in pediatricians' offices when vaccinations are offered. They might also use psychoeducation in practice when these issues do arise to help proactively distribute information when relevant. Psychologists can also be key figures in the explanation of the onset of autism, the typical presenting symptoms, and the trajectory of the disorder from a neuropsychological framework. Lastly, psychologists can act as champions for the dissemination of accurate and accessible information on autism and vaccinations online, building on platforms already available to target vulnerable populations, as well as capitalizing on social psychological literature regarding respectfully and effectively countering the trend of denial of empirically based information.

General Implications.

A few policy-oriented effects become manifest when considering the statistically significant findings for this study. First, these findings suggest efforts to counter vaccine-

related misinformation are currently insufficient. Despite attempts by the CDC, among other organizations, to distribute information on this topic in pediatrician offices and on various government websites, efforts to reach the public are nonetheless severely lacking in breadth. Social media is extensively used by anti-vaccination campaign groups to distribute easily accessible and relatable information that is heavily flawed and scientifically unsubstantiated. More than ever, efforts to begin distributing equally effective, targeted campaigns with valid information are critical.

Second, these results suggest individuals who are in favor of vaccinations are relying on more evidenced-based sources of information. However, this information may not be accessible or palatable to the population already wary of information on the internet. For example, the web-edition NYTimes Opinion Section recently released a 4-minute satirical animated cartoon titled, “The Fool House Rock: Anti-Vaxx Fallacies,” which served as a mockery for anti-vaccination logic while following characters “Polio” and “Measles” on their epidemiologically accurate journeys to infection. This is an example of a contemporary use of social media to distribute scientifically accurate facts, a positive effort. However, ridicule of the group in question, should they access the internet and come across pieces like this in the first place, might act only to repel these individuals further. These kinds of campaigns “preach to the choir” and certainly do not help to change opinion. Use of social media to target anti-vaccination groups must be concise, factual, relatable, and, therefore, not deriding. One recent study revealed the effectiveness of changing opinions of deniers of various scientific topics by identifying certain rhetorical techniques used by antivaccination groups. The authors found that employing similar language used by the group was more effective in engaging in

productive dialogue and in sustaining attention (Schmid & Betsch, 2019). It also demonstrated that presenting facts to overwhelm the group's opposition proved to be a key component of changing opinion. For example, when anti-vaccination groups presented the claim that vaccinations should be 100% effective, the rebuttal might sound something like "most vaccines are 85% to 95% effective, which is pretty close." The authors also explored what they termed "impossible expectations," such as the claim that vaccines should be 100% effective at all (Schmid & Betsch, 2019). A retort to such an expectation might look like proposing that no medical intervention can be guaranteed to be 100% effective in any domain (Schmid & Betsch, 2019). These techniques might be useful to counteract false information regarding vaccines and autism both online and offline.

Third, beginning policy considerations regarding the importance of mandating vaccines for nonmedically exempt populations is critical in order to contain the spread of previously eradicated diseases given the number of outbreaks currently being reported across the country by the CDC (2018). Going forward, policy makers must consider both the importance of herd immunity to protect the vulnerable and the benefits of vaccines, such as the complete eradication of cervical cancer by the administration of the HPV vaccine, in devising suggestions or imposing mandates for childhood vaccinations (CDC, 2018). Certain anti-vaccination groups have opposed mandates on vaccinations on libertarian principles. These individuals have historically made their voices heard by protesting efforts to litigate vaccines under the premise that mandating vaccines undermines civil liberties (Vines & Faunce, 2012). It remains critical to target this

population with not only data, but also perhaps examples of other arguably intrusive laws (e.g., seat belt laws) to which all abide for common protection.

The null findings also suggest several related implications. First, the dichotomizing of source of information between internet and physician may not be realistic, as most internet users would also consult their physicians and possibly be even more informed regarding the facts about vaccine and autism than any individual group on its own. Second, some individuals are indeed responsible in their use of the internet. Individuals may be pulling valid information from more reliable sources, such as medical online libraries or well-reputed and openly available sources, such as the CDC. In these cases, reliance on the internet would not necessarily be incongruent with reliable information sourcing, an assumption of this study. Third, most internet users who are accessing information about anti-vaccination positions might consult with medical professionals outside of the mainstream medical community who are using alternative practices toward commonly recommended vaccinations. Individuals might be inclined to seek out further information from a medical source they do not view as entrenched in mainstream views (Kata, 2012). More studies are needed to further examine these possibilities.

Advocacy Implications.

Psychologists and medical professionals aware of the effect of overconfidence on patients' decision making are in a prime position for educating, as well as redirecting, patients toward more accurate and evidence-based sources of information regarding the link between autism and vaccinations. The United States is also in the midst of its most significant measles outbreak in nearly 3 decades as a result of misinformation spread by

the highly influential anti-vaccination movement (Kata, 2012). Without making clear, simple, and evidence-based information immediately accessible, it will become increasingly difficult to retort the dissemination of false information that has been shown to spread far more quickly (Soroush et al., 2018).

Limitations

The primary limitation of this study was the difficulty in accessing individuals not in favor of vaccinations. While the sample was representative of the attitudes toward vaccines in the population at large, more participants who endorsed not being in favor of vaccinations would have likely offered a more useful point of comparison. A second limitation of this study was the use of online survey data to inform levels of confidence, as well as knowledge base about autism. Specifically, controlling the access subjects have to online materials that could inform their answers remains impossible. Though a caveat to not search for information during the assessment was in place, there is no guarantee subjects complied. The scales are also entirely dependent on self-report, which comes with reliability and validity concerns. Third, the validity and reliability of certain scales must be further established. For example, the Autism Survey is a dated survey, and while reportedly validated by good psychometric data, it could potentially not represent more current aspects of autism as it is now understood. The Trust in Internet Scale was also developed for the purpose of this research, and while based on a previously validated measure, has not been validated on its own (Anderson, 2006). Further study of the scales used is necessary in future research. Other limitations include the dichotomization of source groups between physicians and internet to access information about vaccinations and autism. Individuals might trust or choose to use both sources and make decisions

regarding vaccinations regarding input from various sources equally. As heavy use and trust in the internet for medical information could lead to a bombardment of conflicting or false information, the internet also could be used responsibly to access valid information on the topic of autism and vaccines. Lastly, a potentially problematic assumption of this study is that internet usage for medical information is necessarily irresponsible and that physicians are necessarily reputable sources. Generally speaking, the assumption of the reputability of physicians as a source is overall less of a concern.

Future Directions

As this research considered only the role of physicians in decision-making processes, future research could examine the role of other authority figures in the community (e.g., religious leaders, family members, friends) and their impact on parental or personal decision making regarding vaccinations. Next, as overconfidence is likely a strong factor in choosing to forgo vaccinations, future research directions could also consider cognitive, social, or ideological effects beyond the Dunning-Kruger effect in decision-making processes regarding vaccinations. This could include further study into the effect of confirmation bias or specific demographic factors as they pertain to both access to information and decision-making processes regarding vaccination. For example, men aged 40 to 44 years old, individuals in high-income brackets (or low-income brackets in midwestern, rural areas specifically), or men with minimal college education have been more likely to identify as being against vaccination (Tomeny et al., 2017). Conflicting information has been collected on political stance or gender at large; however, women (new mothers especially) and those on extremes of the political

spectrum (both far left and far right) appear to be more likely to be against vaccinations (Hoffman et al., 2019).

Future research should also consider examining the role of social media outlets, specifically over the internet as a broad category, to separate the use of reliable sources from the use of more questionable sources. Although this research is concerned primarily with vaccinations and autism, some research has also been conducted that examines other scientific topics of relevance that continue to be debated despite strong evidence of a single viable position. This includes the tendency of individuals on various media platforms to use power terms to promote ideology consistent with belief (e.g., *climate change* vs. *global warming*; Lakoff, 2002; Schuldt et al., 2011). Others have looked at the tone the media uses when discussing the regulation of genetically modified crops (GMOs) and how attitudes in populations change over time as a result (Bickell, 2019). Although this research is relevant and important, future research could continue to examine these topics in depth.

Last, the demographic reached by this online survey revealed a mainly White, highly educated, upper-middle-class population of primarily female respondents. Although class and gender are associated with anti-vaccination stance to a degree, with certain subsets of women (e.g., new mothers) and those in both high-income and low-income brackets in rural areas specifically being more likely to choose not to vaccinate, these effects must be explored further. Ideally, future studies would target a diversified population that is more representative of the population at large in order to further generalize findings (Wei et al., 2009). These effects among racial minority groups, male individuals, or individuals from more varied geographical areas within the United States

might reveal different patterns of response that would be critical to more relevant and targeted public-service efforts.

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