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Scientific Perspectives on Autism Over Time

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ABSTRACT

Purpose: The study was conducted to examine changes in the beliefs and contents of articles on autism since the mid-twentieth century. Characteristics analyzed were the mentioning of pharmaceutical drugs, country, and institution of the first author, methodologies used, journal, and the year of publication. Methods: All articles (N=566) analyzed were published between January 1st, 1943 and December 31st, 2021. Inter rater reliability was assessed and there was a 94.4 percent agreement amongst raters. All articles were analyzed through both PubMed and PsycInfo. Results: A one way chi square indicated that there was a significant number of articles expressing mixed beliefs on the cause of autism. Scientific perspectives on the cause of autism have changed significantly over time. Particularly, the belief of empiricism (environmental factors) has decreased significantly, while both mixed beliefs and nativism have increased remarkably. Additionally, the mentioning of pharmaceutical drugs is involved with the beliefs on the cause of autism. Conclusion: Articles in the twenty first century are most likely to express both nativist and empiricist viewpoints on the cause of autism. Articles that express mixed beliefs are most likely to mention drugs in their study. The results impact scientific self-understanding on autism and beliefs in high-income countries, and advance scientific understanding globally.

Keywords: Autism, beliefs, nativism, empiricism, nature, nurture

The debate about whether mental illness is caused by environmental factors (nurture), biological factors (nature), or both factors has been ongoing for 2000 years (Spelke, 1998). Nativism refers to the idea that our skills and abilities are hardwired into the brain at birth. By contrast, empiricism is the approach that all knowledge and illnesses arise from our life experiences.

The nature versus nurture theory was credited to Francis Galton, an experimental psychologist who predominantly examined twin studies. Galton conducted twin studies to assess the relative impact of nature versus nurture. He concluded that nature had a greater effect on an individual's development than nurture. Edward Thorndike also believed that most personality traits between twins were shared and inherited. Thorndike believed that mental illness and personality were innate, rather than acquired through the environment.

Since the 1950s, a significant amount of research has led to a resurgence in scientific research revolving around genetic aspects of psychology (McGue, et al, 1993). Twin studies became a

common method among scientists in 1977 (Ronald & Hoekstra, 2011). Between 1930 and 1980, scientists promoted the idea that psychological and biological aspects of the mind and behaviour are distinct (Logan & Johnston, 2007). Scientist August Weismann promoted an influential theory that behavioural traits were inter-generational and separate from environmental effects (Logan & Johnston, 2007). Extreme nurturing theory is also referred to as empiricism, which is a belief that humans are born with a tabula rasa and that it is filled with experience. Both Freud and Skinner supported this approach. Nativism, on the other hand, argues that our traits are innate.

Autism is a neurodevelopmental disability that has been studied since 1911. Autism is a behaviourally diagnosed condition that is defined by impairments in social communication and the presence of restricted and repetitive behaviours (Randall, et al, 2018). Autism spectrum disorders include Asperger's syndrome (also referred to as high functioning autism), Rett syndrome, Childhood Disintegrative Disorder, Kanner's syndrome, and Pervasive Developmental Disorder. All these disorders of autism share similar traits, such as poor social skills, delayed fine motor skills, and problems related to sensory processing.

Academic studies prove that there is little discrimination between all autism diagnoses (Correa & Filipe, 2016). While neuroanatomical size in those diagnosed with autism is determined by genetic factors, environmental factors contribute to the varying neural trajectories (Jones, 2019). Further symptoms of autism spectrum disorders include abnormal body posturing and facial expressions, abnormal tone of voice, avoidance of eye contact or poor eye contact, behavioural disturbances, motor control problems, inappropriate social interactions, lack of empathy, and social withdrawal.

Asperger's syndrome was first described in 1944 by Hans Aspergers. Asperger's syndrome is characterized by difficulties with social and communication skills in children who have at least normal intelligence and language development. Aspergers believed that autism was fostered through innate factors. Contrary to this, the American doctor Leo Kanner believed that autism was induced by uncompassionate mothers (Correa & Filipe, 2016). Specifically, this ideation was known as the "refrigerator mother theory" (Correa & Filipe, 2016). Kanner's syndrome was identified by Kanner in 1943. It is known by many as the classical form of autism. Kanner used the term "infantile autism" to describe this condition (Jacobsen, 2010).

Rett's syndrome is a genetic neurological and developmental disorder that affects brain development and leads to a progressive loss of motor skills and speech. Rett's syndrome is the latest form of autism to be discovered (Hagberg, 2002). Rett's syndrome was identified in medical literature by physician Andreas Rett in 1966 (Hagberg, 2002). It is typically diagnosed between the ages of 6 and 18 months old (Hagberg, 2002).

Heller's syndrome (childhood disintegrative disorder) is a rare condition characterized by a late onset, in addition to genetic, autoimmune, and neurobiological deficiencies (Mehra, et al, 2018). In the DSM-4, pervasive developmental disorders encompass all disorders within autism (Waterhouse, et al, 1992). Since the DSM-5 was published in 2013, autism spectrum disorders encompass all diagnoses mentioned in this paper (Vaughan, et al, 2017).

Pharmaceutical drugs have a significant impact on our mental health and are commonly prescribed for those diagnosed with autism (Compton et al, 2004). Drugs prescribed to treat autism spectrum disorders include selective serotonin reuptake inhibitors, such as Sertraline and Fluoxetine and Risperdal. Other drugs prescribed include antipsychotics like Clozapine and Haloperidol.

Specific serotonergic receptor genes are associated with autism spectrum disorders (Herault, et al, 1996). Specifically, the cerebellum, midbrain, pons, fusiform gyri, and the anterior cingulate, and orbitofrontal cortices (Dawson, 2013). Neuroinflammatory factors in the central nervous system may play a role in the development of autism (Picciotto, et al, 2006). Folding of the cerebral cortex is associated with environmental factors during childhood in both neurotypical and neurodivergent children (Jones, 2019). Furthermore, environmental factors were more influential than biological markers over cortical thickness and cerebellar white matter (Jones, 2019).

There exist differences in neural functioning between high functioning autism and low functioning autism (Correa & Filipe, 2016). For example, people diagnosed with high functioning autism have lower grey and white matter volumes, increased gyrification, and abnormal cortical folding in the inferior frontal areas (Correa & Filipe, 2016). Specifically, they have a greater amount of grey matter in supramarginal, superior temporal, and inferior parietal gyri compared to those diagnosed with low functioning autism (Correa & Filipe, 2016).

Results from both twin and family studies show that autism is predominantly inherited (Picciotto, et al, 2006). There is a 77 percent concordance rate (the rate of probability that two people with shared genes will develop similar traits) for male monozygotic twins and 50 percent for female identical twins (Grabrucker, 2013). The concordance rates of twins among fraternal twins were 31 percent for males and 36 percent for females (Grabrucker, 2013). This is contrary to earlier beliefs where scientists postulated that autism was caused by poor parenting styles. This supports the idea of empiricism (Picciotto, et al, 2006). Research has shown that siblings, cousins, and children of those diagnosed with autism were more likely to inherit autism (Bai, et al, 2019).

Many scientists express the belief that autism is caused by genetic mutations (Grabucker, 2013). For example, Rett's syndrome is often caused by mutations in the Methyl CpG binding protein 2 gene (Neul, et al, 2010). Children who are exposed to high levels of air pollution are more likely to develop autism (Dawson, 2013). Children exposed to the highest levels of traffic related pollution were three times as likely to develop autism compared to children with low exposure (Dawson, 2013). This supports the idea of empiricism in the modern era of technology, specifically that environmental factors are crucial to the development of autism (Dawson, 2013). Children diagnosed with autism were more likely to live in a region with high levels of air pollution during their prenatal and early postnatal periods (Dawson, 2013). For example, prenatal exposures to certain minerals like thalidomide may influence the development of autism (Picciotto, et al, 2006).

Methodological constructs and their relations to autism spectrum disorders, as well as empiricism and nativism, were explored through scientific articles and journals. Examples of methodologies relating to autism include technologies, psychometric testing, and diagnostic

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manuals like the DSM. To illustrate, a technology used for studying symptoms of autism is the magnetic resonance imaging. The magnetic resonance imaging provides is a powerful tool for investigating brain structural differences in children and adolescents diagnosed with autism spectrum disorders (Chen, et al, 2011). Specifically, the magnetic resonance imaging (MRI) is used to measure cortical and subcortical volumes (size) of certain brain regions. This includes the hippocampus, amygdala, and frontal lobes (Laakso, et al, 1995). These three neuroanatomical regions are involved with autism, and MRI can be beneficial in making a diagnosis (Laakso, et al, 1995).

Functional magnetic resonance imaging (fMRI) is also beneficial in revealing key functional brain differences in individuals who are neurotypical compared to those who are neurodivergent (Modinos, et al, 2011). FMRI is beneficial for examining the theory of mind in those diagnosed with developmental disabilities, such as autism spectrum disorders (Craig, 2004). Both an electroencephalogram and quantitative electroencephalogram have been used to examine functional differences regarding social behaviours in diagnosed individuals (Precenzano, et al, 2020). In the mid-1990s, MRI was used to show that autism is associated with brain enlargement (Dawson, 2013).

Based on positron emission tomography, there is evidence that there exists abnormally high level of microglial activation in individuals with autism spectrum disorders (Dawson, 2013). There are no medical tests to diagnose autism spectrum disorders. Rather, doctors and psychologists look at the child's developmental history and behaviour to make a diagnosis. Developmental screening examines how the child is developing. With developmental screening, the child will take a brief test, or the parent will complete a questionnaire about the child. In addition, a diagnosis of autism spectrum disorders may be done through the DSM-5 (Tanguay, 2011). The process of diagnosing autism spectrum disorders is usually conducted by either a clinical psychologist or a medical professional (Tanguay, 2011).

Scientific journals are crucial in research, as they are excellent means to convey research findings and latest developments. The *impact factor* of a journal indicates the importance of a journal within its subject and is used to measure the frequency of citations from the articles. The impact factor *is crucial*, as it is the frequency with which the average article in a journal has been cited in a particular way.

Journals that discuss the topic of autism and have a high impact factor are *Autism Research*, *The Journal of Autism and Developmental Disorders,* and *Molecular Autism.* The journal *Autism Research* is a bimonthly peer reviewed medical journal covering all forms of autism as well as other developmental disabilities. Established in 2008, it is the official journal of the International Society for Autism Research. *The Journal of Autism and Developmental Disorders* (originally named the *Journal of Autism and Schizophrenia*) is a historical medical journal founded in 1971 that is peer reviewed and publishes materials on developmental disabilities. The journal *Molecular Autism* had an impact factor of 7.509 in the year 2021, and it is also a peer reviewed medical journal covering research on the cause, biology, and the treatment of autism of neurodevelopmental disorders. The journal *Molecular Autism* was founded in 2010 and has a predominant focus on neurodiversity through a biological and genetic viewpoint.

While most people diagnosed with autism live in low- and middle-income countries, research knowledge about the condition is primarily generated in high-income countries (Hahler & Elsabbagh, 2014). Specifically, most research conducted on autism is from Europe, North America, and Australia (Gona, et al, 2016). The amount of research conducted by a country is directly affected by country income (Patel & Kim, 2007). Roughly, only 3.7 percent of published research in psychiatric journals emerges from less affluent countries (Patel & Kim, 2007). The proportions of psychiatrists in a country were associated with that country's research output (Patel & Kim, 2007).

Nearly 50 percent of research from low and middle countries is published by authors from high-income countries (Patel & Kim, 2007). This can impact the views of the scientist, as the research being conducted is being conducted from a different author. The proportions of articles submitted in psychological journals from low- and middle-income countries compared to that of high income were very low (Patel & Kim, 2007). A study conducted in 2007 showed that, out of a total of 2624 articles, less than 4 percent were published from low- and middle-income countries (Patel & Kim, 2007). Articles from both low- and middle-income countries were rejected far more than those from high-income countries (Patel & Kim, 2007). This may directly affect research about autism, as there is less research conducted in these countries. Furthermore, different psychometric tests are conducted between high- and middle/low-income countries (Vaughan, et al, 2017). A possibility for this could be the advancement in research and technology in high-income countries (Fitzpatrick, 2014).

GLOBAL PERCEPTIONS OF AUTISM

Separate regions around the world have different beliefs regarding autism (Fitzpatrick, 2014). For example, low- and middle-income countries are predominantly focused on environmental factors and autism spectrum disorders (Viljoen, et al, 2020). Specifically, many low- and middle-income countries are focused on parenting styles and the child's social life. High-income countries examine a range of themes regarding developmental disabilities, such as autism (Viljoen, et al, 2020). This includes viewing multiple aspects of autism spectrum disorders like neuroanatomy and environmental factors. Research on biological aspects of autism spectrum disorders was similar across low- and middle-income countries and high-income countries (Vaughan, 2014). An example of this is the functional neuroanatomy of those diagnosed with autism spectrum disorders.

Countries like India, Pakistan, South Africa, Jordan, Kenya, and the Philippines emphasize examining autism and social skills, quality of life, family life, and sensory processing (Viljoen, et al, 2020). Conversely, the United States of America, the United Kingdom, and Canada emphasize researching environmental factors of autism, as well as inheritance and mutations (Viljoen, et al, 2020). Also, in high-income countries, there is an interest between political views and autism (Viljoen, et al, 2020). Stigma surrounding autism was a theme that emerged mainly from studies of low- and middle- income countries (Viljoen, et al, 2020). In fact, in the Middle East, parents have reported being accused by relatives and peers around them for their child developing autism (Viljoen, et al, 2020).

THE RESEARCH QUESTIONS

This exploratory study examines the evolving scientific views on autism over time and its comparison to both empiricism (nurture) and nativism (nature), or nature and nurture (mixed

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beliefs). Another question that was assessed was the use of methodologies in articles that propose empiricism, nativism, mixed beliefs, and no beliefs regarding the cause of autism. For the category of methodologies, technologies like the MRI, psychometric testing (for example, ADOS), and relevant databases like the DSM criteria were coded in Microsoft Excel.

Scientists and professionals frequently examine neuroanatomical functioning and genetics leading to psychological disease (Fitzpatrick, 2014). It is a common belief that mental illness is caused by environmental and biological factors (Fitzpatrick, 2014). The research questions were (1) whether beliefs on autism have changed significantly over time, (2) in which journals the articles were published and their impact factor, (3) whether the country of the scientist is involved with beliefs on autism, (5) which methodologies were conducted and how the application of it is related with the beliefs on autism, and (6) whether there is an increase in the referencing of pharmaceutical drugs over time and how this is intertwined with the beliefs on autism.

METHODS

Articles Assessed

The scientists in this study used two databases to access the articles required for assessment. Five hundred and sixty-six (N=566) articles were analyzed through both PubMed and PsycInfo. All articles were selected from 7291 articles from both PubMed and PsycInfo. Specifically, 269 articles were from PsycInfo and 297 articles were from PubMed. Years were grouped as pre-1970 (N=6), 1970 to 1975 (N=34), 1976 to 1980 (N=25), 1981 to 1999 (N=4), 2000 to 2005 (N=17), 2006 to 2010 (N=50), 2011 to 2015 (N=154) and 2016 to 2021 (N=276). Search terms were autism and environmental factors, as well as autism and biology. All articles analyzed were required to be published between January 1, 1943 and December 31, 2021. The scientists chose to search for articles beginning in 1943, as autism was first described at that time by Leon Kanner (Jacobsen, 2010). An additional search between the years of 1943 and 1980 for each set of search terms was conducted. Also, for an article to be assessed, it had to mention autism in either the title or abstract. This further search was conducted because most articles were from the 21st century. The articles analyzed were assessed through a random sampling of the 7291 articles available.

Statistics

Inter rater reliability was assessed through random sampling of the 566 articles. Specifically, 25 articles (N=25) were assessed by the second rater. There was a 94.4 percent agreement amongst raters. Every twenty second article was assessed by the second rater to gather 25 articles. A random number generator was used to begin this assessment. Additionally, methodologies, drugs, countries, year, scientific journal, and the institution of the first author were coded in the software package Excel. Drug therapy was coded as either absent (0) or cited (1). Countries were coded as a 1 or 2 depending on whether they were high- or middle- and low- income. Beliefs were coded as 0, 1, 2, 3. A 0 represented no beliefs, while a 1 represented nativism, a 2 represented empiricism, and 3 represented mixed beliefs. Descriptive statistics, such as frequency, were conducted for the country and institution of the first author, as well as the methodologies used. Descriptive statistics on the journal of the article was also computed.

RESULTS

Scientific Beliefs and Autism

A one-way chi square proved that there was a significant number of articles that expressed mixed beliefs on the topic of autism $\chi 2$, (3, N=566) =232.14, P=<.001. As seen in Figure 1, integrated beliefs were the most common in 260 articles (N=260). This was followed by 199 articles (N=199) expressing beliefs of nativism. There were 56 articles (N=56) that expressed no beliefs on the cause of autism. Articles with empiricists beliefs had the least number of articles (N=51). The results indicate that most articles expressed perspectives that both environmental and biological factors contribute to the development of autism.

In addition, a chi square indicated that beliefs on the cause of autism changed significantly over time $\chi 2$ (21,566) =98.43, P=<.001. A Crammers V indicated that there is a moderate relationship between both categorical variables (V∈.241). Articles expressing empiricist beliefs were most common prior to 1970, with 33.3 percent of articles. This can be seen in Figure 2. From the period of 2000-2005, no articles expressed empiricist beliefs. Rather, in the period of 2011-2015, only 3.9 percent of articles mentioned empiricism. Only 8.3 percent of articles between 2016-2021 expressed empiricist beliefs. This can be seen in Figure 2. Specifically, there was a significant decrease in articles expressing empiricist viewpoints prior to 1970 and between 1970 and 1975. Between 1970 and 1975, only 26.5 percent of articles express empiricism. Based on the adjusted residual, there was a significant increase to 32 percent between 1976 and 1980. Articles expressing nativist beliefs peaked in the years of 1981 and 1999, with 50 percent of articles expressing nativist beliefs. From the years of 2016-2021, 36.2 percent of articles expressed nativist beliefs. After mixed beliefs during this period, nativist beliefs were most common.

Furthermore, none of the articles prior to 1970 expressed no beliefs on the cause of autism. There was a significant increase of 26 percent in articles expressing no beliefs in 1970-1975. Most articles (40 percent) expressing no beliefs were between the years of 1976-1980. Also, between 1981 and 1999, zero percent of articles expressed no beliefs on the cause of autism. From 2016 to 2021, only 7.6 percent of articles expressed no beliefs. Of the articles analyzed, mixed beliefs were the most frequent belief (47.8 percent) expressed recently (2016-2021). Mixed beliefs (both nativism and empiricism) were most common in the era of 2006-2010, as 60 percent of articles expressed this perspective. Mixed beliefs increased significantly since 1976-1980, as only 12 percent of articles expressed this belief.

The one-way chi square conducted proved that there was a significant amount more of articles analyzed from high-income countries $\chi 2$, (1, N=566) =428.31, P=<.001. Specifically, 522 articles were from high-income countries opposed to 34 articles came from middle- and low-income countries. The most common source countries of the articles analyzed were the United States of America (N=270), the United Kingdom (N=42), Italy (N=29), and Canada (N=27). High-income countries of the author for the articles analyzed included the Netherlands (N=15), Germany (N=11), France (N=12), Japan (N=11), and Australia (N=15). Examples of articles from middle- and low-income countries include Argentina (N=1), Iran (N=3), and Egypt (N=1). The most common low- and middle-income source countries were Brazil (N=11), Korea (N=7), and India (N=4). The most common institutions of the first author were UCLA (N=14), Stanford University (N=11), Harvard University (N=11), the University of Toronto (N=8), and the University of California (N=8). Prominent journals of articles assessed were the *Journal of*

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Autism and Developmental Disorders (impact factor of 3.04), *Molecular Psychiatry* (impact factor of 16.0), *PLos One* (impact factor of 3.24), and *Autism Research* (impact factor of 4.52). There was no significant difference between the beliefs on autism and the country of the first author, $\chi 2$, (3, N=566) =2.028, P=.567. A Crammer's V indicated that there is a weak relationship between both these variables (V∈.060). 92.7 percent of articles with no beliefs were from high-income countries compared to 95.4 percent of articles expressing nativist beliefs. 95.8 percent of articles which expressed empiricist views were from high-income countries, while 92.6 percent of articles expressing mixed beliefs were also from high-income countries. For articles expressing no beliefs, 7.3 percent of articles were from middle- and low-income countries. Articles expressing nativist beliefs had 4.6 percent of articles from middle- and low-income countries. For articles expressing empiricism, 4.2 percent of the articles from middle- and low-income countries. 7.4 percent of articles which expressed mixed beliefs were also from middle- and low-income countries.

The mentioning of pharmaceutical drugs did not increase over time $\chi 2$ (7, N=565)=2.289, P=.942. Contrary to this, there was a significant belief difference among articles mentioning drugs $\chi 2$, (3, N=565)=13.45, P=<.004. More articles expressing no beliefs had mentioned drugs compared to articles which did not. Specifically, 10.7 percent of articles expressing no beliefs mentioned drugs compared to 7.6 percent not mentioning drugs. Articles that emphasized nativist beliefs were more likely to have mentioned drugs. Specifically, 38.2 percent of articles which expressed nativism had mentioned drugs. This was the most common belief mentioning drugs after articles that expressed mixed beliefs (52.1 percent which mentioned drugs). There was a significant difference between empiricist articles mentioning drugs (11.4 percent) opposed to those that did not (2.1 percent). These results can be seen in Figure 3. A Crammer's V indicated a weak relationship between drugs and beliefs (V∈.154). Although the Crammer's V indicated that there is a weak relationship between both categorical variables, the results were still significant.

Methodologies and Beliefs

There were no significant differences between the methodologies and the beliefs $\chi 2$, (3, N=566)=4.953, P=<.175. A Crammers V indicated that there is a weak relationship between methodologies and beliefs (V∈.094). The most common methodologies used in the articles analyzed was rodent models (N=87), biological sampling (N=53), content analysis (N=51), and the DSM (N=34). Questionnaires conducted include the childhood autism rating scale, social communication questionnaire, and autism spectrum quotient. Examples of technologies which were applied in articles assessed include the EEG, PET, SPECT, MRI, and the fMRI. These technologies are all commonly applied methods for studying and treating autism (Kientz, et al, 2020).

While the results were not significant, articles with nativistic beliefs were most likely to have included methodologies (80.4 percent) followed by articles expressing mixed beliefs (78.8 percent). 72.5 percent of articles with empiricists included methodologies. Articles expressing no beliefs on the cause of autism were least likely to include a methodology (67.9 percent). With reference to articles expressing no beliefs on the cause of autism, 32.1 percent of these articles did not include a methodology. However, articles expressing nativist perspectives were more likely to include a methodology (80.4 percent), as only 19.6 percent of articles expressing this

belief did not include them. Most articles (72.5 percent) with empiricist perspectives applied methodologies, as 27.5 percent of these articles did not apply it. Methodologies applied were common in articles expressing mixed beliefs (78.8 percent). Contrary to this, 21.2 percent of articles with mixed belief perspectives did not solicit methodologies.

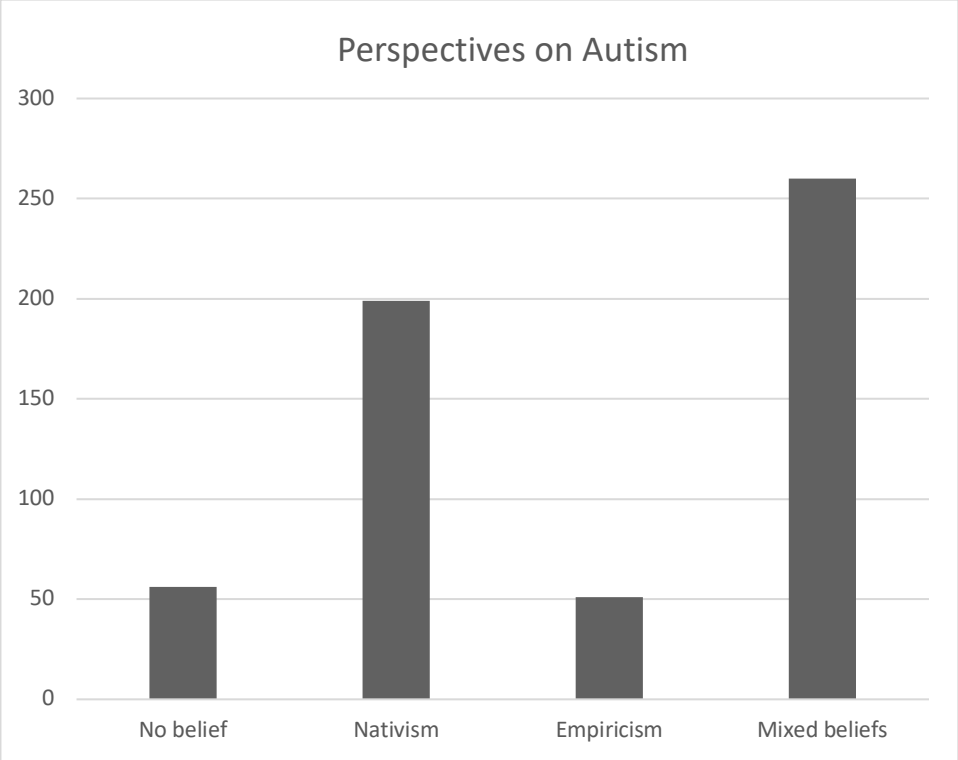

Figure 1: Number of Articles by Belief.
Note. Number of articles with mixed beliefs = 260 articles, rather articles with empiricist beliefs=51 articles.

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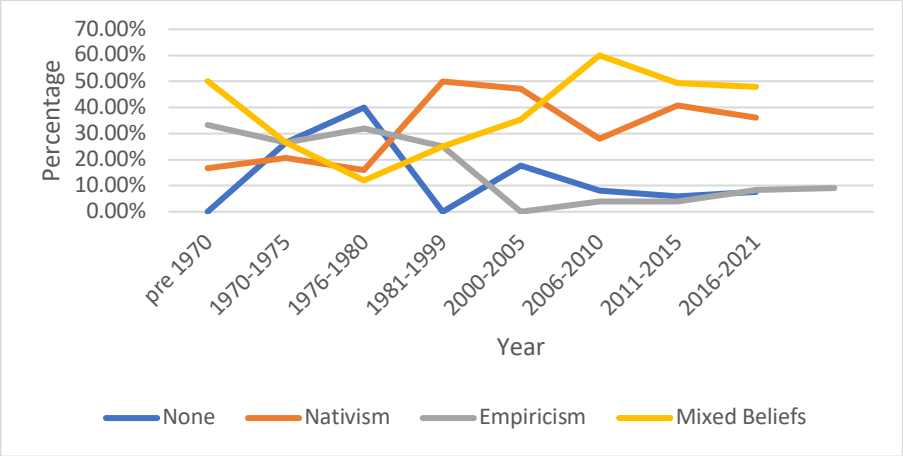

Figure 2: Beliefs on the cause of autism over time.
Note. Mixed beliefs and Nativist beliefs on autism have increased significantly over time.

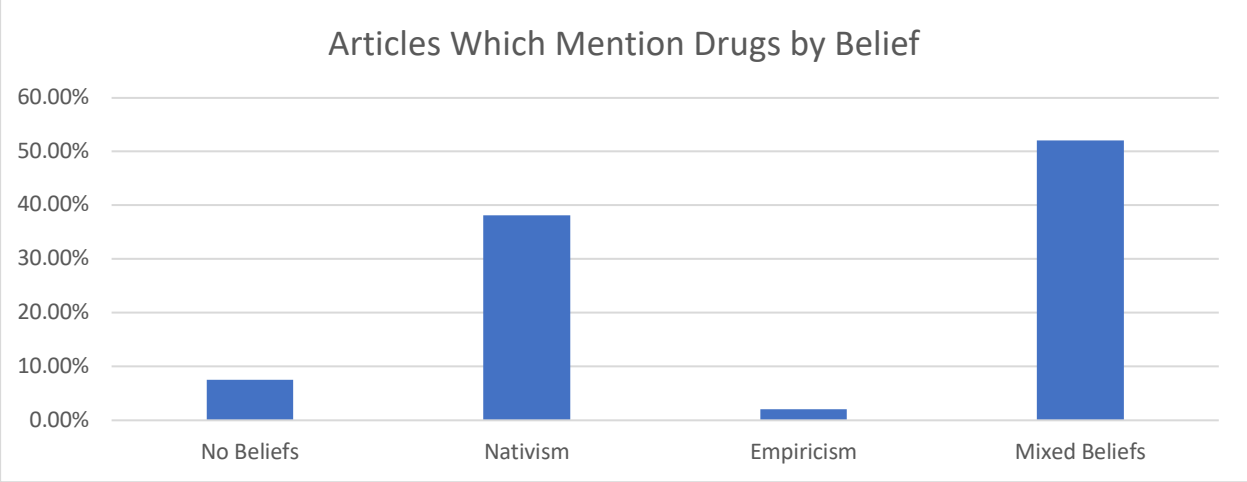

Figure 3: Beliefs on the cause of autism and mentioning of drugs
Note. Articles expressing mixed beliefs were the most likely to have mentioned drugs.

DISCUSSION

Limitations

Limitations of this study include a low number (N=34) of articles from middle- and low-income countries. While we assessed differences in beliefs between high-, middle-, and low-income countries, there was a smaller number of articles published from middle- and low-income countries. In this study, articles from the United States of America constituted 47.7 percent of articles. This made it challenging to assess differences among beliefs. Additional limitations include not examining the relationship between comorbid disorders of autism over time and scientific beliefs. Not tracking specific forms of autism mentioned in articles is a further limitation. It would have been beneficial to have determined how each form of autism compares to the scientific belief. An additional limitation of the study is that there is an uneven number of articles from year groups prior to 2006. Most of the articles analyzed were published between the years of 2006 to 2021 (specifically, 480 articles were from this period). Ideally, having a proportionate number of articles from each year group would have given us a broader perspective on how beliefs on autism have changed throughout history.

Impact of the Results

The results collected in this study indicate that perspectives on autism have changed significantly over time. The results also indicate that, recently, most scientists believe that autism is caused by both biological and environmental factors (mixed beliefs), as 47.8 percent of articles from 2016 to 2021 expressed this belief. Scientists examining autism through biological and environmental mechanisms has increased significantly since early years (prior to 1970). Articles examining parenting style, environmental factors, and autism have diminished significantly (Ronald & Hoekstra, 2011). A possible cause of this could be the increased prevalence of twin studies and various biological methodologies and technologies. For example, brain scanning techniques like the MRI, fMRI, CT, and PET scans have become popular within the past fifty years (Portnow, et al, 2013).

As seen in the results, there is no significant relationship between the methodologies and the scientific viewpoints on autism. Psychometric and battery tests are crucial instruments in diagnosing autism in all age groups (Wigham, et al, 2018). Various methodologies applied for researching autism have progressed significantly over time (Thompson, 2013), particularly, psychometric tests and biological sampling such as DNA analysis (Thompson, 2013). Examples of these methods include the ADOS, which was developed in 1989, as well as DNA analysis beginning in 1984 (Sorokin, et al, 2021; Cavalli-Sforza, 1998). The increase over time in specific methodologies, such as twin studies, is a potential reason for mixed beliefs on the cause of autism being common among scientists.

The mentioning of pharmaceutical drugs has increased dramatically over time in journals (Di Feo & Whissell, 2020). Despite this, the mentioning of drugs has not increased in articles regarding autism which were analyzed. As seen in the results, drugs are related to beliefs on the cause of autism. Many articles which expressed both mixed beliefs and nativistic beliefs had mentioned drug therapy in the article. Additionally, research in the pharmaceutical business has been impacted by the increase in modern technology and biological samplings (Vorstman, et al, 2013). This may influence scientific beliefs on autism.

The most common institutions of the articles published in the study were ranked within the top 100 universities internationally. Research from world renowned universities is more likely to get published, particularly in journals with a high impact factor (Oclay & Bulu, 2017). Higher ranked institutions are known to have higher financial accountability. Thus, they can use various types of studies to conduct research on psychological disease (Oclay & Bulu, 2017).

Overall, our results aid scientific self-understanding of autism among scientists. Through the results of this study, scientists can better understand how research on the cause of autism has progressed. These results will also encourage both scientific creativity and scientific communication among professionals worldwide.

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