**The Influence of the Gut-Microbiome on Early Childhood Behavior**

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**In recent years, more attention has been directed towards understanding the science behind mental disorders. The field is relatively unexplored compared to other areas of science. However, as the stigma surrounding mental disorders decreases and more reliable methods of quantifying psychological variables become available, research progresses. Recent studies have explored the effects of the human microbiome on mental state and other ailments. Rapid changes in the microbiome occur during the first two years of life (Lin et al. 2013). This time could heavily influence the mental state of the individual throughout adulthood (Lin et al. 2013). Therefore, it is important to understand how the microbiome affects the mental state of children under two, while their bacterial population is still developing. The focus is on the gut-brain axis. This refers to the signaling between gut bacteria and the central nervous system (Weltens et al. 2018). This article reviews a study conducted by the Ohio State Medical Center, which researches the relationship between gut microbial composition and temperament of subjects in early childhood. Several behavioral traits were found to be associated with specific taxa and abundance of bacteria. The researchers suggested that their work could lead to the possibility of altering gut composition to combat mental disorders.**

**Introduction**

There are more bacterial cells present in the human body than there are human cells (Slashinski et. al 2013). The sheer number and range of microbes emphasizes the influence they have on human health. The bacteria living in the human body can contribute positively to proper functioning such as: aiding with digestion, maintaining pH, and deterring pathogenic microorganisms through competition (Sanders, 2000). A considerable volume of research has allowed for an understanding of bacterial function in regards to physical health in humans. However, the possibility of bacteria contributing to mental state is a relatively unexplored topic. If a connection is established between the gut mircobiome and mental state, there is potential for intervention to treat and prevent mental disorders or improve mood. Shedding light on the unknown aspects of the human psyche is a pivotal step in the scope of human health.

**Recent Progress**

Recent studies show a relationship between bacteria present in the gut with the central nervous system (Cryan and O’Mahony 2011). The gut-brain axis describes this phenomenon. The details of the gut-brain axis have been the focus of many studies in the past decade. Variations in the makeup of the gut microflora have been linked to mental disorders, mood, obesity, and other issues (Dinan and Cryan 2014). The bacterial activity in the gut microflora affects the hypothalamic-pituitary-adrenal axis and the central nervous system (Carabotti 2015). Multiple studies have reported that stress hormones affect gut bacteria diversity (Irimia and Gottschling 2016).

The study reviewed measures the composition of the gut mircobiota and compares it to children’s temperament. Connections were found between certain species of bacteria and mood on one of the three composite scales of the Early Childhood Behavior Questionnaire, with the Surgency/Extraversion scale having the strongest correlation to bacterial species. There was a difference in males and females, but this aligns with previous work regarding gender differences in infants.

**Discussion**

This study focused on children under 24 months. Once a child reaches approximately two years old, their microflora will closely resemble that of an adult (Lin et al. 2013). Babies in the womb are sterile, but from the moment they are born, they begin to be colonized by bacteria. The gut microflora of children under the age of two is more malleable. Diet before the age of two affects the composition of the microbiome heavily. Babies who are breast-fed have substantially different microbiomes than those who are fed formula. The method of birth, and physical contact with the environment continues to alter the microbiome until it reaches a more stable state after approximately two years (Irimia and Gottschling, 2016). The researcher’s choice to observe babies under the age of two allows them to explore other questions regarding the gut-brain axis. This opens up the possibility of preventing mental disorders before they begin.

The researchers elected to use the Early Childhood Behavior Questionnaire as one of the measures of mood. The ECBQ is used frequently in psychological research and is well accepted. It measures 18 dimensions of temperament over three scales. The Shannon Diversity Index was also used to measure mood. It is difficult to generate methods involving mood and mental disorders that generate consistent results because mood and mental state can be very subjective and variable. The inability to take bias out of measuring mood brings up a degree of skepticism with the study. It has been established through previous studies that there are gender differences regarding mood. Gender also influences how the HPA axis functions (Butler and Nolen-Hoeksema 1994). To account for this, the results from males and females were analyzed separately. Next generation pyrosequecing was used to quantify the diversity and number of bacteria in the gut. Mothers collected stool samples from their children, which were then pyrosequenced to determine gut-microbiome composition.

The Surgency/Extraversion scale includes two subscales: sociability and High-Intensity Pleasure. Both of these subscales had higher readings associated with more diversity in gut composition. The results reported support the idea that the composition of microbes in the gut effect behavior. However, more research needs to be done to build a stronger case because the sample size used was small, and confined to one geographic region. Furthermore, it is difficult to have concrete, repeatable data when dealing with human emotions. Measurements of mood have vastly improved, but they are still not exact. Moving forward, these results need to be replicated so there is a more robust collection of data supporting the hypothesis. The hypothesis that artificial changes to the microbiome changes mood needs to be tested and could be extended to adults as well.

The human microbiome’s effect on human behavior is a fascinating new area of study. This particular study focused on children, which is an area that was previously unexplored. Children’s behavior has a substantial impact on their mental state as adults and their rapidly changing bacterial population allows for it to be manipulated easier than an adult’s established microflora. If research could indicate which specific species of bacteria produce positive results in the body, then there is the possibility of artificially introducing it into the microbiome to reap these benefits. The same logic applies for species of bacteria that cause harmful results. Their growth could be discouraged artificially. The possibilities are exciting and could change the way health and mental disorders are perceived.

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