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How are Different Personalities Affected by Social Media? Are Introverts Affected by it more than Extroverts?

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The Effects of Music Therapy on Improving Social Limitations Induced by Autism Spectrum Disorder

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# Maternal Factors that Affect the Child's Brain Development

By Alekhya Buragadda

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*Newborns around the world suffer from numerous dysfunctionalities as a result of maternal factors. To ensure that mothers can learn about these maternal factors and prevent problems with their child's brain development, it is crucial to research these factors and their impacts. By utilizing prior studies and their impacts on children, this paper is written in a cumulative manner that encompasses numerous studies and data to present detailed information about the subject matter. From infectious disease to maternal choices and environmental factors, this research study incorporates major precautions that mothers are recommended to take to ensure a healthy brain development for their child. For example, the amount of brain damage cases caused by preeclampsia is five to eight pregnancies and a newborn exposed to maternal smoking has a head circumference 0.5 cm smaller than a regular head circumference. Preeclampsia is caused by high blood pressure in women and smoking leaves dangerous impacts on the child's brain development. These are two of several maternal factors that have negative impacts on a child's brain development.*

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## INTRODUCTION

From birth to the age of three, the brain had already produced more than a million neural connections per second. How fast the brain develops is based on several factors, such as genes, proper nutrition starting in pregnancy, and the child's experience with others in the world. Depending on what type of experiences the child endures, such as positive or negative, can leave lifelong effects and shape the child's development. Hindrance to the child's development can come from pregnancy as well. For example, factors such as nutrition, infection, and stress can leave major impacts on the child's brain development, which will ultimately affect their physical and mental development. It is crucial to give attention to maternal factors that can

affect the child's development and to take precautions to prevent any sort of obstacles to the child. For preliminary knowledge for the research paper, it is crucial to understand certain nutrients that doctors recommend pregnant women to take to ensure sufficient nutrients for their children. An example of a vital nutrient is folic acid. Folic acid is used as a regulator for treating low and high blood pressure. Mothers usually take folic acid to prevent spina bifida, which is a common birth defect in the US. It translates to "split spine" in Latin because the backbone that connects the spine is incomplete in its formation, leading to physical and mental issues. Furthermore, because folic acid also regulates blood pressure, it prevents mothers from being infected with preeclampsia. Numerous diseases

can affect a child's brain development, but most of these can be prevented. This leads to the scientific question: What are the maternal factors that affect the child's brain development, and how can the negative impacts be prevented? If the mother endures extensive stress and improper nutrition, it will cause a hindrance to the child's brain development. Stress and improper nutrition are common factors that harm one's health, therefore, it can be hypothesized that these are the factors that leave the biggest impact on a child's brain development.

## ANALYZATION OF RESEARCH SOURCES

Through analyzing previous research papers and incorporating major themes from them, a full, in-depth understanding of what maternal factors affects the child's brain development is formulated. The common themes from these research papers include infectious diseases, maternal choices, and environmental factors.

Numerous infectious diseases can be formed from a variety of factors that affect the development of the infant's brain. A major one of these infectious diseases that can occur is asphyxiation, which is caused by the deprivation of oxygen during birth. One of the

maternal factors that trigger asphyxiation is maternal hypertension and preterm birth. Premature births have a greater risk of serious neurological disabilities or, in severe cases, death. Therefore, mothers must learn about the warning signs and know how to prevent premature births. To further ensure the prevention of asphyxiation, mothers should take certain medications, such as barbiturates, that also reduce the risk of infant brain injury. Another infectious disease that can affect the development of the infant's brain is preeclampsia. This is the condition in which a pregnant mother has high blood pressure and high levels of protein in her urine. Preeclampsia affects five to eight percent of pregnancies, which results in severe effects on both the child and the mother. This disease ultimately causes cerebral palsy in the child and the malfunction of the mother's vascular system. To prevent this illness, mothers should control their blood pressure by using medications and intaking certain nutrients, such as folic acid.

The choices that the mother takes are another factor that affects the neurological development of the child. Through various papers, researchers found that mothers taking vaccinations are beneficial for her and her baby. Mothers being protected from infections ultimately leads to the infant's

protection. For example, the baby's brain can be infected with the Zika virus during pregnancy. This virus is most common for miscarriages or babies born with defects, such as a smaller head. Therefore, mothers must take vaccinations their doctor recommends and attend regular gynecology screenings. The screens are beneficial for identifying potential dangers that affect the newborn's brain and preventing it early on. Another choice that mothers could make that would be disastrous for the child's brain development is exposure to toxins, including tobacco smoking and alcohol. A research study compares that a baby that is exposed to toxins such as nicotine, found in tobacco smoking, has a 0.5 cm smaller head circumference than a regular-sized baby's head circumference. Maternal smoking has severe consequences on fetal brain development and function. The nicotine has effects on the axonal pathfinding and formation of the neurons, interfering with the baby's brain development. Overall, mothers must make careful choices that are approved by the doctor to prevent any neurological diseases in the infant.

Lastly, the environmental factors that the mother is surrounded by can have severe impacts on the child. A stress hormone, called cortisol, plays a

vital role in fetal development.

However, if the woman is exposed to intense stress during pregnancy, or intense levels of cortisol, it can disrupt the development of the unborn child's brain. These disruptions in the child's brain can lead to hypersensitivity to stress later in life and vulnerability to disease, due to an immune system problem. Psychiatry professor from Harvard Medical College says, "Parental stress does not cause these disorders, it creates vulnerability to them." Therefore, mothers mustn't get exposed to intense stress, otherwise, the mother and the child are placed in a harmful environment. Alongside, proper hygiene influences the child's nervous system. The mother is in an uncleanly environment can lead to severe consequences, such as vulnerability to neurodevelopmental and psychiatric disorders. For example, unsanitary environments usually trigger inflammatory events during pregnancy by "farming" the intestinal microbiota, which has a direct effect on the developing nervous system. Disorders, such as autism and schizophrenia, are a result of these developmental problems. In conclusion, the environment in which mothers are surrounded has a huge impact on the child's brain.

## DISCUSSION

The information collected from the research studies adds additional information to the hypothesis. Uncleanly environments, improper nutrition, tobacco smoking, and infectious diseases are common factors that trigger bad health in a common person. Therefore, it is understandable that these are also the same factors that cause hindrance to the child's brain development during pregnancy. The scientific process is parallel to this research study as previous knowledge was applied to generate a hypothesis and common patterns seen can be used to create parallels with similar cases. The information contained in this research paper is crucial not only for mothers who can take precautions to ensure a healthy, developing mind for their child but for the scientific community. As explained earlier, these common factors are recurring in several other fields. For example, if the scientific question was to be what are the maternal factors that affect a child's cardiac development or bone growth, several of the common factors from this paper will be included. Furthermore, this research's objective will also be achieved, which is to present valuable information to pregnant women to understand what are the factors that can trigger improper brain development in

their childhood, allowing them to take precautionary measures. However, the maternal factors that contribute to a child's brain development discussed in this paper are not entirely complete. There are always several other minor or major factors that can differ on an individual basis, which can also contribute to improper brain development for the child. Additionally, no matter how many precautionary measures are taken, there could be chances that the hindrances cannot be prevented, which is largely due to genetics. This would be the largest drawback to this research because all the methods that mothers can take to ensure a safe brain development for their child cannot work in all pregnancies due to other possible chances of problems caused by other variables. However, it is still wise and recommended to take these methods in hopes that it could prevent problems for the child's brain development in most cases.

## CONCLUSION

Several mothers and children across the world suffer from hindrances to brain development due to certain maternal factors. If the mother has immense stress and an improper diet, there will be some problems with the child's brain development because these factors are common to leave negative

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# The Effects of Air Pollution on Cognitive Abilities in Children vs. Adults

By Jeslyn Fernandes

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*Environmental Neuroscience studies how the physical environment affects the brain and behavior. For example, a walk outside can improve memory and attention by 20% and life in a fast-paced city environment can lower rates of depression. The topic has yet to be fully integrated into undergraduate education, which is why this research utilizes Environmental Neuroscience to study the effects of air pollution on cognitive functions while raising awareness of the pollution problem. This research was gathered through readings of similar research papers trying to find a correlation between air pollution and the brain. Correlations can be found through observational studies and varying tests. Anthropogenic pollution studies show impairs on sensory systems and behaviors: such as signaling and navigation in animals. Neural and sensory responses show health benefits when exposed to “green” experiences, in other words, nature. Research, done by Brockmeyer and D’Angiulli, studies how air pollution alters brain development. For example, the children population in large cities, suffer some degree of neural/behavioral and cognitive changes with air pollution exposure. These toxic air particles lead to neuroinflammation that contributes to cell loss in the CNS which causes deficits in cognitive abilities. Current policy and research link air pollution to diseases in our respiratory, cardiovascular, and CNS especially in the pediatric population. Six certain air pollutants are affecting cognitive abilities: Particulate Matter, Ozone, Carbon Monoxide, Sulfur Dioxide, Nitrogen Oxide, and Lead. This research specifically looks at Particulate Matter, Ozone, Carbon Monoxide, Nitrogen Oxide, and Lead. The results show that both children and adults are facing implications of air pollution, but it's more prominent in children and the results are not fully conclusive.*

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## INTRODUCTION

Environmental Neuroscience is a topic that is mostly unheard of in the science community, however, it is vital in our understanding of how the environment can affect human cognitive abilities. Over the last couple of years, the contribution toward reducing climate change has been the bare minimum compared to the human contributions to enable climate change. Anthropogenic pollution has been proven scientifically for many years for the deterioration of our environment.

Specifically, air pollutants have been affecting several living organisms on our planet. Whether it be human health, metabolism in plants, the stratospheric ozone, or the ecosystem, air pollution can create deficits in human cognitive abilities. Bringing up the question if air pollution alters brain development that results in a decrease in cognitive abilities? This research delves into five air pollutants that are altering brain development: Particulate Matter, Ozone, Carbon Monoxide, Nitrogen Oxide, and Lead. Looking into other successful

research that tries to debunk or prove the hypothesis that if the specific six air pollutants are exposed into the atmosphere, then humans will show signs of impairments in cognitive abilities because of their brain-altering effects. The paper looks into other research that seems to explore the hypothesis through a variety of age groups which this paper later analyzes for correlations between different age groups. It is important to understand and improve the environmental quality we surround ourselves with daily because of its direct effect on human health and well-being. Finding solutions to provide clean air to this generation and the next is vital for improvement as a society and loved ones that suffer from anthropogenic pollution.

## ANALYZATION OF RESEARCH SOURCES

This research will reference six different air pollutants that correlate to implications for the cognitive abilities of the child and adult brain.

## CHILDREN

Children are continuously undergoing neurological and physical changes, making them more susceptible to the harmful effects of toxins within their surroundings. Particulate matter –

known as PM<sub>2.5</sub>– is suggested to alter brain development. PM<sub>2.5</sub> exposure was correlated to an increase and decrease in gray matter surface area, thickness, and volume which can result in loss of memory and reduce motor functions. Ozone is a reactive oxygen species that can damage the brain by inducing oxidative stress. Low doses of ozone result in progressive neurodegeneration, altering the hippocampus and brain plasticity to those similar diagnoses with Alzheimer’s disease. With carbon monoxide, a team at Dokuz Eylul University found that chronic exposure to 0.3% CO<sub>2</sub> air decreased IGF-1 levels in the serum, hippocampus, and PFC, and increased oxidative stress. These findings were associated with increased anxiety behavior, and impaired memory and learning. Recently published research assessed the risk of developing ASD in Taiwanese children and found a significant relationship between yearly average exposure to outdoor environmental CO and a new diagnosis of ASD. Concerning neurodevelopment, an acute, non-lethal maternal CO exposure at 20 weeks gestation due to the use of a defective indoor gas heater, resulted in dystonia in the exposed infant at 2 months of age. In a study of schoolchildren in China, researchers found a significant association between air pollution, particularly levels of NO<sub>2</sub>,

and poorer results on neurobehavioral tests designed to measure the children's sensory, motor, and psychomotor functions. Children with greater exposure to NO<sub>2</sub> also had an increased risk of developing attention-deficit hyperactivity disorder (ADHD). Increasing data have also indicated that even children with blood lead concentrations <10 µg/dL are at significant risk for reduced cognitive development and functioning, including IQ deficits and poor academic performance. Overall, regional and hemispheric differences in the brain are associated with several mental health and neurodevelopmental disorders: ADHD, Autism, and Depression. Because air pollution is a complicated mixture of toxins, teasing out the biological effects of individual agents is inherently challenging. However, children and adolescents are especially at risk for neurotoxic effects from air pollution with their developing brains.

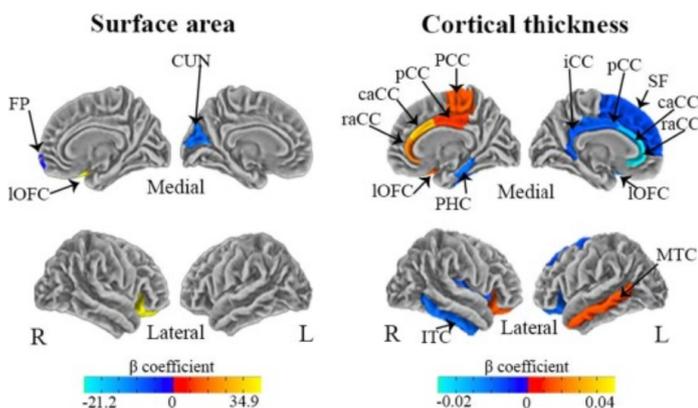


Figure 1. Hemispheric and regional specific differences of PM<sub>2.5</sub> exposure shown above. The dark-light blue colors have a negative association and the red-yellow colors show a positive association.

## ADULTS

In the labor force, some adults spend most of their time indoors in an office or home. Increased concentrations of fine particulate matter (PM<sub>2.5</sub>) and lower ventilation rates were associated with slower response times and reduced accuracy on a series of cognitive tests. Researchers noted that they observed impaired cognitive function at concentrations of PM<sub>2.5</sub> and CO<sub>2</sub> that are common within indoor environments. Increased levels of ozone correlated with an increased rate of cognitive decline, following adjustment for key individual and community-level risk factors. Furthermore, individuals harboring one or more APOE4 alleles exhibited a faster rate of cognitive decline. Performance of reasoning tasks, such as AB logic problems, was significantly slowed at the higher levels of CO<sub>2</sub>. More prolonged studies with inhalation of 6.5% CO<sub>2</sub> showed that after the first 10 min ventilation tended to increase, end-tidal PCO<sub>2</sub> to fall, and slowing of reasoning to recover, but a substantial decrement in performance continued for 80 min, by which time performance virtually stabilized. Research by Professor Ian Forsythe at the University of Leicester found that too much nitric oxide is extremely toxic and will cause the death of nerve cells; so within the kernel of this important

signaling mechanism are the potential seeds for neurodegeneration, which if left unchecked contribute to the pathologies of stroke and dementia. Whether breathed in, swallowed, or absorbed, lead particles have the same negative health effects when a person is exposed to very high levels of lead over a short period. This lead poisoning can cause memory loss, convulsions, and brain damage specifically that can lead a person into a coma.

## CONCLUSION

Pollution is a significant and complex problem that affects infants, children, adults, and seniors. Air pollution may act via multiple pathways, imparting wide-reaching effects on the brain and central nervous system: leading to some the widely known diseases such as Alzheimer's and dementia. "Evidence from the study of sociodemographic factors provides important and compelling data to prompt further consideration of pollution exposure and effects across different populations." And, leads me to question how economic factors play into cognitive decline. Should working from home be supported with results backing up the increase in cognitive response? Nevertheless, there are some limitations to the results. "Epidemiological studies indicate that

exposure to ambient air pollution can have adverse effects on cognitive decline and impairment, but the overall results are heterogeneous and not fully conclusive." The difficulty with studying the effects of pollutants on the nervous system via human studies is that exposure is hard to quantify. "More definitive phenotyping would also assist in circumscribing future studies of neurobiological mechanisms of action for cognitive impairments."

Anthropogenic pollution studies show impairs on sensory systems and behaviors such as signaling and navigation in animals. These animal studies allow exposure to be quantified in a more complex model, but the results may not be comparable to human studies. The number of epidemiological studies is still limited and additional longer-term studies are needed to confirm the findings. Acknowledging the relationship between cognitive impairments with air pollution is important to combat the ever-growing air pollution today that affects billions of people worldwide. Just by studying environmental neuroscience, people can engage and apply efforts to sustainability. Taking regulatory actions to counteract the exposure of the implicating air pollutants will better benefit societal well-being.

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# The Effects of Music Therapy on Improving Social Limitations Induced by Autism Spectrum Disorder

By Keshika Kajendran

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*This study was conducted to examine the effects of music therapy (MT) intervention on improving the social limitations in individuals with an autism spectrum disorder. This research paper is based on an analysis of several clinical papers provided by the National Library of Medicine. A total of 7 peer-reviewed articles were selected. The authors studied this problem by conducting clinical trials and interpreting data from other researchers. Analysis of these articles has led to the understanding that music therapy intervention may significantly aid the facilitation of social skills in individuals with autism. Further examination is needed to determine the limitations in the use of this therapy as a viable approach to improving communications skills.*

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## INTRODUCTION

Autism spectrum disorder is an umbrella term that represents all developmental disorders that present challenges with communication and socialization. Over the past four decades, there has been a ten percent increase in the number of children diagnosed with ASD (Ghasemtabar, et al. 2015). Limitations and deficits in social interaction are the main impairment in individuals with ASD, regardless of whether they are higher or lower functioning. Social interactions unravel an entirely different view of life that many take for granted. The modern world and society, in general, are built on a basis that supports this non-inclusive view. Children with ASD will become adults with ASD who are left to navigate the world on their own. Additionally, it has been identified that individuals with ASD are four times more likely to suffer from depression

than neurotypical (NT) individuals (Hudson, et al. 2018). In today's age, communication with others is used as an outlet to relieve stress and resolve problems, but a lack of this leads to isolation, which may worsen depressive symptoms. It is important to explore the methods that can be used to improve communication deficits in children with ASD so that they can have an easier time navigating life as an adult. Since social interaction and social skills are crucial to one's development in all stages of life, this issue must be addressed. If music therapy is implemented into the lives of individuals with autism spectrum disorder, then symptoms of social limitations can be reduced.

## ANALYZATION OF RESEARCH SOURCES

Emotional Recognition in Adults with High-Functioning Autism

In this experiment, fMRI was used to determine the correlation between emotional recognition in high-functioning adults with ASD and neurotypical adults. 43 participants were included in the study, and 23 participants had a formal diagnosis of ASD. The participants completed a questionnaire regarding their music preferences and overall history with music. The stimuli used were 12-second duration instrumental excerpts from real musical pieces. A group of 12 neurotypical individuals was used as the control group. Twenty happy and twenty sad excerpts were used and they were rated as either very happy/sad or just happy/sad by the members of the control group. All of the stimuli were matched on volume and duration. After the participants listened to the excerpts, they were given 6 seconds to rate them. The results demonstrate “intact neural processing of emotional music in high-functioning adults with ASD compared to NT adults”. It was also observed that individuals in both groups experienced greater activation in the limbic and paralimbic areas of the brain. These areas are known to be crucial for the emotional processing of music as well as other emotional stimuli (Gebauer, et al. 2014).

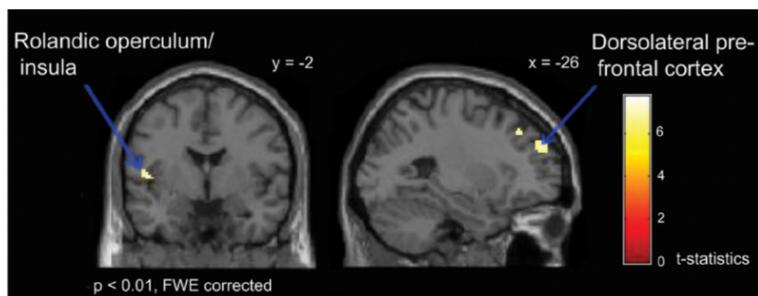


Figure 1: Increased brain activity in the emotional processing centers of the brain in individuals with ASD (Gebauer, et al. 2014).

### Music Therapy Intervention in Reducing Communication Deficits

In one study, children with mild autism (approximately 27 on the autism rating scale) were chosen and split into two groups: control and experiment. The social skills rating system scale was used to measure the social skill level of both groups. Children in the experimental group took part in Orff-Schulwerk music therapy programs for 45 days (2 one hour sessions per week). The Orff-Schulwerk music therapy program included singing songs and chants, listening to music, clapping, dancing, and working with select percussion instruments (triangle, bells, and tambourine). The control group did not receive any music therapy. “Statistic Package For Social Science (SPSS) software t-test” was used to compare the two groups. The results provide that music therapy can be used to introduce social skills in children but it can be

gradually eliminated, and children may be able to use the acquired skills independently of musical intervention. Statistical analysis of the results also provides that the effectiveness of music therapy on children can be present for up to two months after the intervention, and up to two years after the intervention when Music Interactive Therapy is applied (Ghasemtabar, et al. 2015).

Group	Test phase	n	Mean	SD
Experiment	Pretest	13	27.69	4.76
	Posttest	13	30.55	4.00
	Follow-up	13	30.61	4.25
Control	Pretest	14	26.92	4.49
	Posttest	14	27.34	3.54
	Follow-up	14	26.85	3.82

P-value = 0.02865

Graph 1: Mean SSRS scores of the control and experiment groups

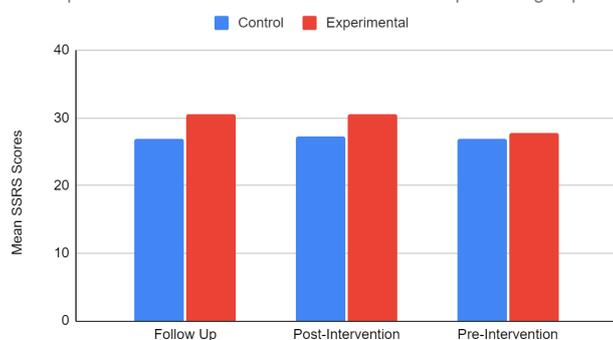


Figure 2: Mean SSRS scores of the control and experiment groups (Ghasemtabar, et al. 2015)

In another study, the neurobehavioral outcomes of music intervention on social communication were observed. Fifty-one children between ages 6-12 with autism were selected and separated into experimental (n = 26) and control

(n = 25) groups at random. This was a double-blinded study. The music intervention in experimental groups utilized cues from instruments, songs, and rhythm, and implemented social integration. The control group received non-music-related behavioral therapy. Both groups received 45 minutes of individual weekly sessions over a span of 8-12 weeks in a controlled setting. Two of the tests used to measure the social skills of the children were: CCC-2 (children's communication checklist) and SRS-II (social responsiveness scale). A baseline assessment was taken both pre and post-intervention to compare data. Evaluation of the CCC-2 data revealed that communication increased as inappropriate behaviors were reduced and social interests were increased. Evaluation of the SRS-II data did not reveal any significant music therapy-related improvements (Sharda, et al. 2018).

Group	Age	n	Pre-Intervention Mean	Post-Intervention Mean
Control	6-12	25	72.24	70.8
Experimental	6-12	26	70.15	69.36

\*SRS-II Social Responsiveness Scale T-Score \*Higher score means poorer skills

P-value = 0.082314

Graph 2: Mean SRS-II Scores in Control and Experimental Groups

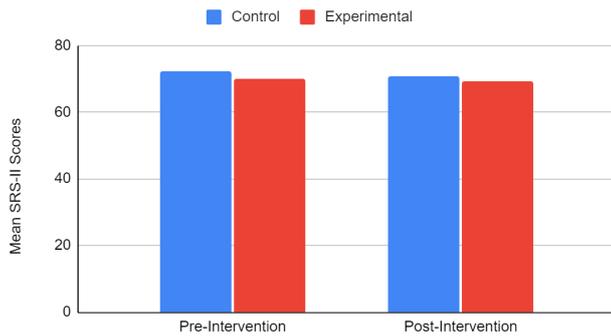


Figure 3: Mean SSR-II Scores in Control and Experimental Groups (Sharda, et al. 2018)

Group	Age	n	Pre-Intervention Mean	n	Post-Intervention Mean
Control	6-12	23	77.65	23	76.43
Experimental	6-12	25	76.84	24	80.46

\*Children's Communication Checklist Composite score

P-value = 0.24400

Graph 3: Mean CCC-2 Scores in Control and Experimental Groups

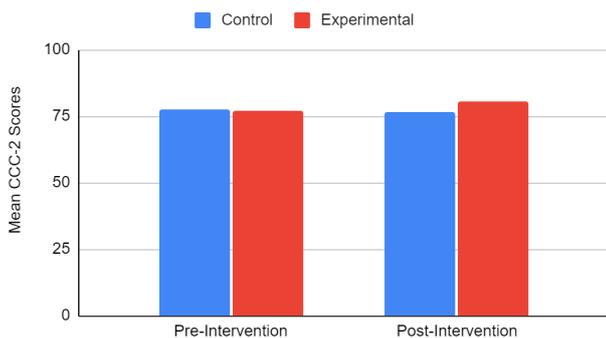


Figure 4: Mean CCC-2 Scores in Control and Experimental Groups (Sharda, et al. 2018)

### Effects of Playing Instruments on Improving Communication Skills

It has been identified that language limitations in individuals with ASD may be due to structural or physical abnormalities in the brain. Studies suggest that children who participate in “long-term instrumental practice” have a larger corpus callosum, frontal, temporal and motor areas, relative to their counterparts.” The authors have

concluded that music-making (AMMT) interventions may help facilitate communication and social skills. AMMT may also strengthen long-range connections between auditory and motor regions. AMMT stands for auditory-motor mapping training, this method utilizes the musical strengths of individuals with ASD. The method utilizes imitation, singing, as well as motor activity. Overall, the potential of AMMT is supported by neuroimaging (fMRI) research. As a result, AMMT interventions should be considered to improve ASD-induced social limitations (Leubner & Hinterberger, 2017).

### CONCLUSION

The research topic of interest is the effect of music therapy or music intervention on facilitating the communication deficits presented by individuals with autism. Individuals with autism spectrum disorder present challenges with social interactions and communication, and just within the past four decades, the diagnosis rate of children with ASD has increased by tenfold. It has been determined that individuals with ASD are capable of recognizing emotional stimuli, suggesting that music therapy can be used as a treatment to manage ASD induced communication deficits.

The research supports that with regular intervention, music therapy can reduce the symptoms of social limitations in individuals with autism spectrum disorder. A thorough analysis of several publications has suggested that music therapy may be an effective method to increase socialization in children. Data suggests that communication skills increased in children who received music therapy compared to children in the control group. When the mean test score values post-intervention were compared to the baseline scores, an increase was observed. The p-values less than 0.05 prove that these results are statistically significant. Research also sustains that direct engagement ( such as singing, songwriting, dancing, and playing instruments) garners stronger results rather than passive involvement, which includes listening to music.

Research needs to be conducted with participants of a larger demographic in order to determine the true effect of music therapy on increasing communication in individuals with ASD. Additionally, more studies need to be conducted to understand the biological and neurological activities that are triggered by music intervention that permit the changes in behavior to occur. It can be deduced that music therapy can be used as an effective tool to increase social participation in individuals with ASD.

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# How Does Parkinson's Disease Affect the Level of Dopamine in a Person's Brain?

By Aastha Kulkarni

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*Currently, there is no treatment for Parkinson's Disease however it has been speculated that the medication levodopa can potentially have a positive effect on a person living with this disease. The purpose of discovering the effects of levodopa on a Parkinson's disease patient is to further advance scientists' understanding of the disease and to further develop ideas to possibly treat Parkinson's. Several people around the world live with this disease and finding new ways to treat this disease would greatly assist in eventually finding a long-term treatment for people. The experiment was designed to be a double-blind, randomized, and cross-over trial. To evaluate the effect of this medication, an experiment was conducted to determine the ability of people to perform different tasks with and without the presence of levodopa in their bodies. It is determined that there is an interaction between Parkinson's disease and valence electrons that was measured by multiplying the action and valence. This helps to figure out the  $n^2$  and  $p$  levels in patients' bodies. Participants who were discovered to represent this finding have an  $n^2$  number of about .01 and a  $p$  level of .5. This experiment helped to elucidate that there is a relation between Parkinson's patients' ability to perform specific tasks and the presence of the medication levodopa.*

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## INTRODUCTION

An experiment conducted by Radboud University in the Netherlands determines how the variability in dopaminergic medication affects different types of reinforcement learning in Parkinson's patients. This research is relevant because all around the world, people live with Parkinson's disease and as of right now, there is no real treatment or medication to stop this disease from affecting people's lives. The understanding scientists learn from this research helps to advance the knowledge of Parkinson's disease and point scientists in the right direction to find a cure for this disease. Being able to come across a medication that allows people to live with Parkinson's disease

without having any major effects is a great deal in the world and would certainly improve people's quality of life. Levodopa is a medication that is taken by a person and directly affects their brain's nerve cells. This medication is converted to the chemical dopamine, which is needed to send information between brain areas and nerves that regulate movement within a person's limbs and body. So far, it is thought that increasing the amount of dopamine with the use of levodopa generally improves any movement problems people are experiencing. The problem is scientists have not yet understood how exactly levodopa affects a person with Parkinson's ability to perform tasks. Little is currently

known about how the medication improves different aspects of people's lives. Is there a way to determine how the medication levodopa affects a person with Parkinson's disease's ability to think and answer questions? The experiment conducted by this University informs scientists and the general population of how exactly this medication affects Parkinson's patients' way of solving questions by having participants perform different tasks. These tasks require the use of different parts of the brain to accurately and correctly perform them. Based on prior knowledge and understanding of the effect of levodopa on Parkinson's patients, the hypothesis is if a person who is living with Parkinson's disease experiences tremors and is given the medication Levodopa, then they will be able to thoroughly answer high-level thinking questions and perform tasks that require the use of different parts of the brain. This hypothesis was formed with the understanding that Levodopa primarily affects the neurotransmitter dopamine and dopamine is a chemical messenger that controls movement as well as pleasure. Different areas of the brain have specialized functions; the cerebellum cortex coordinates high-order thinking and processing, the frontal lobe is associated with reasoning and high-level cognitions, and the midbrain processes auditory and visual information, etc. It can be concluded that different parts of the

brain regulate different processes leading to the idea that if Parkinson's patients are given levodopa, the brain will function properly and be able to answer high-level thinking questions and perform high-level tasks.

## ANALYZATION OF RESEARCH SOURCES

This experiment was conducted twice and occurred over a period of three years from 2014 and 2017. The experiment consisted of a double-blind, randomized, and cross-over design. In both trials, patients attended both sessions in an OFF condition, which is defined as not taking medication for more than 3 times the drug's half-life, i.e. >12 hours after their last dose of levodopa and > 48–72 hours after their last dose of dopamine-agonist. Initially, before actually doing the procedure, a measurement of motor symptoms was taken in patients and healthy participants to serve as a control, a basis for comparing the results. To enhance gastrointestinal absorption and prevent adverse effects, all patients received a dose of domperidone (10 mg) 1 hour before drug/placebo administration in both sessions. Followed by the measurements and dose of domperidone, the medication levodopa or the placebo was administered to all participants. Participants who were given levodopa received a dose of 200/50 mg dispersible levodopa-benserazide, that was dispersed in water;

this triggered the ON response in Parkinson's disease patients. Participants who received the placebo were given a cellulose tablet that was dispersed in water (to match the texture), the tablet was visually similar and tasted similar to the medication levodopa. This ensures that participants and authorities would not know if they received levodopa or the placebo. Next, functional MRI scans and anatomical scans were taken to measure brain activity. Participants then completed the behavioral task after a brief break. To decouple the independent but interacting axes of motor response requirement (Go/NoGo) and motivational valence (Win/Avoid), participants completed a reinforcement learning task with four different task circumstances. Subjects were told to strive to win as many points as possible while losing as few as possible. The assignment took about 30 minutes to complete. Then after the tasks were performed, motor symptoms were assessed one more time to get measure how severe the medication or placebo affected participants. The cognitive evaluation (FAB/MMSE) was done on Day 2 to best fit the overall time on the first and second days, either in between the UPDRS/MRI and behavioral sessions or after the behavioral session. Among all the participants, every person demonstrated a motivational bias. There weren't any major differences between the patient group

that had taken levodopa (healthy control subjects) and the patient group that had not taken levodopa (healthy control subjects). When non-tremor patients were on Levodopa, they performed similarly to a control. Tremor patients that were not on medication performed similarly to the control as well. When patients with tremors did not take levodopa, they performed worse for avoid cues when compared to win clues. On the other hand, non-tremor patients who took levodopa performed better for win cues to avoid cues. Rodent studies have shown a stimulus-locked dopaminergic surge during Go-to-avoid trials, as well as enhanced functional MRI blood oxygen level-dependent responses in the dopaminergic midbrain during successful active avoidance, which aligns with the observation of dopamine enhancing avoidance learning in patients with tremors. This finding lends credence to the idea that dopamine plays a significant role in 'safety learning'. The research and outcome of the experiment prove that the hypothesis is supported because when people living with Parkinson's disease were administered the medication levodopa, they performed certain tasks better and answered questions more thoroughly and accurately.

## DISCUSSION/CONCLUSION

The problem this experiment answered is How does the medication levodopa affect the ability of a person living with

Parkinson's Disease to perform certain tasks? The hypothesis is if a person who is living with Parkinson's disease experiences tremors and is given the medication Levodopa, then they will be able to thoroughly answer high-level thinking questions and perform tasks that require the use of different parts of the brain. The hypothesis is supported because when people living with Parkinson's disease performed a variety of tasks, they were able to perform these tasks better when the medication levodopa was in their bodies.

Numerical data from the experiment can be used to demonstrate the validity of the hypothesis when comparing it to the results. First, in patients, inclusion criteria were created with the use of a table to create parameters for different models. The table included p-values for each model such as 2.1 for model 3, b values such as 0.22 for model 4,  $\epsilon_0$  values such as 0.06 for model 3, and other values to identify differences between the models for the different tasks. The importance of a small p-value is to tell scientists how statistically significant an experiment is. Although the p-value could be lower, a small p-value does not necessarily indicate that a hypothesis will not be supported. Parkinson's patients with severe tremors had a resting tremor point greater than or equal to 1 while patients without tremors had a resting point of 0. These points were classified based on the

Movement Disorders Society Unified Parkinson's disease Rating Scale. When participants take part in the motivation Go/NoGo learning task, it is learned that there is a strong trial-by-trial proportion of Go responses measured with an average accuracy number presented in a chart. By using a chart to display the data, it is clearly shown by the average accuracy in questions correct (numbers including .8 and 1) that there is a strong performance in the Go/NoGo learning task by Parkinson's patients who had the presence of levodopa in their systems. Additionally, it was determined that dopamine-enhancing avoidance learning in patients with tremors leads to enhanced functional MRI blood oxygen level-dependent responses in the dopaminergic midbrain during successful active avoidance. Scientists are now able to understand the greater idea that dopamine specifically plays a big role in 'safety learning', which is constantly avoiding an unpleasant stimulus. The results of the experiment were verified with an ANOVA test to determine if a relationship exists between a comparison of the groups in the trial. The test helped to assess the connection between medication and the patient groups and relate it to the hypothesis, therefore, clarifying the ANOVA test as a vital part of determining the validity of the experiment. By understanding the various parts of the experiment and their purpose, it can be concluded that the

experiment can produce accurate results that are tied back to the original hypothesis. Furthermore, the information learned from this experiment can be exceedingly useful to scientists and the general population. Learning specific aspects of the brain significantly helps the understanding of Parkinson's disease as a whole and how it specifically affects certain regions of the brain. Something discovered by this experiment that surely improves scientists' knowledge is certain medications such as levodopa don't affect all parts of the brain and this results in certain tasks being performed well while other tasks weren't affected as much even with the presence of medication. Different tasks and questions required the use of different parts of the brain and with the medication levodopa, it was discovered specifically how the medication was able to improve the performance of certain tasks and the answers to specific questions. Although this experiment was thoroughly conducted, there are a few limitations that can be identified. A major limitation was that the retest of the experiment occasionally produced differences in some answer responses to questions. This severely affects the whole study because test-retest is the last step of the scientific process and the purpose of this step is to verify that the results are accurate therefore improving the validity of the experiment. If the test-retest data had

determined that both trials of the experiment produced similar results, then this study would have been more statistically significant and more accurate in determining how levodopa affects Parkinson's patients' ability to perform tasks. Another problem in the experiment was that precise/specific questions weren't allowed to be asked to patients. This limited the actual amount of knowledge participants used to answer the questions and perform the tasks. If specific questions were allowed to be asked, it would have been interesting to see the variations between the different responses people answered when presented with the questions. After deducing the research, there are aspects of the experiment that prompt additional questions. To research and learn more about this topic, more trials can be done to determine whether the retest of this experiment produced invalid results. A question this experiment produced that can be solved if the experiment is conducted again is if participants took levodopa and answered high analysis questions five minutes later, would the answers to the questions be different than if the participant waited for twenty minutes and then answered the questions? It would be interesting to find the answer to this question because it proves a valid point: how long does it take for the medication to affect Parkinson's patients. In conclusion, this experiment helped to determine how the medication levodopa

specifically affected a Parkinson's patient's brain and is helpful in the long-term study of how to find a cure for Parkinson's disease. With this experiment, scientists were able to understand the effect Levodopa has on people living with Parkinson's disease and how this medication affects their ways of thinking.

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# Mozart Effect In Primary Children

By Asma Makkouk

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*It is thought that children listening to classical music such as Mozart will boost their brainpower and increase their spatial abilities. However, is this psychological phenomenon accurate and reliable? The concept of the Mozart effect has been widely explored in scientific literature and some researchers speculated that the generality of the initial positive results of the Mozart effect was due to the "pleasure excitement" evoked by this genre of music. Additionally, it has also been hypothesized on the other hand that listening to classical music can improve a person's spatial skills and boost cognitive and academic performance, especially in young children. Thus, finding out whether the Mozart effect is reliable or just a myth is really important psychological research. To test this hypothesis, a group of randomized subjects of young children should perform spatial IQ tests after listening to 10 minutes of Mozart, while another group of subjects will perform spatial IQ tests without listening to Mozart.*

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## INTRODUCTION

Often, people listen to classical music for entertainment purposes. However, what people don't know is that exposing children for 10 minutes a day to classical may be an effective method of increasing the executive functions of children and their cognitive and spatial abilities. If this is true, this would be helpful to children where classical music would be presented in all activities and would have a positive impact on children's lives as Roascher, Kys, and Shaw (1995) stated. However, upon replications of this original experiment, studies have failed to show a positive correlation between listening to Mozart and increasing spatial abilities in children.

In Roascher's study, the Mozart effect was explored on college students

to see if classical music enhances spatial abilities. In 1994, a behavioral experiment was conducted that tested their performance on spatial IQ tests which was the first one to show a positive correlation between listening to Mozart and enhanced spatial-temporal reasoning. The same results were implicated in Ivanov and Geake's study as well as Rideout and Wernert's study whereupon replication of Roascher's original study, both showed evidence of a beneficial effect of listening to Mozart on primary children where scores were significantly higher on a paper-folding task than the control group of primary children who didn't listen to Mozart. By contrast, although other studies show conflicting findings that Mozart has spatial benefits, and this experiment was able to support Rauscher's original experiment, most of the experiments

failed to replicate it. Crinec, Wilsons, and Prior's purpose of the study was to investigate the Mozart effect in children and to compare two different theories given to account for the effect, which is the trion model and the arousal-mood model. In this experiment, a group of grade 5 children was exposed to trendy music, Mozart sonatas, and silence. After each condition, the students performed spatial tasks and the results proved that there was no significant relationship between spatial performance and listening to Mozart, as children didn't perform any better than when exposed to trendy music or silence. A failure to replicate Rauscher's findings was also observed in McKelvie and Low's research where researchers conducted two experiments. For the first experiment, in a pretest-post-test design, spatial IQ scores of children who listened to Mozart were contrasted with spatial IQ scores of people who just listened to trending music. Since the results didn't match the original, the researchers decided to replicate the experiment that did imply the Mozart effect. However, even upon replication, the experiment didn't support that Mozart's music enhanced spatial abilities and the results were insignificant. A failure of replication also was found in Newman, Rosenbanch, Burns, Latimer, Matocha,

and Vogt's study where this study was based on a pretest-posttest design, 114 students were tested using items from the Raven's Progressive Matrices-Advanced Form. In all 3 treatment groups, there were no differences in Raven's scores among groups before or after treatment or those results don't confirm Rauscher's findings.

The design of this study will explore Priors and Wilson's research (2006) that shows no evidence of a positive correlation between listening to Mozart and an increase in spatial abilities of children while building on Roascher's original design. I predict that yes the Mozart effect is real and it does have a positive impact on primary children.

## METHOD

### Participants

In this study, there were 55 participants. 31 of the children were female and 24 were male, and they were either year 7 or 8. There were randomized 4 groups of 8-17 children per session. There was a control group as well, having all participants in the experiment in a quiet room in their school.

### Materials/Design

In each session two audiotapes were presented, one being 16-minutes long and then followed by a verbal distractor

task which is 4 minutes long. Since a control group was present, this is a between-subjects design where the control group was asked to do the folding and cutting subtask only. A replication of this study was conducted, and the independent variable of this study is listening to classical music and the dependent variable is the children's spatial abilities.

## Procedure

The experiment took place in a quiet room in the participant's school where participants were randomized 4 groups of 8-17 children were presented with two audiotapes followed by a verbal distractor task serially. After listening to the tapes, participants were asked to do the paper folding and cutting task of the Stanford Binet Intelligence Task. There was a control group as well, which didn't listen to the audio task and was asked to do the folding task only. Before the experiment, all groups were asked to fill out a questionnaire about their musical experience. Also to ensure uniformity, children were asked to wear headphones all the time even during breaks.

## Results

For this experiment, an ANOVA test was performed where  $p < 0.01$ , meaning that the results for this study

were statistically significant showing no evidence of a relationship between listening to Mozart and an increase in spatial abilities in primary children.

TABLE 2. Group performance on preexperimental measures of spatial and musical ability and their intercorrelation.

	Porteus Maze test	Rey figure	Paper folding	Vandenberg rotations task	Bentley total
Porteus Maze test		.24*	.25*	.27*	.29*
Rey figure			.36*	.31*	.34*
Paper folding				.36*	.29*
Vandenberg rotations task					.15
Means	15.20	26.06	9.60	7.37	36.53
SDs	1.43	4.81	3.44	4.31	7.19
Range	8.5-17	9-35	2-18	0-19	16-56

\* $p < .01$ .

TABLE 3. Participant subjective ratings following exposure to the experimental listening conditions.

Rating	K. 448		Popular music		Silence	
	Mean	SD	Mean	SD	Mean	SD
Interested	2.25	1.18	3.64**	1.21	1.74	1.23
Happy	2.48	1.19	3.81**	1.13	2.40	1.32
Surprised	1.89	1.16	2.55**	1.41	1.67	1.20
Sad	1.23	.76	1.07*	.29	1.37	1.04
Angry	1.18	.65	1.23	.79	1.52	1.18
Disgusted	1.56	1.05	1.17**	.72	1.74	1.38
Bored	2.97	1.42	1.66**	1.08	3.68	1.44
Scared	1.08	.46	1.04	.28	1.28	.97
Shy	1.09	.49	1.09	.38	1.22	.87
Neutral	2.48	1.45	1.74**	1.14	2.51	1.52
Preference	2.70	1.04	4.28**	.82	2.57	1.18
Familiarity	1.78**	1.02	3.51	1.35	3.83	1.59
Complexity	3.01*	1.22	2.66	1.23	1.55	1.17

Note. All items were rated using 5-point Likert-type scales.

\* $p < .05$ . \*\* $p < .0001$ .

TABLE 4. Correlations between variables used in the K. 448, popular music, and silence multiple regression analyses.

Variables	Condition	Pretest paper-folding score	Happiness	Preference	Familiarity	Musical ability
Posttest paper-folding score <sup>a</sup>	K. 448	.63**	.04	.09	-.06	.29*
	Popular	.65**	.05	.09	-.02	.26*
	Silence	.66**	.07	.11	.10	.30*
Pretest paper-folding score	K. 448		-.09	-.05	-.00	.28*
	Popular		-.14	.01	-.01	.29**
	Silence		.02	.05	.14	.27*
Happiness	K. 448			.59**	.04	.06
	Popular			.55**	.12	-.03
	Silence			.38**	-.07	-.01
Preference	K. 448				.15	.14
	Popular				.20*	-.05
	Silence				.27*	.03
Familiarity	K. 448					-.03
	Popular					-.00
	Silence					.02

<sup>a</sup>Refers to posttest score collapsed across all counterbalanced presentations of each listening condition.

\* $p < .01$ . \*\* $p < .0001$ .

TABLE 5. Multiple regression analyses of within-participants variables on paper-folding scores following exposure to K. 448, popular music, or silence.

Variables	Condition	B	$\beta$	$sr^2$ (unique)
Happiness	K. 448	.27	.08	.00
	Popular	.31	.10	.01
	Silence	.11	.04	.00
Preference	K. 448	.25	.07	.00
	Popular	-.01	-.00	.00
	Silence	.04	.01	.00
Familiarity	K. 448	-.36	-.09	.01
	Popular	-.14	-.05	.00
	Silence	.01	.00	.00
Musical ability	K. 448	.07	.13	.02
	Popular	.05	.09	.01
	Silence	.08*	.15	.02
Pretest paper-folding score	K. 448	.65**	.60	.33
	Popular	.66**	.63	.35
	Silence	.62**	.62	.35

Note. K. 448 regression:  $R^2 = .44$ , adjusted  $R^2 = .41$ ,  $R = .66^*$ ; popular music regression:  $R^2 = .44$ , adjusted  $R^2 = .41$ ,  $R = .66^*$ ; silence regression:  $R^2 = .46$ , adjusted  $R^2 = .44$ ,  $R = .68^*$ .

\* $p \leq .05$ . \*\* $p < .0001$ .

## CONCLUSION

All in all, my original hypothesis about the Mozart effect and that listening to classical music sonata increases IQ and cognitive abilities in children contradicted the findings in the research and were refuted such as research shows that after exposure to a piece of music and asked to do a paper-folding task, the group who listened to the sonata the same performed the same as the group who didn't and the group who listened to popular music. In the experiment, the observed difference was significant since  $p < 0.01$  meaning there would be less than a 1 % chance that upon replication, the results would be most likely due to random error. One of the limitations may be the use of one specific spatiotemporal task only, where using more tasks in the experiment would've increased the validity of the results. Another limitation would be developmental factors, such as children's brains aren't quite mature yet and the level of maturation differs from one child to the other. Because of the absence of the Mozart effect in children, there are no benefits to exposing children to Mozart. The Mozart effect is a myth that causes parents to believe in misleading perceptions about their children's progress. However, this doesn't mean that this music isn't of any importance and there's a need for future research to investigate the importance of music in children's lives.

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# Feasibility Study on a Novel Blood Transfusion Protocol in Mass Trauma Situations

By Siddharth Nareddy

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*Every year, millions of people die from hemorrhage in massive trauma situations. In such cases, one of the leading protocols for treatment is component blood therapy. However, component therapy cannot adequately address all of the issues that patients face from hemorrhage. This study analyzes the feasibility of a novel reconstituted whole blood consisting of type O- red blood cells and type AB plasma and platelets for the treatment of patients in mass trauma situations. To determine the feasibility of such a product, this study gathered data and information from a variety of research studies. These studies were about the comparison of whole blood vs component therapy and various factors that are important to measure in reconstituted whole blood. After a thorough analysis of the studies, it was evident that the use of whole blood in mass trauma situations has some merits over the standard component therapy. It was also evident that reconstituted whole blood could also be beneficial with a couple of key modifications. This creates a solid evidence base upon which future studies of the aforementioned novel reconstituted whole blood could be conducted.*

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## INTRODUCTION

Every year, over 1.2 million people who suffer severe trauma die from hemorrhage. Patients who suffer from hemorrhage from massive trauma often have a myriad of symptoms such as anemia, coagulopathy, acidosis, and hypothermia. The current standard of care is component blood therapy. To preface, this paper will start with a quick overview of component blood therapy. Blood is made out of three key components: red blood cells, plasma, and platelets. Within these components, there are many different types. These types are determined through the antigens/antibodies present on the components. The different types of blood are extremely important as giving a patient a mismatched type can lead to

a severe reaction. If the recipient of a blood transfusion is given blood of a different type, their immune system will react to the antigens/antibodies present and result in a severe reaction. For example, type O blood has no antigens on the red blood cell so the red blood cells can be given to anyone. However, type O plasma has anti-A and anti-B antibodies which have the potential to lead to a reaction if given to anyone other than other type O patients. To avoid such complications, blood is typically separated into components and given to patients. Essentially, donors give blood, and then labs separate them with a centrifuge into the three components and transfuse them separately. This transfusion of separate components, (component blood

therapy), is the current standard protocol. However, component blood transfusion does not adequately address all of the symptoms associated with massive trauma, especially coagulopathy. An alternative form of treatment known as whole blood addresses all of these issues which makes it a potential candidate for a new standard of care for trauma patients. One of the major reasons why whole blood is not the current standard of care is because there is a potential for reaction due to the antigens and antibodies present within either the red blood cells or the plasma. Due to this, if whole blood is given, it is usually only type O- whole blood which also must meet the requirement of having a low titer of antibodies present. Type O- blood is already rare in the population and low-titer O- blood is even more so. These significant restrictions upon whole blood prevent it from becoming the new standard of care. A potential solution to this problem is to transfuse a blood product known as reconstituted whole blood. Reconstituted whole blood is blood in which the components are combined to mimic the whole blood that the patient originally lost. This research paper analyzes the feasibility of a novel reconstituted whole blood. To clarify, the novel reconstituted whole blood is a blood combination where type O- red blood cells and type AB plasma and platelets, (universal

donors in their respective categories), are combined to create a universal reconstituted whole blood. With this in mind, this paper will explore and answer the question, to what extent would the use of the aforementioned reconstituted whole blood be a feasible blood transfusion protocol in mass trauma situations? To determine the feasibility of such a product, this paper will examine the performance of low-titer type O- whole blood against the standard component therapy, and it will also examine the performance of reconstituted whole blood. It was hypothesized that if reconstituted whole blood or low-titer type O- whole blood is given to patients in mass trauma situations, then patient outcomes will improve in comparison to the current standard of care because both blood products can address all of the symptoms of mass hemorrhage while allowing for a more sustainable resuscitation.

## ANALYZATION OF RESOURCE SOURCES

To determine the feasibility of such a blood transfusion protocol and to examine the use of reconstituted whole blood, a comprehensive study of numerous verified sources on this subject matter was conducted. The basis of the novel blood transfusion protocol and even reconstituted whole blood as a whole is hinged upon whether or not

standard whole blood transfusion has merit over the current transfusion protocol of component blood. For context, even though the current standard of care is component blood, the military frequently transfuses whole blood instead which has been shown to have comparable if not positive impacts on patient outcomes (Spinella, 08). This treatment method is based on the principle of replacing what has been lost. Whole blood is the closest match to the blood that patients have lost during a severe trauma situation. With this in mind, studies have been conducted on the use of whole blood in civilian situations, (Williams et al. 20). Transfusion of low-titer type O whole blood in civilians was shown to have significant benefits over groups that received the standard component therapy. “Controlling for age, severity of injury, and prehospital physiology, LTO-WB was associated with a 53% reduction in post-ED blood product transfusion (odds ratio, 0.47; 0.23-0.94 95% CI; p = 0.033) and two-fold increase in likelihood of survival (odds ratio, 2.19; 1.01-4.76 95% CI; p = 0.047)” (Williams et al., 2020, para. 4). On top of improving patient outcomes, it has also been shown that whole blood can be safely transfused in the large amounts that may be needed for severe trauma/hemorrhage (Gallaher et al., 2020). Patients with similar baseline

characteristics were treated either with the standard component therapy or low-titer type O whole blood supplemented with component therapy. While the whole blood group received more blood products overall, there was a statistically significant reduction in the amount of pRBCs and FFP that needed to be transfused. In addition to this, the authors note that “It appears to be a safe and effective addition to component therapy and may lead to a more balanced resuscitation” (Gallaher et al., 2020, para. 4). From this, it is evident that whole blood transfusion is not only safe in large volumes but is also beneficial for a more balanced resuscitation. Other studies have also supported this conclusion and further established the benefits of whole blood transfusion. One such study had a similar methodology with the key difference of having the whole blood group receive whole blood supplemented with platelets, (Cotton et al. 2013), versus the study above where patients received whole blood supplemented with component therapy. Like the study above, the patients in both groups had similar characteristics such as overall injury severity score, arrival vital signs, and mechanism of injury. The data collected determined that there was no difference in 24-hour blood use or the 24-hour and 30-day mortality rate. However, it is important

to note that the whole blood treatment group had more patients with traumatic brain injury. This had the potential to skew the results because the resuscitation and treatment for coagulopathy differ for patients suffering from a TBI in comparison with that of standard resuscitation. As such, a sensitivity analysis excluding those with severe TBI was conducted, (Figure 1).

	WB Group (n = 33)	COMP Group (n = 34)	P
Median 24-hr RBC transfusions, U	4 (2, 6)	6 (2, 13)	0.02
Median 24-hr plasma transfusions, U	4 (2, 7)	6 (2, 14)	0.02
Median 24-hr platelet transfusions, U	0 (0, 1)	1 (0, 2)	0.09
Median 24-hr total transfusions, U	11 (5, 17)	16 (4, 41)	0.02
24-hr mortality, %	6%	9%	0.62
30-d mortality, %	6%	9%	0.62

Continuous values are presented as median with 25th and 75th interquartile range.

Figure 1 (Cotton et al. 2013)

As shown by the sensitivity analysis in Figure 1, the whole blood group had significantly lower 24-hour RBC-equivalent, plasma-equivalent, platelets, and overall product transfusion. With the use of whole blood being supported, many studies have examined reconstituted whole blood and whether or not it would be beneficial. For context, reconstituted whole blood is a product composed of various blood products that are combined to reach a certain hematocrit. Since reconstituted whole blood is such a novel method of transfusion, these studies have primarily focused on various factors of the reconstituted

whole blood such as the ratio of components used or its ability to effectively form clots. The ratio of the components used in the reconstitution process is very important because each component plays an important role in the blood. A study was conducted to evaluate these ratios based on TEG R-time, maximum amplitude, angle, and lysis at 60 minutes (Agren et al., 2014). In this, four different ratios of components were tested in vitro, 4:4:1, 5:5:2, 8:4:1, and 2:1:0, (pRBC, plasma, and platelets respectively). After evaluating these combinations with thromboelastography, it was evident that the 4:4:1 and the 5:5:2 overall performed much better than the other ratios, especially within the angle and maximum amplitude. Other studies went on to conduct more comprehensive coagulation tests. A later study related to this compared multiple combinations of reconstituted whole blood to other blood products with a more comprehensive set of coagulation tests (Ponschab et al., 2015). In this study, 4 different types of reconstituted whole blood in a 1:1:1 ratio, (packed red blood cells, plasma, and platelets respectively) were created. The hemostatic profile of these 4 different types of reconstituted whole blood was then compared with the profile of fresh whole blood and citrated whole blood. The difference between the 4 types of reconstituted whole blood was the plasma type used:

fresh frozen; solvent-detergent; lyophilized quarantine; and lyophilized methylene blue-inactivated plasma. The results showed that the hematocrit, platelet count, endogenous thrombin potential, and coagulation factor activity were significantly lower in reconstituted blood compared with citrated whole blood yet still above the requirements set for transfusion, (Figure 2).

	Normal range	CB	FWB	FFP-RWB	SDP-RWB	LYO-QU-RWB	LYO-MB-RWB	p value
Standard coagulation tests								
aPTT, s	30-40	32.4 (3.6)	33.3 (4.1)	37.3 (3.3)	42.6 (1.9)	44.8 (4)	45.7 (2.4)	< 0.001
PTI, %	70-140	95 (8)	90 (8)	62 (8)	56 (4)	56 (7)	62 (5)	< 0.001
Coagulation factor activity (%)								
Factor II	70-100	121 (27)	109 (22)	76 (8)	66 (3)	73 (4)	74 (11)	< 0.001
Factor V	70-100	153 (15)	141 (13)	105 (16)	85 (5)	98 (14)	95 (12)	< 0.001
Factor VII	70-140	124 (23)	111 (22)	97 (13)	73 (4)	75 (14)	93 (10)	< 0.001
Factor VIII	70-200	91 (25)	91 (21)	62 (12)	46 (5)	47 (14)	46 (8)	< 0.001
Factor IX	70-110	104 (9)	108 (7)	75 (5)	64 (3)	60 (5)	70 (7)	< 0.001
Factor X	70-140	124 (12)	115 (9)	83 (15)	75 (3)	70 (9)	75 (10)	< 0.001
Factor XI	70-120	110 (16)	111 (16)	79 (10)	69 (4)	69 (7)	63 (7)	< 0.001
Factor XII	70-120	109 (22)	104 (19)	91 (12)	83 (3)	76 (12)	76 (9)	< 0.001
Factor XIII	70-120	141 (16)	132 (15)	124 (29)	106 (5)	104 (16)	107 (21)	< 0.001

CB, citrated whole blood; FWB, fresh whole blood; FFP-RWB, reconstituted whole blood with FFP; SDP-RWB, reconstituted whole blood with solvent-detergent treated plasma; LYO-QU-RWB, reconstituted whole blood with lyophilized quarantine plasma; LYO-MB-RWB, reconstituted whole blood with methylene blue-inactivated lyophilized plasma; aPTT, activated partial thromboplastin time; PTI, prothrombin time index.

Figure 2 (Ponschab et al., 2015)

However, as shown by the study conducted by Agren et al., (2014), this could potentially be attributed to the ratio of the components of the reconstituted whole blood which was a ratio of 1:1:1. Another article based on this one evaluated the data from the study and offered potential solutions for the poor performance of the reconstituted whole blood (Ho et al., 2015). Since the importance of components such as plasma fibrinogen have been proven to be important in the survival and achieving hemostasis, the article suggests that the blood combination could be supplemented with the missing components to make up for what it is lacking.

## CONCLUSION

With millions of people in a severe trauma situation dying every year from hemorrhage, it is imperative to devise a blood transfusion protocol that saves as many lives as possible. The current protocol is to transfuse the components of blood separately, (component therapy). However, in cases of massive trauma, component therapy cannot adequately address all of the symptoms associated with massive trauma, especially coagulopathy. With this in mind, this paper analyzes the feasibility of a novel reconstituted whole blood consisting of type O- red blood cells and type AB plasma and platelets for the treatment of patients in mass trauma situations. The first steps to determining the feasibility of such a product were to determine the merits of low-titer type O- whole blood and reconstituted whole blood over the standard component therapy. It was hypothesized that if reconstituted whole blood or low-titer type O- whole blood is given to patients in mass trauma situations, then patient outcomes will improve in comparison to the current standard of care because both blood products can address all of the symptoms of mass hemorrhage while allowing for a more sustainable resuscitation. The hypothesis was mostly supported in that the transfusion of low-titer O- whole blood was proven to have some advantages over standard component therapy. Studies conducted

by Cotton et al. (2014), Gallaher et al. (2020), and Williams et al. (2020) all clearly showed that whole blood transfusion resulted in lower amounts of blood products that needed to be transfused and a two-fold increase in the likelihood of survival. In addition to this, even in cases where larger volumes of blood are needed, the study by Gallaher et al. (2020) shows that it is safe to have large volumes of whole blood transfusions. However, the study conducted by Ponschab et al., (2015) revealed that reconstituted whole blood is deficient in its function based on numerous coagulation tests. Despite this, another article referencing this study written by Ho et al., (2015) stated that reconstituted whole blood can still be feasible if missing/deficient components such as fibrinogen are added to the reconstituted mix. The results of this paper clearly show that there is a solid evidence base that supports the use of low-titer type O-whole blood and perhaps even a modified reconstituted whole blood over the standard component therapy. Based on this, it can be extrapolated that the novel reconstituted whole blood has some merits which give it the potential to save many unfortunate victims of massive trauma. However, this paper is simply a collection and review of previous studies about low-titer type O- whole blood and

reconstituted whole blood. As such, this paper does not guarantee the feasibility of the proposed novel reconstituted whole blood, (type O- red blood cells with type AB plasma and platelets), but rather provides an evidence basis upon which future experiment-based studies can be conducted, either in-vitro or in-vivo. Future research can be conducted on the thromboelastography of a mixture of blood components of different types.

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