

### Introduction

Throughout the years it has been observed that anesthetics ultimately have their effect in the brain. It has been shown that anesthetics have the ability to alter brain structures, such as the hippocampus, that are responsible for functions such as learning and memory (2). Another important structure that greatly effects memory and learning functions, the thalamus, was shown to develop neuronal damage after babies were exposed to anesthesia (1). These alterations can lead to conditions such as Attention-deficit/hyperactivity disorder (ADHD) which can affect an individual for the rest of their life (5). The biggest concern for these alterations is in children, who still have a very underdeveloped brain. According to the center for disease control and prevention (CDC), most development that determines the course of further learning and behavioral functions occurs before the child is eight years of age (4). A previous study identified that if an individual was exposed to anesthesia as an infant, their risk of obtaining a learning disability as they become a teenage is over doubled (3).

There are many things to consider when determining the effects of anesthesia on the brain. First, it should be considered if the number of times a child is exposed to anesthesia has any effect on the negative changes that occur in the brain. It should also be observed if individuals who must undergo multiple surgeries as a young child are already at an increased risk of developing learning disabilities in the future. One example of how the learning abilities of these children can be tested is by taking standardized tests such as the primary school leaving examination (PSLE), or having a medical diagnosis of a diminished learning ability such as dyslexia (3). These diminished learning and behavioral abilities have been shown in animal tests which is why it is so important to determine if these results will affect humans the same.

Through the evaluation of children younger than the age of three undergoing varying instances and duration of anesthesia, will testing reveal altered learning and behavioral functions due to the negative impact of anesthesia exposure on a young child's brain development? It is predicted that young children who have reoccurring exposure to anesthesia have an increased likelihood of developing a learning or behavioral disability before they become an adult.

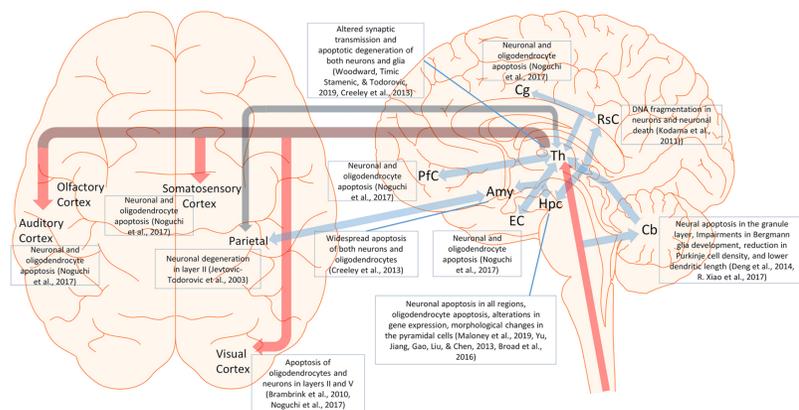


Figure 1. Sensory pathways in red; Learning pathways in blue (1).

### Methods

This study will be conducted as a retrospective twin study. There will be a control group including 30 sets of twins that have never had anesthesia exposure (study group 1). Also, there will be two experimental groups including one group of 30 twins where one twin has been exposed to anesthesia and the other has not (study group 2) and one group of 30 twins where both individuals have had anesthesia exposure as a child (study group 3). Anesthesia exposure must have occurred before the age of 3, and the children must have been born within 32 and 42 gestational weeks with a birth weight of at least 2.5kg. Finally, both twins must be the same gender and currently be between the ages of twelve and sixteen.

This retrospective cohort study will use previous medical records to evaluate previous anesthesia occurrences in each individual twin. Current learning and behavioral abilities will be tested with a standardized achievement test for one hour, followed by a standardized IQ exam for 30 minutes, and ending with a psychiatrist evaluation for an hour. There will be an hour break in-between each test and each participant will take them in the exact same order and time frame. Bias in the study will be avoided due to the use of the exact same examinations and completion of these examinations in the same order. Also, the same psychiatrist will do all the evaluations to ensure the results are not skewed due to differing provider opinions.

### Results

Study group 1 is expected to have behavioral and learning abilities similar to their peers showing no diminished performances on learning and behavioral exams. Twins in study group 2 should have no diminished learning abilities with just one exposure to anesthesia. On the other hand, individuals that are exposed to anesthesia more than once before the age of 3 will likely develop some type of learning dysfunction. Finally, individuals in study group 3 are expected to have diminished learning and behavioral performance compared to their peers who were not exposed to anesthesia as a child. These diminished learning and behavioral abilities will most likely be present in group 3 regardless of how many times each individual was exposed to anesthesia.

### References

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### Discussion

The course of this study will show the increased likelihood of an individual to develop a learning or behavioral deficit if they had exposure to anesthesia before the age of 3. However, the chances of developing some type of learning or behavioral dysfunction as an individual becomes an adult are much less if the individual was only exposed to anesthesia a single time when they were a child (1). It has previously been observed that as an individual is exposed to anesthesia more and more as a child, their risk of developing a learning or behavioral deficit becomes greater (6). When observing the outcomes of study group 3, it can be predicted that learning and behavioral dysfunction will occur regardless of exposure occurrence due to the predisposed risks of groups of twins requiring certain surgeries before 3 years of age (2).

### Conclusion

The hypothesis of this study concluding that exposure to anesthesia as a child leads to diminished learning and behavioral functions later in life can be assumed partially true. It is expected that the study will determine that learning and behavior dysfunction can be developed with multiple anesthesia exposures, but not necessarily just one. Due to the expected outcome, different studies in the future should observe if different conditions and environments that individuals grow up in can predispose them to diminished learning and behavioral abilities later in life, regardless of their exposure to anesthesia as a child. Future studies should also focus on the different types of surgeries that individuals are exposed to and if different procedures alter different centers in the brain. This would help determine if only certain types of procedures alter the centers in the brain responsible for learning and behavior. Overall, an otherwise healthy individual undergoing an elective procedure involving anesthesia before the age of 3 should not be concerned about the development of some type of learning or behavioral dysfunction later in life.

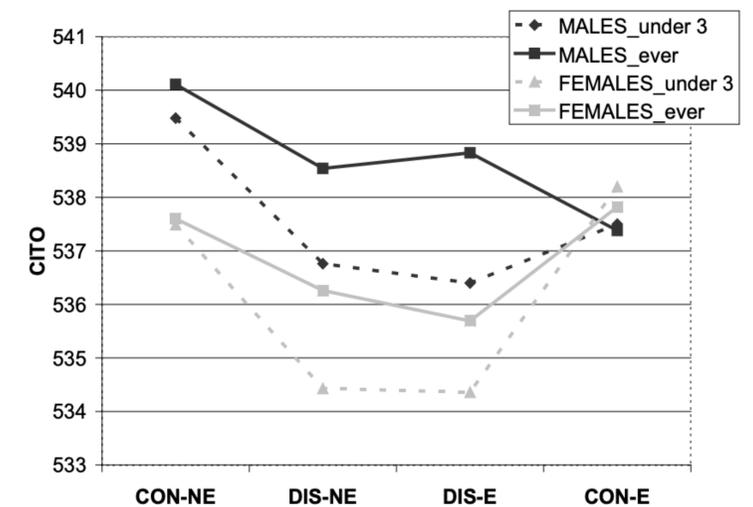


Figure 2. Diminished educational achievement values for males and females who were exposed to anesthesia before three years of age (2).