We already know that air pollution adversely affects the developing mind. However, many questions remain unresolved. At what periods of development is the brain o most vulnerable to air pollution? What specific areas or connections in the brain are affected by air pollution? Several important studies have already been published on this topic, but their results are often divergent. In this project, we aim to a) define the critical periods when the mind and brain are most vulnerable to the harmful effects of pollution, and b) reveal the universal neuronal “footprints” of the impact of air pollution. Our approach combines advanced statistical methods, and predictive methods, including machine learning-based methods similar to those used by artificial intelligence. The basis of our work is the data set from the NeuroAir pollution project. With the help of parents and schools, we were able to survey elementary school children in 19 cities in southern Poland. The cities differed in the level of air pollution - in some it was high, in others medium and low. We were interested in children with a diagnosis of ADHD, as well as randomly selected children who were not diagnosed with attention deficit disorder. On the basis of interviews with children and parents, psychologists and psychologists obtained information on how they were doing at school and their relationships with peers and adults. Then, we invited the children for an MRI scan to measure the structure and functioning of their brains.

In this grant, we intend to use advanced methods to analyze this data. We will use Distributed Lag Non-Linear Models (DNLMs) to identify critical periods of vulnerability to the effects of air pollution on cognitive and brain development. DNLMs have the potential to show how different periods of air pollution exposure, from fetal to present, affect a given outcome, such as IQ or connections in the brain. We want to provide clear answers to the question of when exposure to air pollution is particularly harmful and provide caregivers with evidence-based recommendations on when children's exposure to air pollution should be specifically avoided.

The second research goal is to find a common denominator for the disparate brain imaging results that we and other teams obtain. Our goal is to use a predictive approach: Connectome-Based Predictive Modeling (CPM) and NBS-Predict to identify common patterns in functional connectivity (rs-fMRI) and brain structure (sMRI) In this approach, an algorithm is trained to “guess” participants' exposure to air pollution based on their brain images.

By addressing critical questions about when and how air pollution affects the mind and the brain, this project will significantly advance our understanding of its neurodevelopmental impact. Our findings will provide evidence for public health strategies aimed at protecting children’s developing brains, offering clarity on critical periods to minimize exposure and the neural systems that are most at risk. Through collaboration and data-sharing, this work will also help build an integrated understanding of air pollution’s effects on children’s health and development.