YOUR BRAIN ON BIKES!

ABOUT OUTRIDE

Outride is a non-profit organization that provides research, cycling programs, and funding to empower all people to experience the social, emotional, and cognitive benefits of cycling. Research is one of our core focus areas, and we collaborate with universities, schools, and community partners to better understand the impact cycling has on how we think, feel, and act.

BIKING FOR YOUR BRAIN AND BODY

Physical activity, like biking, is one of the BEST things you can do for both your physical and mental health, no matter your age. And riding a bike not only has benefits for your body and your physical health, but it also affects the function and structure of your brain in amazing ways! (And you don't have to be a professional cyclist to reap the benefits. Some of the benefits kick in after as little as a 10 minute ride!) Read on to learn a bit more about the benefits of biking for your brain and the science behind it.

LEARN ABOUT OUR WORK AT
WWW.OUTRIDEBIKE.ORG

BENEFITS OF BIKING

Cycling regularly can **reduce the risk for all-cause mortality** by 10%[1] and by 35% in those with diabetes[13]

Cycling to work **decreases the likelihood** of having a prescription for **depression & anxiety**[2]

Cycling lowers risk for **Type II Diabetes**[3]

Regular physical activity, like bicycling, **supports brain health** - increasing gray matter volume and white matter integrity[4]

Being active and biking boosts mood and **lowers anxiety** and **depressive** symptoms in youth[8]

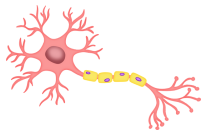
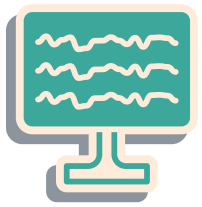
Cycling to school **improves cardiorespiratory fitness** in middle school students[5]

A 6-month physical activity intervention **improved cognition** in adults with risk for dementia[6]

Youth who are active see **improved attention** and **academic performance**[14]

Exercising can help **boost BDNF levels,** which support brain cell growth and connectivity[7]

MEASURING THE BRAIN

There are many ways to measure the brain (fMRI, fNIRS, EEG, etc.). Depending on the question you want to answer, you may use a different method. Some methods are really good at showing us the detailed structure of the brain. Others can't tell us a lot about *where* in the brain something is happening, but can tell us a lot about the *timing* of brain activity. Here, we will focus on one method called *electroencephalogram*, or EEG.

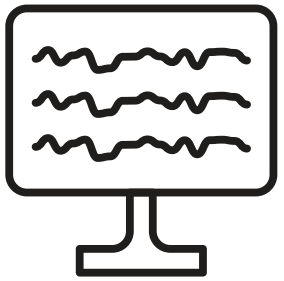
WHAT IS EEG?

Electroencephalogram (EEG) is a non-invasive tool used to measure and record your brain's activity in real time. Electrodes placed on the scalp measure synchronized electrical signals from large groups of brain cells (neurons) in your brain which are then sent to the computer to analyze.

WHAT CAN IT TELL US?

EEG signals can provide insight into many of our day-to-day cognitive processes, including our reactions to what we see or hear, how focused and attentive we are to the world around us, our mood and emotional states, and more. EEG is also used in medical settings to monitor health and to examine a number of disorders, including brain dysfunction, brain damage, and sleep disorders.

ANALYZING EEG



EEG signals contain a lot of information and we can analyze them in different ways. For example we can look at the strength, or *power*, of the signal over time (*time-frequency analysis*) or we can average the brain response after many exposures to a particular event (e.g. a flashing red light) to examine *event-related potentials*. Our brains respond to different stimuli (e.g. seeing a bright flash) in predictable ways, and we often exhibit consistent patterns of brain waves for different activities (e.g. sleeping). We can also compare how EEG activity differs across left and right sides of the brain (asymmetry).

FREQUENCY BANDS

The complex raw EEG signal can be broken into component parts through a mathematical algorithm known as *Fast Fourier Transform* (FFT). As a result of this process, we are able to look at different frequency bands within the EEG signal, and researchers have learned a lot about how the strength (power) and location of these frequency bands correlate with different cognitive states.

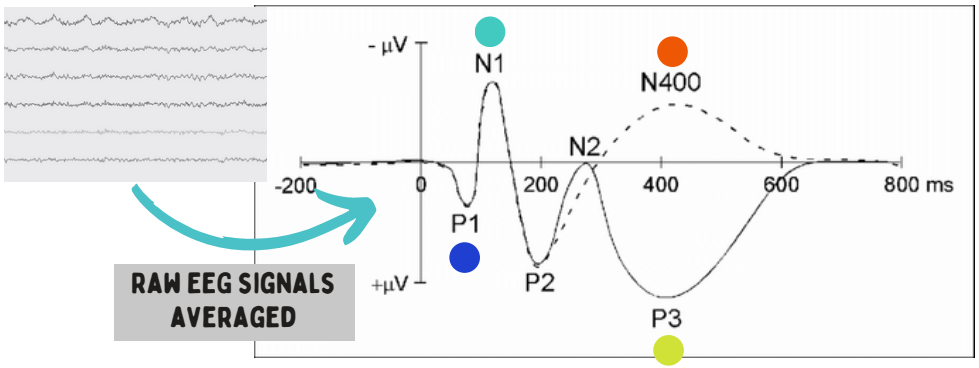
FREQUENCY BAND (HZ)	ASSOCIATED STATES	SAMPLE WAVE FORM
GAMMA (>35 HZ)	DEEP CONCENTRATION, PROBLEM SOLVING	
BETA (12-35 HZ)	ACTIVE, ATTENTIVE MIND	
ALPHA (8-12 HZ)	RELAXED, RESTFUL	
THETA (4-8 HZ)	DEEPLY RELAXED, MEDITATIVE	

The frequency of the brain wave is measured in Hertz (Hz) and represents the number of cycles per second. So, 10 cycles per second = 10 Hz.

WHICH FREQUENCY BAND DOES 10 HZ CORRESPOND TO?

EVENT-RELATED POTENTIALS

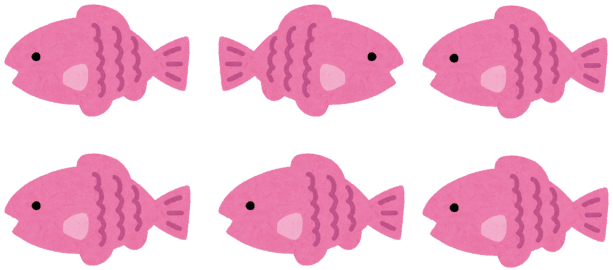
Event-related potentials (ERPs) are specific brain responses that occur after exposure to different stimuli (sights, sounds, etc.) or cognitive tasks. Researchers compare both the *amplitude* (height) and *latency* (timing) of the averaged response to examine changes in the brain's reaction across different scenarios.



ERP COMPONENT	ELICITED BY	EXAMPLE STIMULUS / EVENT
P1	REACTION TO A STIMULUS	
N1	SENSORY PROCESSING	
P3	ATTENTION & DECISION MAKING	
N400	SEMANTIC PROCESSING	

MEASURING COGNITIVE FUNCTION

During an EEG study, participants are often asked to perform cognitive tasks to understand how changes in brain activity are related to changes in cognitive behavior. Measures of *executive function* are often used, which capture our ability to stay focused and filter out distractions, self-regulate and manage emotions, and our ability to think about things in more than one way (flexibility). Researchers can then compare how activities like going for a bike ride change how our brain responds to such tasks.



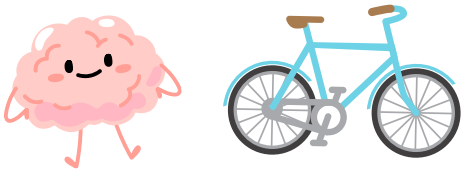
One common task that is used to tap into our ability to filter out distractions is the "Flanker Task". The task requires paying attention to some aspects of an image while ignoring others. People often find it more difficult to ignore the distractions when they conflict with the object of focus, and this also shows up in how our brain responds!

TRY IT FOR YOURSELF!

https://scripting.neurotask.com/exp/t5q5wgWjvq

PUTTING IT ALL TOGETHER

Now that you've learned a bit about EEG - let's look at some studies digging into how our brain changes after going for a bike ride, and how this impacts how we think, how we feel, and how we behave!



Physical activity interventions, like cycling, can reduce the **theta / beta ratio** in EEG signals in aging adults, associated with improved attentional processing.[9]

After physical activity like cycling, **alpha and beta frequency band power increases** in frontal regions, associated with greater attentional control. [10]

Increased *amplitude* of **P300 waveforms** after biking, associated with improved cognitive performance on attentional tasks.[11]

After a single bike ride, students can experience enhanced **focus, motivation,** and **relaxation,** as measured by EEG indicators.[12]

HOW DOES GOING FOR A BIKE RIDE MAKE YOU FEEL? TELL US ABOUT IT!

CITATIONS

(1) Do the health benefits of cycling outweigh the risks? (Johan de Hartog, 2010)

(2) Does cycle commuting reduce the risk of mental ill-health? An instrumental variable analysis using distance to nearest cycle path. (Berrie et al., 2024)

(3) Associations between Recreational and Commuter Cycling, Changes in Cycling, and Type 2 Diabetes Risk: A Cohort Study of Danish Men and Women (Rasmussen et al., 2016)

(4) Move Your Body, Boost Your Brain: The Positive Impact of Physical Activity on Cognition across All Age Groups (Festa et al., 2023)

(5) Experiences from a randomised, controlled trial on cycling to school: Does cycling increase cardiorespiratory fitness? (Børrestad et al., 2012)

(6) Effect of Physical Activity on Cognitive Function in Older Adults at Risk for Alzheimer Disease: A Randomized Trial (Lautenschlager et al., 2008)

(7) Immediate effect of high-intensity exercise on brain-derived neurotrophic factor in healthy young adults: A systematic review and meta-analysis (Fernández-Rodríguez et al., 2022)

(8) Physical activity and exercise in youth mental health promotion: a scoping review (Pascoe et al., 2020)

(9) Changes in EEG Activity and Cognition Related to Physical Activity in Older Adults: A Systematic Review (Rodriguez-Serrano et al., 2024)

(10) Effects of exercise on electroencephalography-recorded neural oscillations: a systematic review (Hosang et al., 2022)

(11) Acute exercise has a general facilitative effect on cognitive function: A combined ERP temporal dynamics and BDNF study (Chang et al., 2017)

(12) Cognitive and neurological impacts of a biking program in public schools (Bailey et al., 2021)

(13) Association of Cycling With All-Cause and Cardiovascular Disease Mortality Among Persons With Diabetes (Ried-Larsen et al., 2021)

(14) Effects of physical activity interventions on cognitive outcomes and academic performance in adolescents and young adults: A meta-analysis (Haverkamp et al., 2020)

OTHER RESOURCES

Check out these other great resources on the benefits of physical activity and biking across the lifespan, along with some great reading on the power of riding in natural spaces!

PeopleForBikes Research Library

WHO Report on Optimizing Brain Health Across the Lifespan

WHO Report on Green and Blue Spaces

US Dept. of Heath and Human Services , Physical Activity Guidelines for Americans, 2nd Edition *(be sure to see page 40 for a summary of the effects of physical activity on brain health)*

To learn more about this work, listen to previous Outride Summit presentations and read our most recent impact report!

2022 & 2023 Outride Summits

2023 Outride Impact Report

CONNECT WITH US!


@outride


research@outridebike.org


www.outridebike.org

OUTRIDE