Natural Environments and Executive Functions

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How does nature promote human well-being?

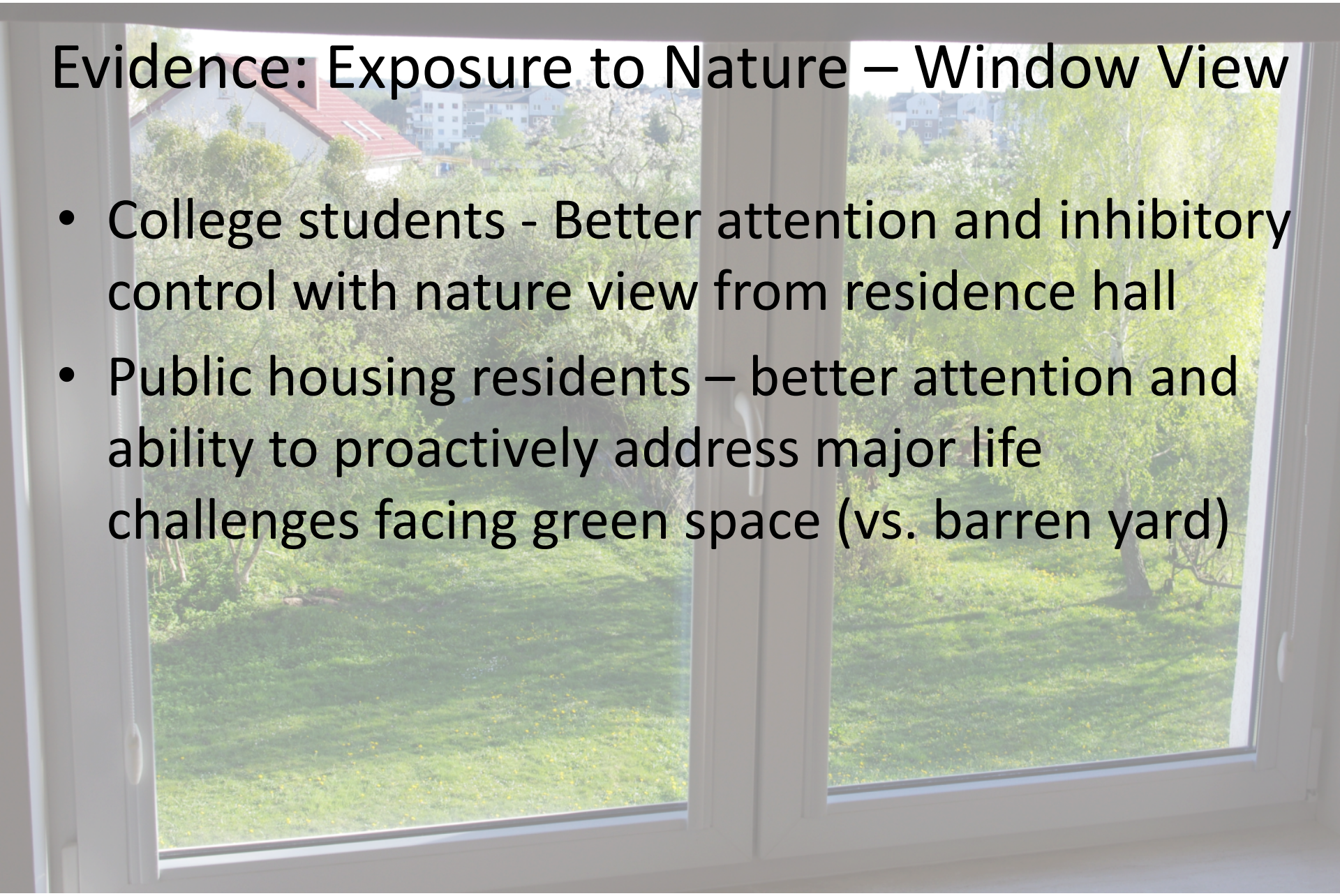
- Stress Reduction Theory – Mental Health
- Immune function pathways – Physical Health
- Behavioral pathways – Physical Activity
- Social pathways – Social cohesion & support
- Attention Restoration Theory

Two Attentional Systems

Directed Attention

Fascination

Evidence: Exposure to Nature – Window View



- College students - Better attention and inhibitory control with nature view from residence hall
- Public housing residents – better attention and ability to proactively address major life challenges facing green space (vs. barren yard)

Children's Views of Nature from Home

Girls ages 7-12 with a natural view had better concentration, impulse control, and delay of gratification than girls without a natural view (Faber Taylor, Kuo, & Sullivan, 2002)

Children's Views of Nature from Home

Parents of children who moved from homes with "less green" to "more green" surroundings reported fewer ADHD symptoms post-move (Wells, 2000).

Research in School Contexts

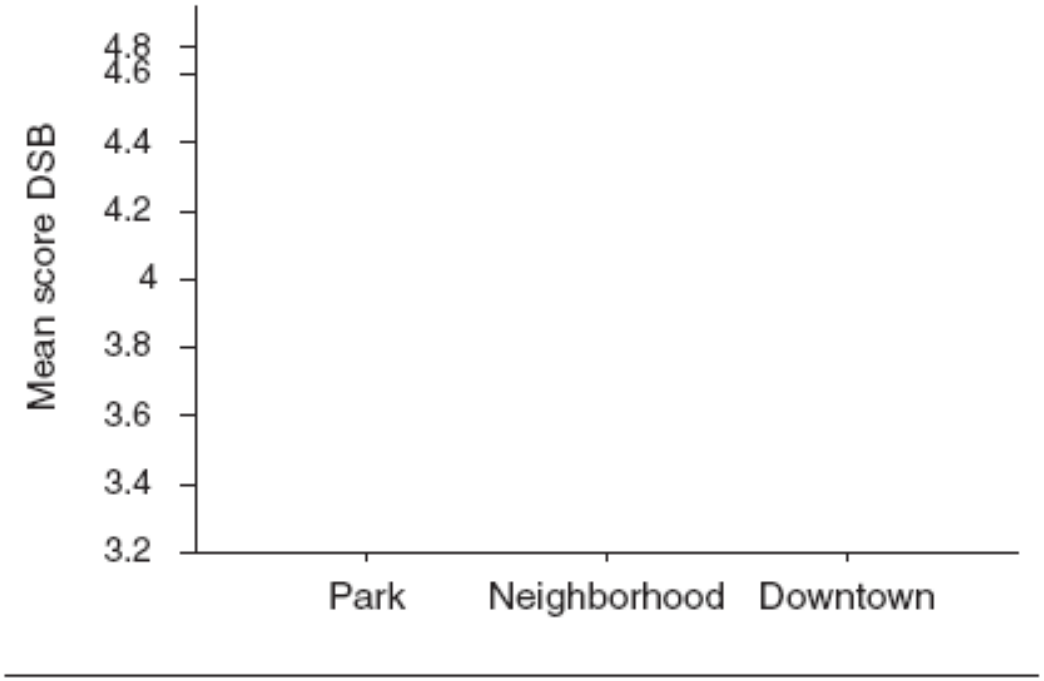
- High school students' window view
  - Better performance on attention tasks
- Comparison of 56 Canadian schoolyards before & after "greening"
  - More physical activity
  - More prosocial behavior, less hierarchical play
- 3 Middle schools in Austria before & after "greening"
  - Decreased physiological stress and increased psychological well-being
- Boston schoolyard initiative
  - Significantly improved standardized test scores

Three-Phase Research Paradigm

Cognitive Fatigue ⟹ Recovery activities
Exposure to Nature
Walk (nature or urban)
Photos or virtual walk ⟹ Cognitive assessments

Nature Walk Study: Children diagnosed with ADHD

Mean Postwalk Scores on Digit Span Backwards for Park, Neighborhood, and Downtown Conditions



Taylor & Kuo, 2009, Figure 1

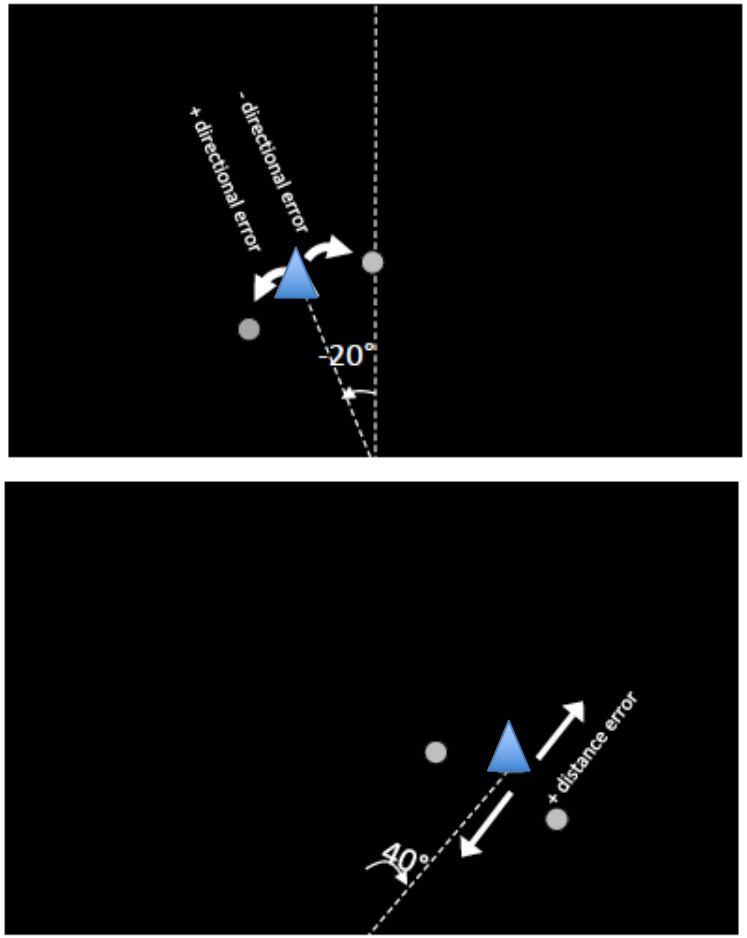
Two studies examining executive functions

1. Comparison of cognitive performance after nature & urban walks
   - Do benefits of nature extend to children **NOT diagnosed with ADHD**?
   - Do benefits extend to **other executive functions**?
   - Working memory, spatial working memory, inhibitory control
   - Do benefits extend to **preschool-aged children**?
2. Comparison of cognitive performance **while** indoors & outdoors

Common Measures for Both Studies

- Spatial working memory
- Verbal working memory
- Inhibitory control
- Sustained attention

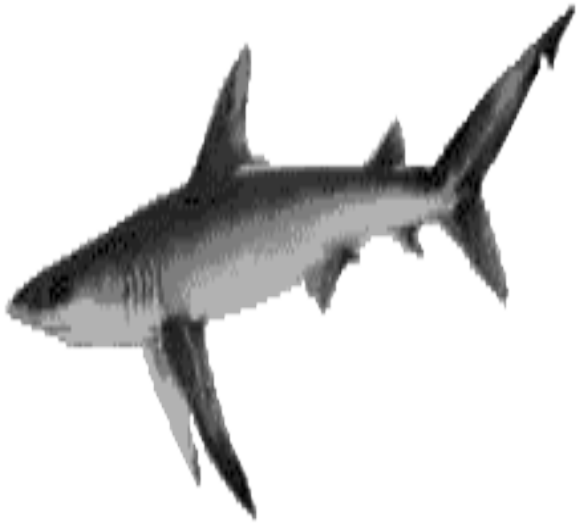
Spatial Working Memory

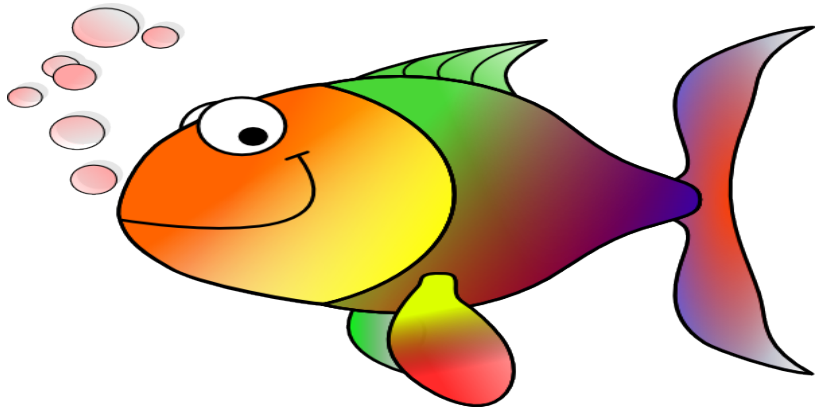


Verbal Working Memory

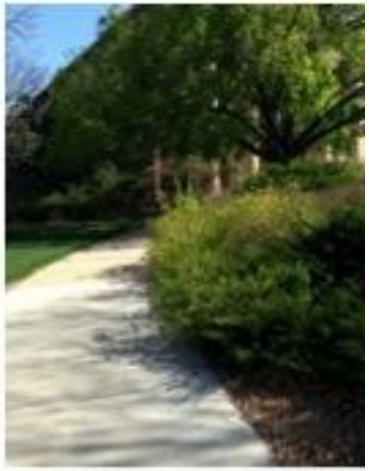
- Digit Span Backwards
  - Longest span (randomly selected digits)
  - 6, 8 (8, 6)
  - 2, 9, 5 (5, 9, 2)

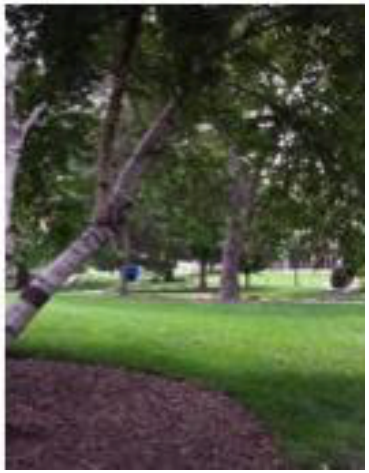
Inhibitory Control: Go/No-go (GNG)
Sustained Attention: Continuous Performance Task (CPT)





Impact of Urban Nature on Executive Functioning in Early and Middle Childhood (Schutte, Torquati, & Beattie, 2015)





- Typically developing 4-5 and 7-8 year old children
- Preschoolers' spatial working memory more accurate after nature walk
- Attention measure – shorter reaction time after nature walk

Attentional Demands of Executive Function Tasks in Indoor and Outdoor Settings: Behavioral and Neurological Evidence

(Torquati, Schutte, & Kiat, 2017)

- 10 Children ages 6-11 years (M=9.3; SD=1.5)
- 2 sessions, counterbalanced: indoors, outdoors
- Spatial working memory, working memory, CPT, GNG
- Continuous EEG; analyzed Event-Related Potentials (ERPs)
- Salivary Cortisol

Results: Indoors vs. Outdoors

- No significant differences in working memory (Digit Span Backwards)
- No significant differences in cortisol concentration
- Better performance on spatial working memory outdoors

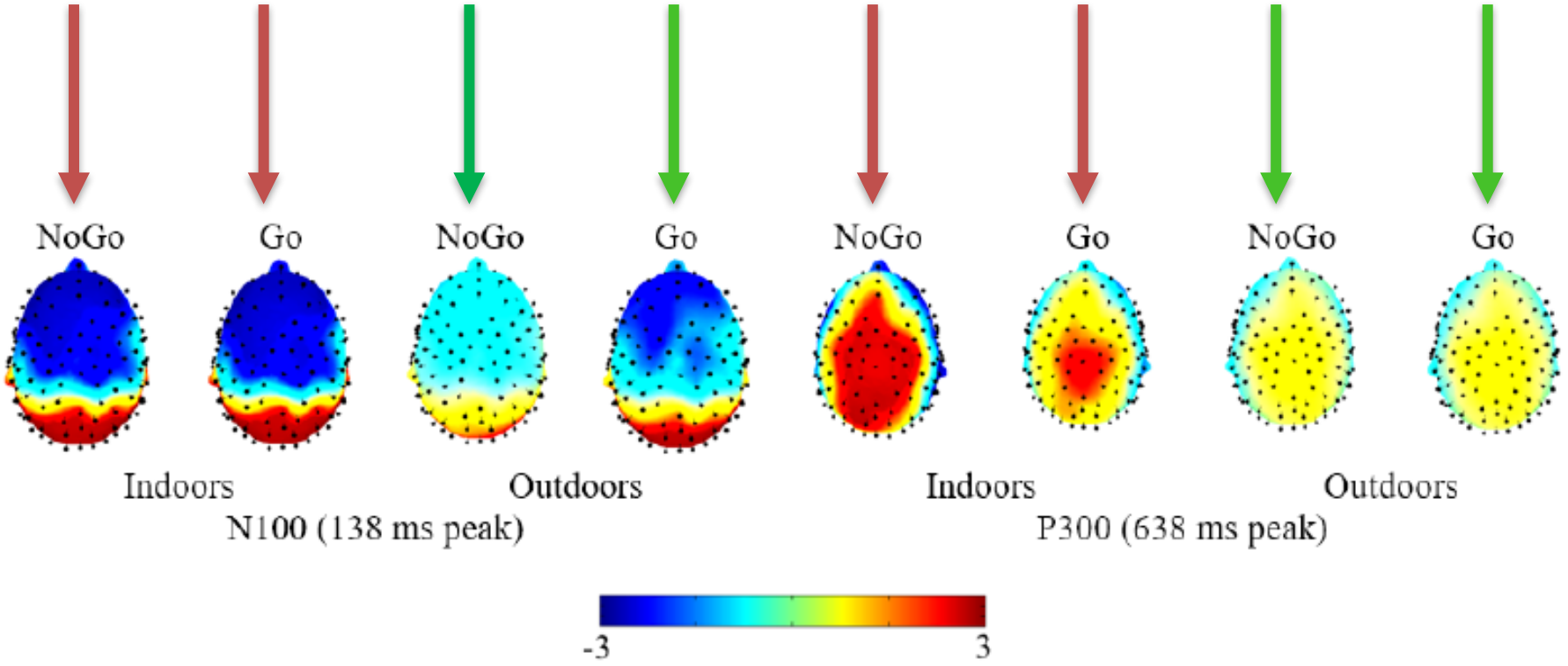
Results: Attention & Inhibitory Control

- No significant differences in attention (CPT) or inhibitory control (GNG)

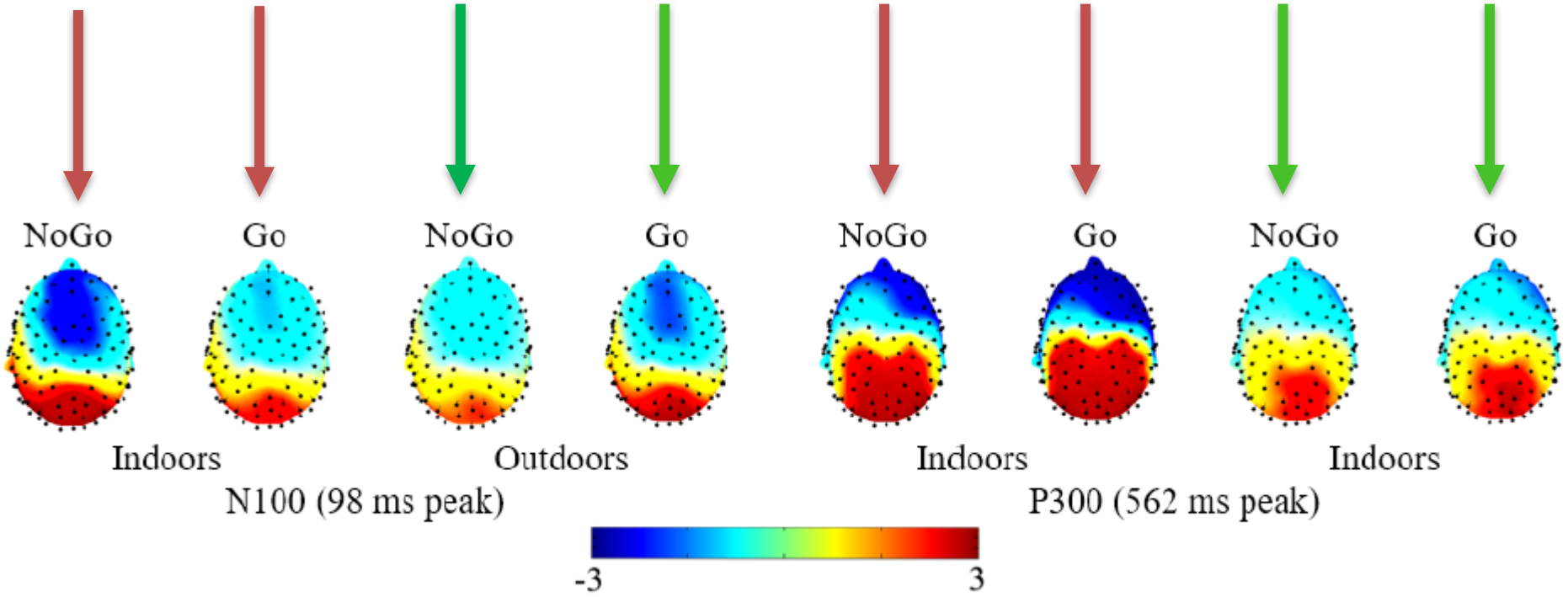
Results: Comparison of ERP indoors vs. Outdoors

- Differences in neurological activity indoors vs. outdoors on measures of attention & inhibitory control
  - N100 ERP: Early perceptual response
  - P300 ERP: Later cognitive processing, comparing stimulus to representation in memory (same? Different? Response needed?)

Comparison of **Go/No-Go** ERP Indoors & Outdoors



Comparison of Continuous Performance Task ERP Indoors & Outdoors



Summary of Cognitive Benefits of Nature – Study 2

- Better spatial working memory **while outdoors**
- No differences in performance on tasks assessing inhibitory control or sustained attention
- However, ERP analysis indicated that **less effort was required outdoors** (smaller amplitude) to achieve the same level of performance

Implications for Education

- Natural environments provide benefits for **how** children think
  - Attention, working memory, inhibitory control
  - Important implications for self-regulation

Implications for Education

- Access to nature during the school day can help children to be successful
  - Recess
  - Windows
  - Outdoor classrooms
  - Forest schools

“If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement, and mystery of the world we live in.”

~ Rachel Carson