

Individual Differences in Intergenerational Sustainability Are Explained by Cortical Thickness of DMPFC and DLPFC

Emmanuel Guizar Rosales^{*1,2}, Thomas Baumgartner^{*1,2}, & Daria Knoch^{1,2}

¹ Department of Social Neuroscience and Social Psychology, Institute of Psychology, University of Bern, Switzerland
² Translational Imaging Center (TIC), Swiss Institute for Translational and Entrepreneurial Medicine, Bern, Switzerland
^{*} The first two authors contributed equally to this work

Background

- Intergenerational sustainability dilemmas like climate change or public debt require the present generation to overcome the social and temporal distance from future generations to sacrifice immediate own benefits for delayed benefits for future others^{1,2}.
- Individuals vary greatly in intergenerational sustainability, but the sources of this behavioral heterogeneity have not been thoroughly investigated using objective methods free from response biases.
- Cortical thickness is a stable³, individually specific⁴, objective trait-like marker capable of explaining individual differences in behavior^{5,6} by allowing for inferences regarding cognitive processes underlying behavioral heterogeneity⁷.

Research Question & Hypotheses

Can individual differences in cortical thickness as objective neural markers explain differences in intergenerational sustainability?

- Taking the perspective of others helps overcome social distance in intergroup situations⁸, and deploying self-control plays a critical role in overcoming social and temporal discounting in social dilemmas⁹ and intertemporal choice tasks¹⁰.
- Perspective-taking is mainly supported by the DMPFC and TPJ¹¹, while self-control is mainly supported by the lateral PFC^{7,10,12}.

We hypothesized that sustainable (vs. unsustainable) participants are marked by greater cortical thickness of the DMPFC, TPJ, and/or lateral PFC.

Methods

Participants

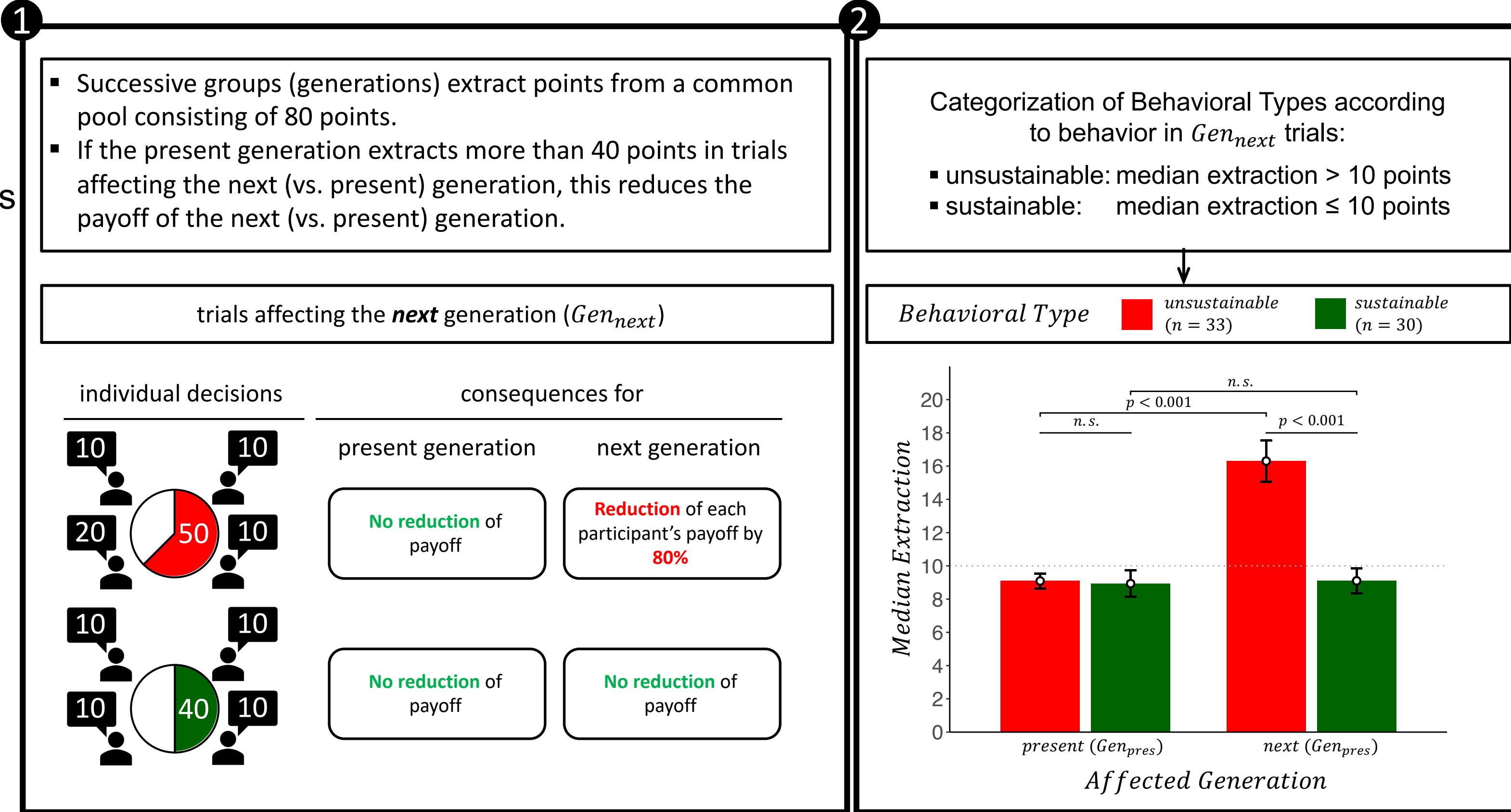
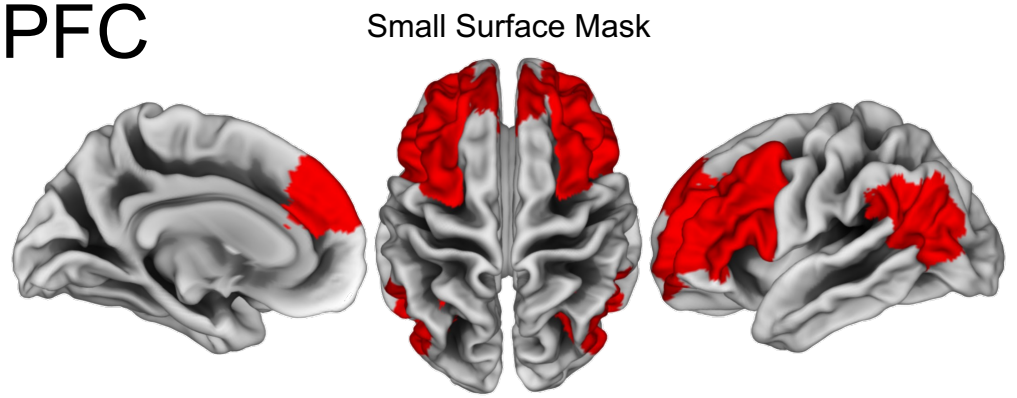
- 63 healthy participants (33 females, mean age \pm SD = 21.79 \pm 2.82 years).

Behavioral economic paradigm

- Intergenerational sustainability dilemma game (see figures to the right)
- Ratings of in-game engagement in perspective-taking and efforts to resist temptations on a scale from 1 ("do not agree at all") to 11 ("completely agree"):
 - "Putting myself in the shoes of others of the [next/present] generation affected my decision in trials affecting the next generation."
 - "I tried to resist the temptation to extract more than 10 points in trials affecting the [next/present] generation."

Brain anatomy

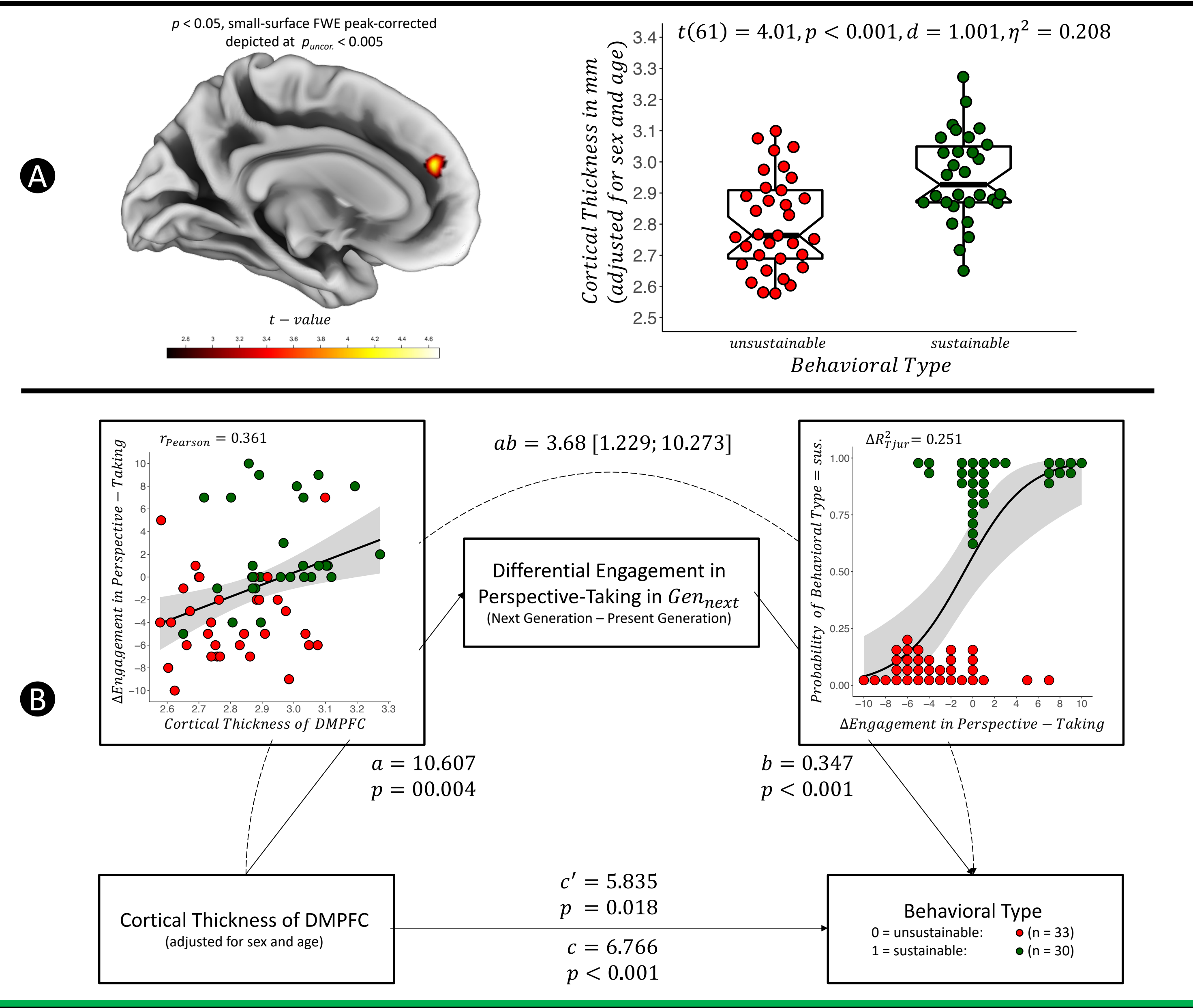
- MRI: T1-weighted MDEFT sequence (resolution: 1 mm³)
- Surface based morphometric analyses of cortical thickness values with correction for sex and age.
- Small-surface correction for DMPFC, TPJ, and lateral PFC
- Control for multiple testing
 - $p < 0.05$ FWE-correction on peak- or cluster-level
 - cluster-defining threshold: $p_{uncor.} < 0.001$



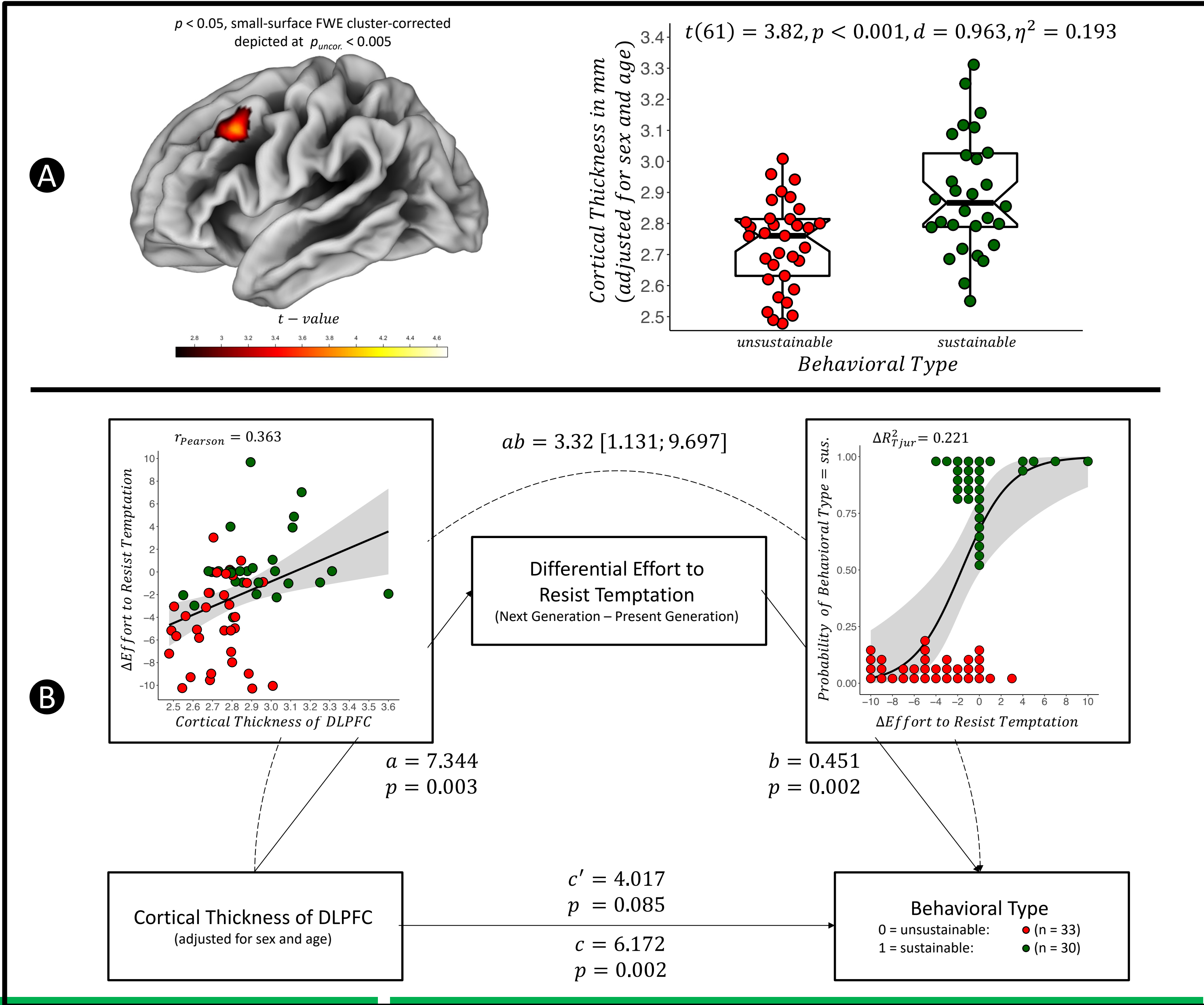
Results

- A** Sustainable (vs. unsustainable) participants were marked by greater cortical thickness of DMPFC and left DLPFC.
- B** Increased cortical thickness of the DMPFC and DLPFC predicted more next generation oriented perspective-taking and efforts to resist temptations, which in turn was associated with a greater probability of being of the sustainable Behavioral Type.

DMPFC (BA 9)



DLPFC (BA 9)



Discussion

Increased cortical thickness of the DMPFC has previously been associated with less biased engagement in taking the perspective of socially distant outgroup members¹³. We speculate that greater cortical thickness of the DMPFC reflects a greater capacity to take the perspective of future others, irrespective of their social and temporal distance to the self, which in turn motivates intergenerational sustainability. Greater cortical thickness of the left DLPFC has previously been associated with a greater capacity to engage in self-control^{5,14}. We reason that an individual

requires self-control to overcome the social discounting of others' (vs. own) outcomes and the temporal discounting of future (vs. immediate) benefits to behave intergenerationally sustainably. The present study might inspire training interventions for promoting sustainability. Long-lasting, effective interventions should be reflected in brain structural changes¹⁵. Promisingly, mindfulness-based trainings have been shown to promote sustainability¹⁶ and to increase cortical thickness in medial PFC¹⁷ and structural interconnectivity of the left DLPFC¹⁸.

Conclusion

- Individual differences in cortical thickness are objective neural markers capable of explaining differences in intergenerational sustainability.
- Sustainable (vs. unsustainable) participants showed greater cortical thickness of DMPFC and left DLPFC.
- Mediation analyses suggest that greater cortical thickness of DMPFC and DLPFC represent a greater capacity to engage in next generation oriented perspective-taking and self-control, which in turn promotes intergenerational sustainability.

References

- (1) Shaden et al. (2021). Scientific Reports
- (2) Wade-Benzoni & Tost (2009). Personality and Social Psychology Review
- (3) Gregory et al. (2020). Journal of Magnetic Resonance Imaging
- (4) Valizadeh et al. (2018). Scientific Reports
- (5) Yamagishi et al. (2016). PNAS
- (6) Han et al. (2020). Neuroimage
- (7) Nash et al. (2015). Frontiers in Behavioral Neuroscience
- (8) Todd & Galinsky (2014). Social and Personality Psychology Compass
- (9) Kocher et al. (2017). Experimental Economics
- (10) Figner et al. (2010). Nature Neuroscience
- (11) van Overwalle (2009). Human Brain Mapping
- (12) Peters & Büchel (2011). Trends in Cognitive Sciences
- (13) Baumgartner et al. (2013). Neuroimage
- (14) Steinbeis et al. (2012). Neuron
- (15) von Bastian et al. (2022). Nature Reviews Psychology
- (16) Thiermann & Sheate (2021). Journal of Cognitive Enhancement
- (17) Valk et al. (2017). Science Advances
- (18) Patsenko et al. (2019). Scientific Reports

Contact



emmanuel.guizarrosales@unibe.ch
thomas.baumgartner@unibe.ch
daria.knoch@unibe.ch



SCAN ME

^b
u

b
UNIVERSITÄT
BERN