

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

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## 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<sup>1,2</sup>.
- 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 stable<sup>3</sup>, individually specific<sup>4</sup>, objective trait-like marker capable of explaining individual differences in behavior<sup>5,6</sup> by allowing for inferences regarding cognitive processes underlying behavioral heterogeneity<sup>7</sup>.

## 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 situations<sup>8</sup>, and deploying self-control plays a critical role in overcoming social and temporal discounting in social dilemmas<sup>9</sup> and intertemporal choice tasks<sup>10</sup>.
- Perspective-taking is mainly supported by the DMPFC and TPJ<sup>11</sup>, while self-control is mainly supported by the lateral PFC<sup>7,10,12</sup>.

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

## Methods

### Participants

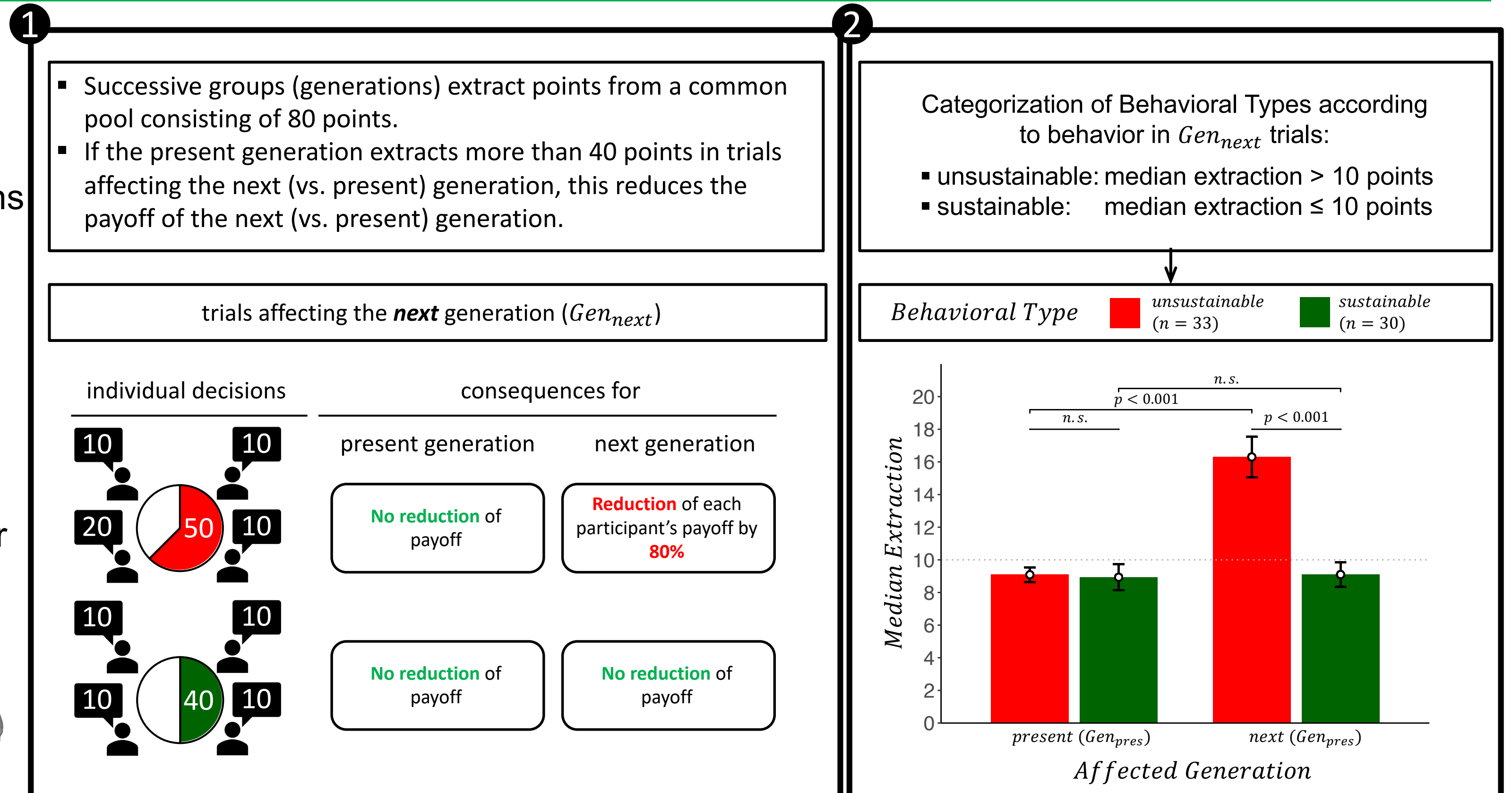
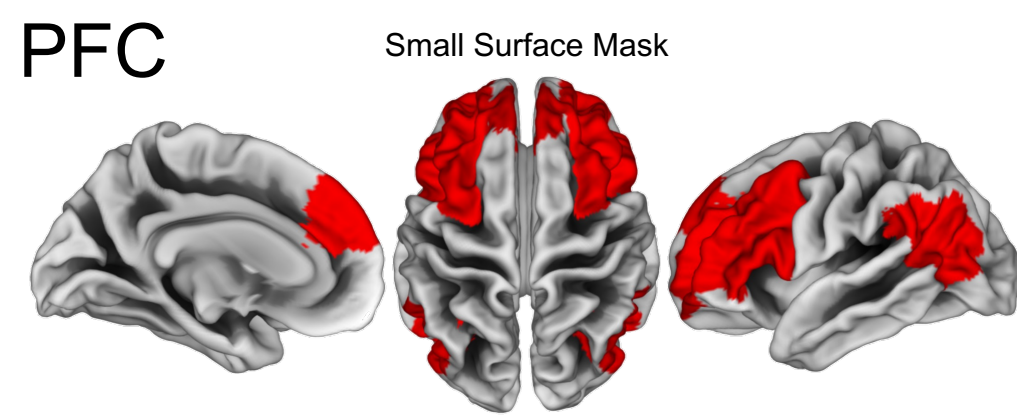
- 63 healthy participants (33 females, mean age  $\pm$  SD = 21.79  $\pm$  2.82 years).

### 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

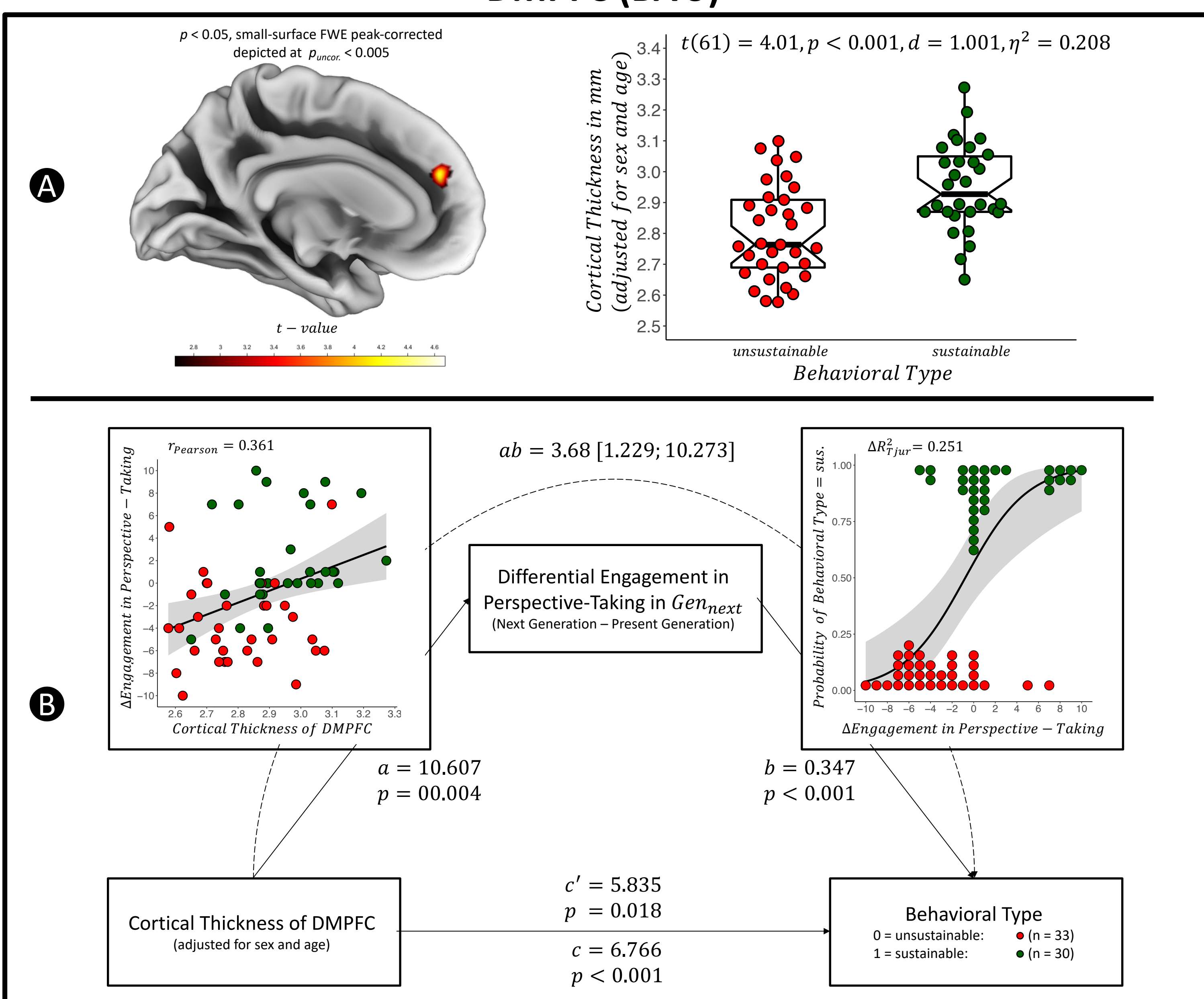
- MRI: T1-weighted MDEFT sequence (resolution: 1 mm<sup>3</sup>)
- Surface based morphometric analyses of cortical thickness values with correction for sex and age.
- Small-surface correction for DMPFC, TPJ, and lateral PFC
- Control for multiple testing
  - $p < 0.05$  FWE-correction on peak- or cluster-level
  - cluster-defining threshold:  $p_{uncor.} < 0.001$



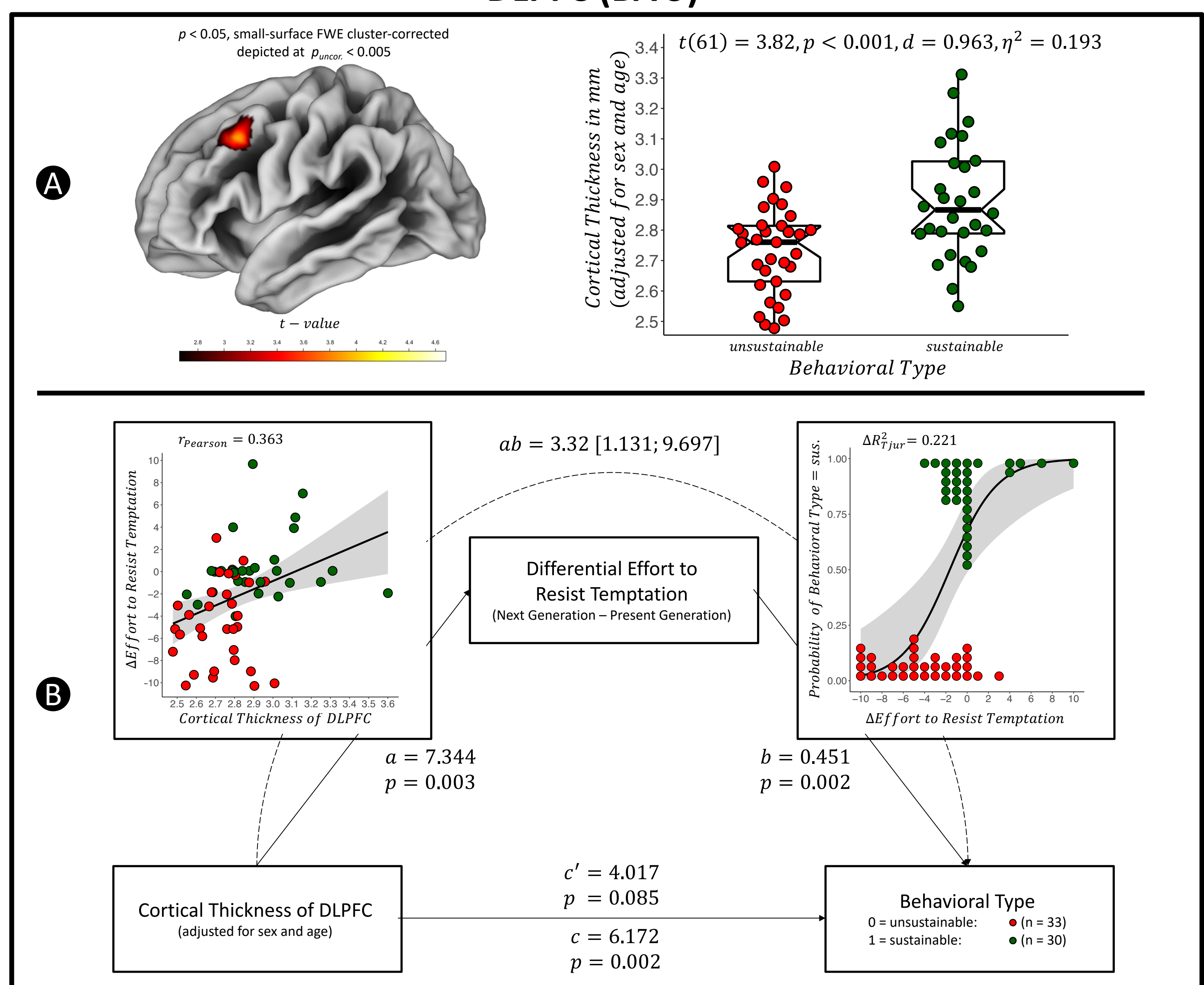
## Results

- Sustainable (vs. unsustainable) participants were marked by greater cortical thickness of DMPFC and left DLPFC.
- 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 members<sup>13</sup>. 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<sup>5,14</sup>. 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 changes<sup>15</sup>. Promisingly, mindfulness-based trainings have been shown to promote sustainability<sup>16</sup> and to increase cortical thickness in medial PFC<sup>17</sup> and structural interconnectivity of the left DLPFC<sup>18</sup>.

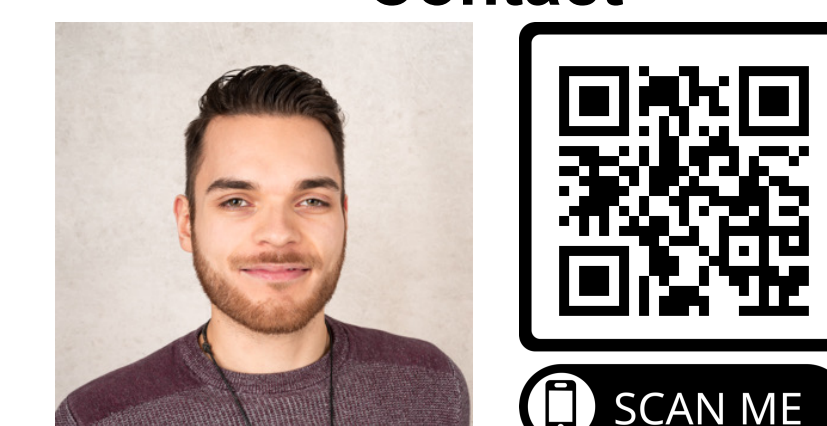
## Conclusion

- 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.

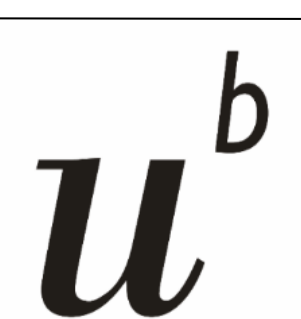
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