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Do neuroplasticity and genetic factors contribute to cognitive training in children?

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Introduction

Inhibitory control (IC)

- important for academic achievement, physical and mental health (Diamond, 2013)
- can be improved with cognitive training programs (e.g., Diamond & Lee, 2011; Jaeggi et al., 2011)

Factors contribute to cognitive training gains

- basal cognitive level (Karchach & Unger, 2014)
- brain activity/anatomy (Baniqued et al., 2019; Chaddock-Heyman et al., 2020)
- genetic factors (Leckie et al., 2014)

Aim of this study : investigate the genetic, cerebral and cognitive factors contributing to the receptivity of IC training

Material & methods

Brain anatomy (pre- and post-training)

- Grey matter volumes in regions of interest (ROI) of the IC network

Cognition (pre- and post-training)

- color-word Stroop task (Stroop interference)
- stop signal task (stop signal reaction time, SSRT)

Genes (saliva sample, pre-training)

- Polygenic risk score (PRS) calculated with the summary statistics of UK Biobank GWAS (N=84,259) related to IC (Trail Making Test, TMT).

Multilevel Structural Equation Model (SEM):

Test simultaneously and globally a set of *a priori* defined hypothetical relationships, combining :

- 2 latent change score models (LCS; Kievit et al., 2018; McArdle, 2009) to investigate training-related changes at both cognitive and brain levels (in yellow)
- 2 mediation models to investigate whether the genetic effect on cognition was mediated by the grey matter volume baseline (in blue) and change (in green)

Model selection for the ROI based on :

- specific IC-training effect
- good SEM fit indices
- significant training-related cognitive changes

Results

Raw grey matter volume (without spatial normalization)

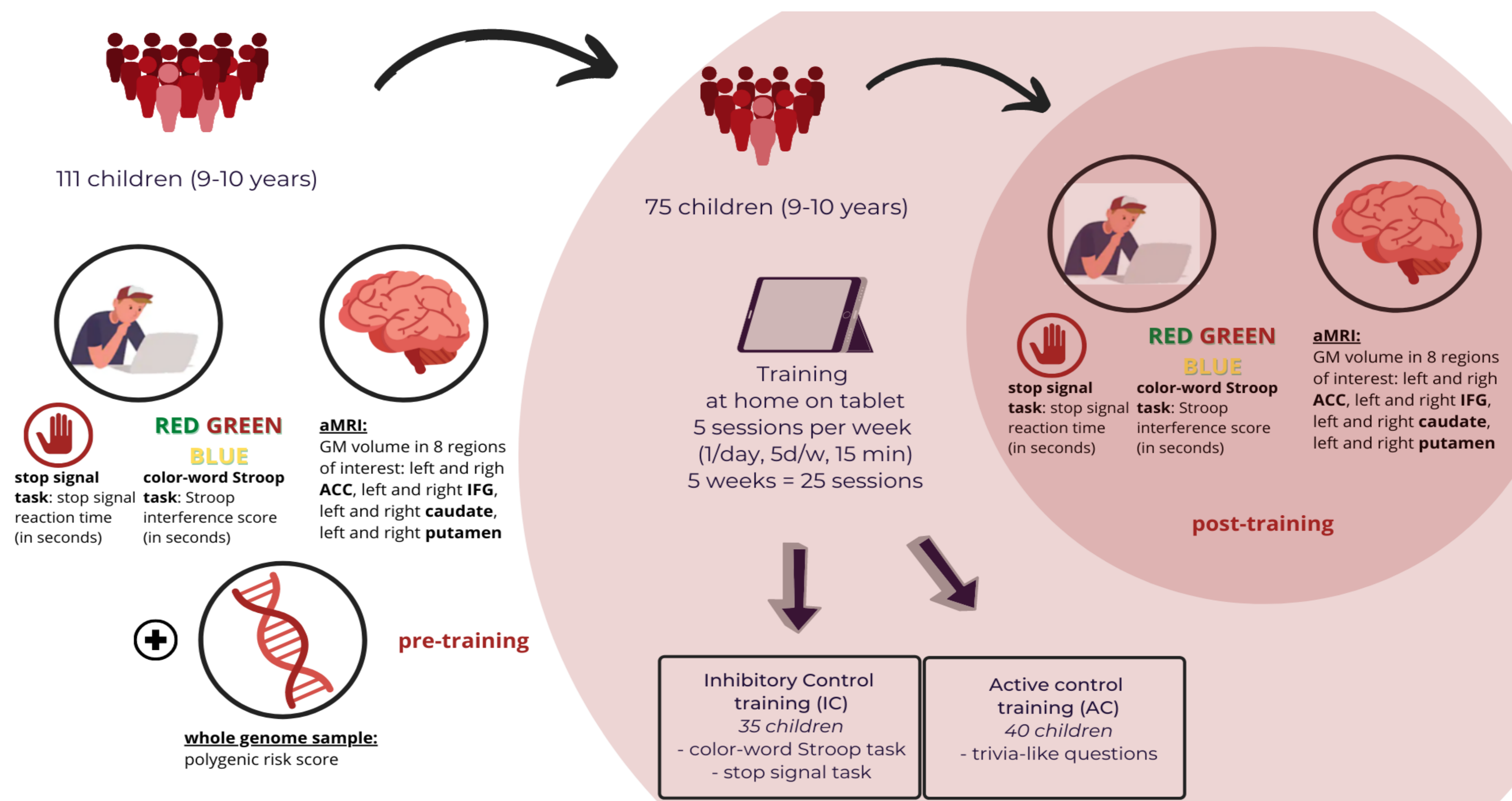
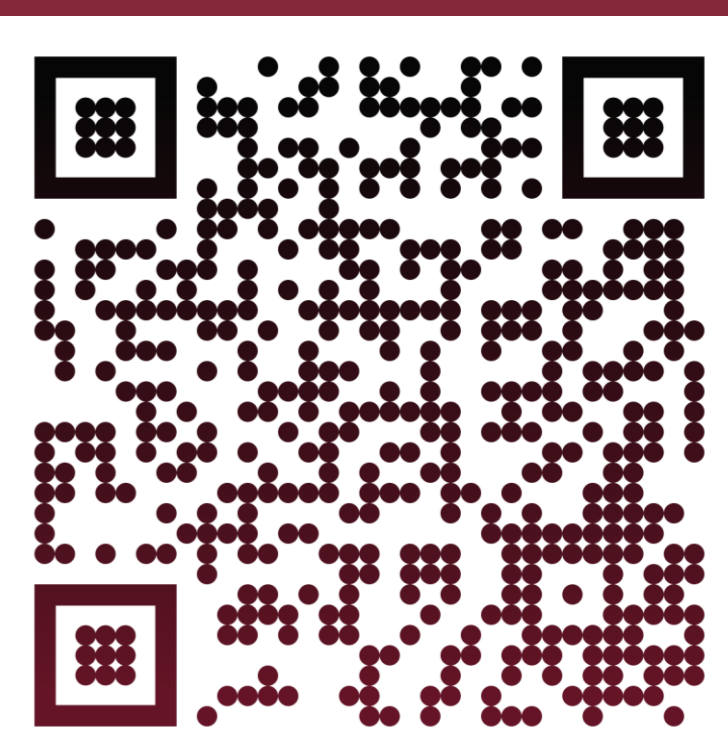
- **IC training:** IC changes depend on genetic (PRS), brain (basal and changes of left ACC volume) and cognitive (baseline SSRT) features
- **Control training:** IC changes only depend on the cognitive (baseline SSRT) features

Normalized grey matter volumes (with spatial normalization to MNI)

- **IC training:** IC changes depend on brain (basal and changes of left Putamen volume) and cognitive (basal SSRT) features
- **Control training:** IC changes depend only explained on the cognitive (baseline SSRT) feature

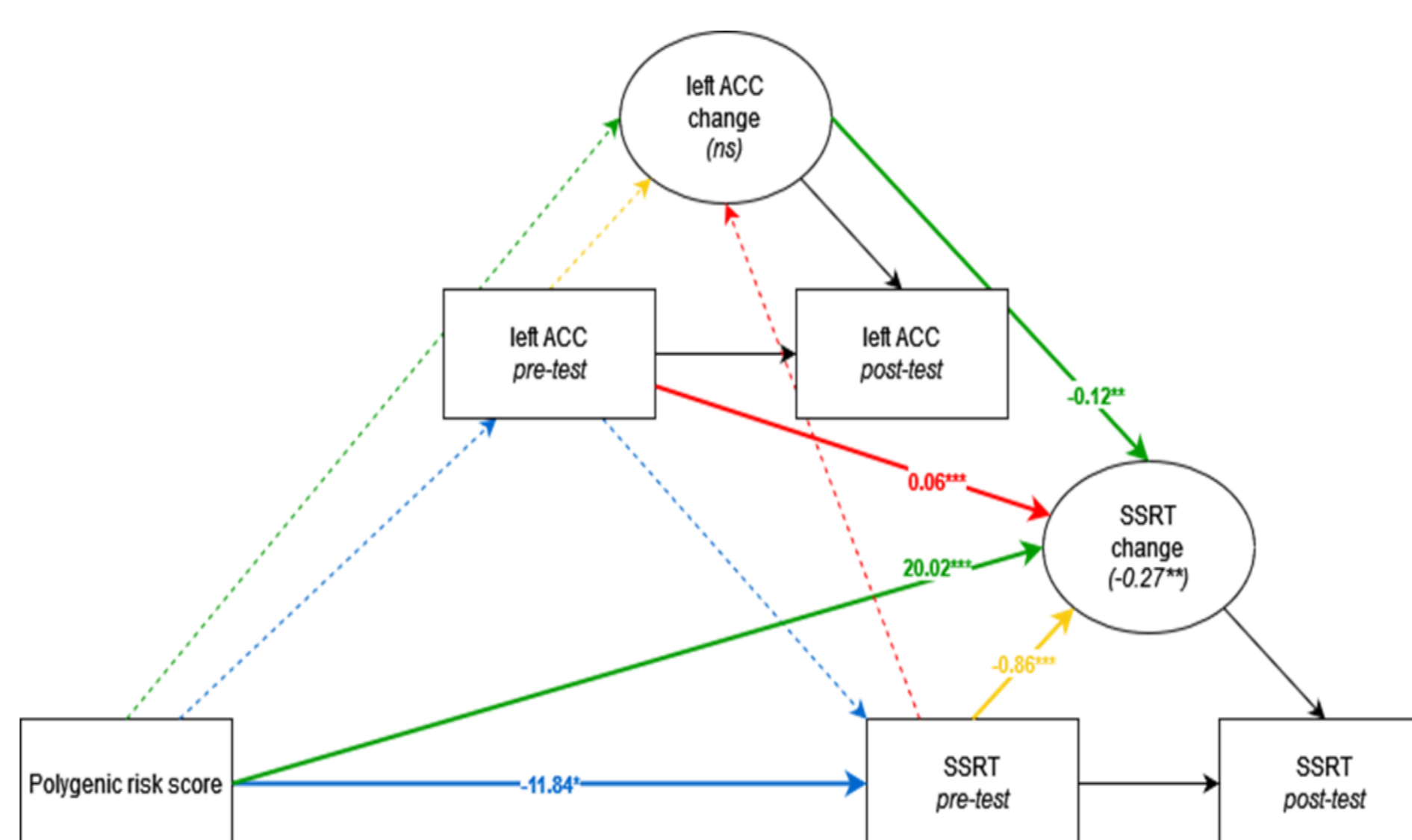
References: Baniqued, P. L., et al. (2018). *Frontiers in Aging Neuroscience*. Chaddock-Heyman, L., et al. (2020). *Frontiers in Human Neuroscience*. Diamond, A. (2013). *Annual Review of Psychology*. Diamond, A., et al. (2011). *Science*. Jaeggi, S. M., et al. (2011). *Proceedings of the National Academy of Sciences*. Karchach, J., et al. (2014). *Frontiers in Psychology*. Kievit, R. A., et al. (2018). *Developmental Cognitive Neuroscience*. Leckie, R. L., et al. (2014). *Frontiers in Human Neuroscience*. McArdle, J. J. (2009). *Annual Review of Psychology*.

➔ Training-relative cognitive changes depends on the interrelation of factors at different levels: molecular (genetics), neural (basal and change of regional grey matter volumes) and cognition (basal level)

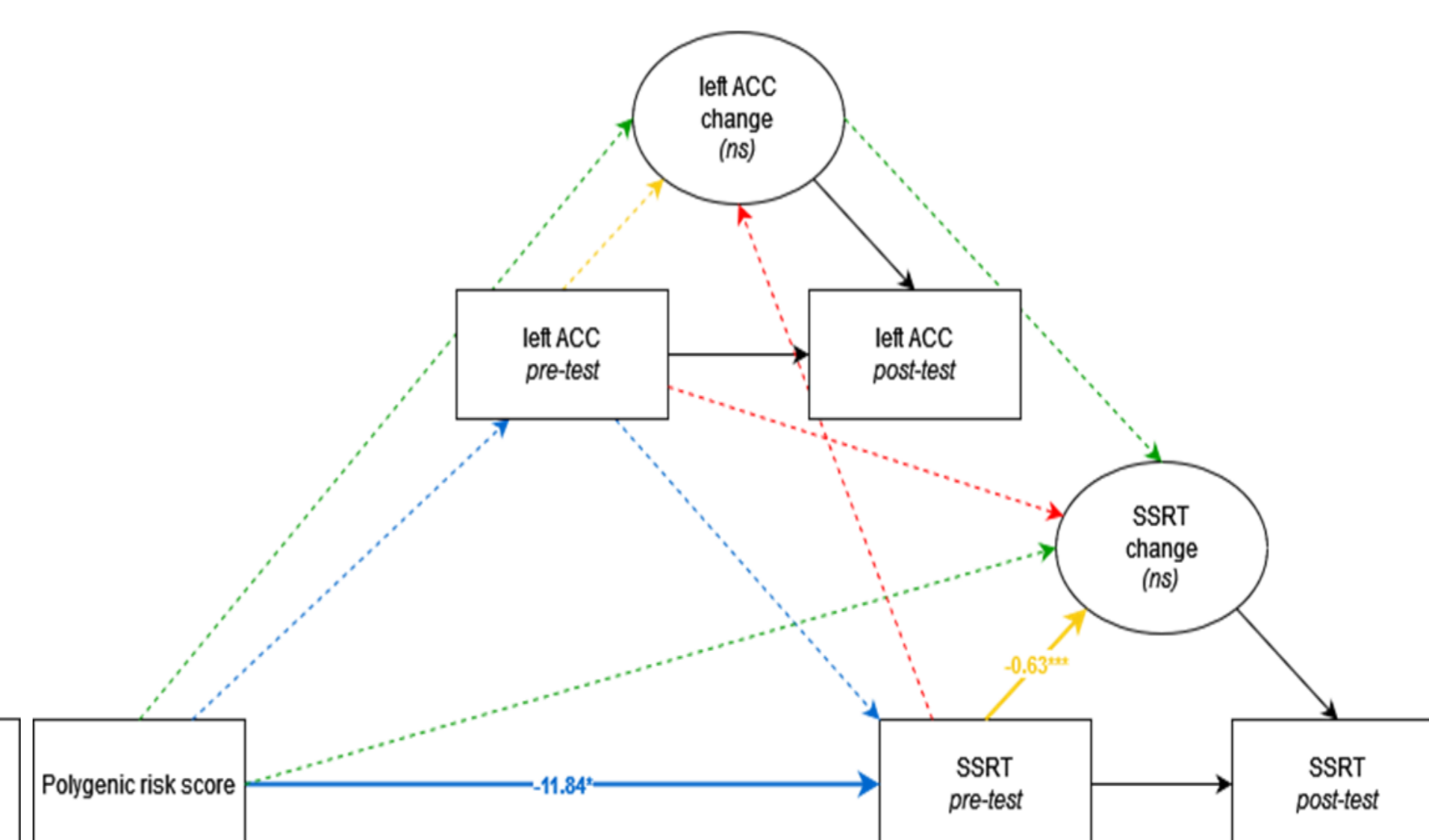


Without spatial normalization (left ACC)

IC training

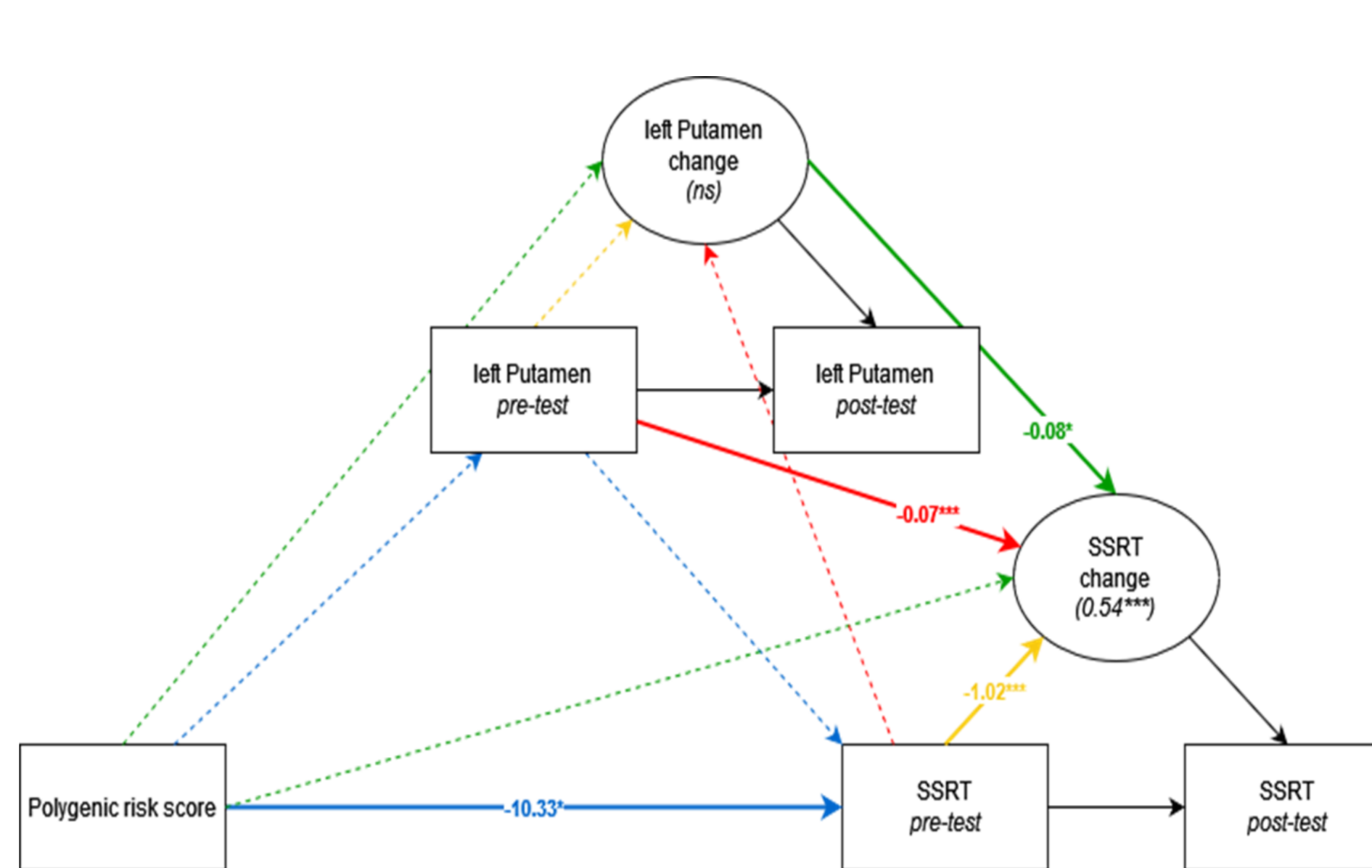


Control training



With spatial normalization (left Putamen)

IC training



Control training

