

EEG-based functional connectivity analysis in preterm infants

A multicenter collation of developmental charts and altered brain development



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Background

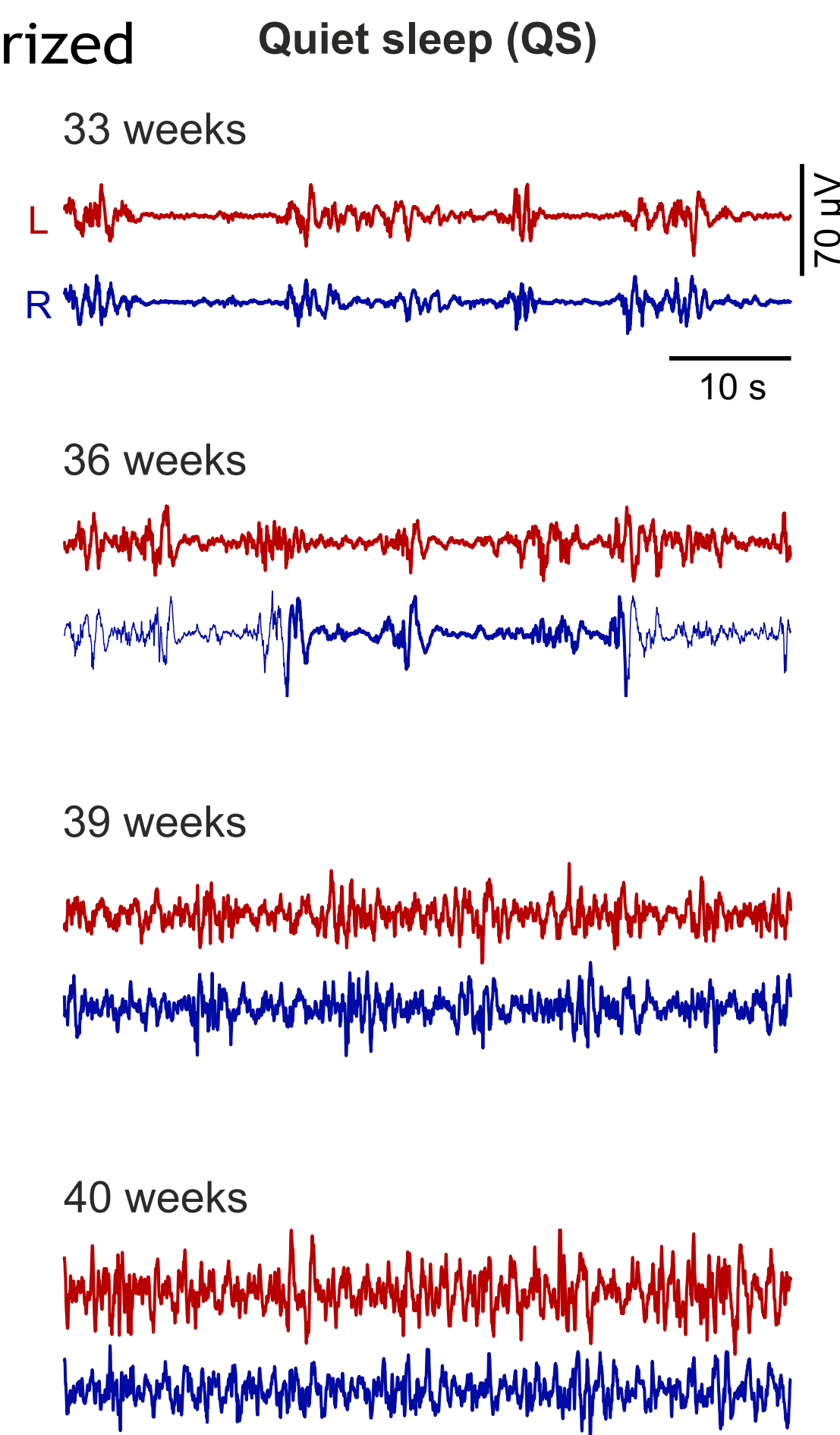
Functional changes during early neurodevelopment

Early brain development is characterized by prominent changes in structure and function. However, studies on the functional connectivity (FC) with measures of direct brain activity remain scarce.

Studying functional brain networks

EEG provides a direct measure of brain activity with high temporal resolution, which does not depend on neurovascular coupling that is still developing in infants.

Here, we present reproducible developmental charts of neonatal FC and show that Family Nurture Intervention (FNI) during neonatal intensive care affects early cortical activity networks.



Data

Multicenter high-density EEG recordings

Repeated neonatal HD-EEG (124 ch) was collected from 33 to 45 weeks of conceptional age (CA) in 3 trials:

RCT1 (New York):
~300 recordings in 137 infants

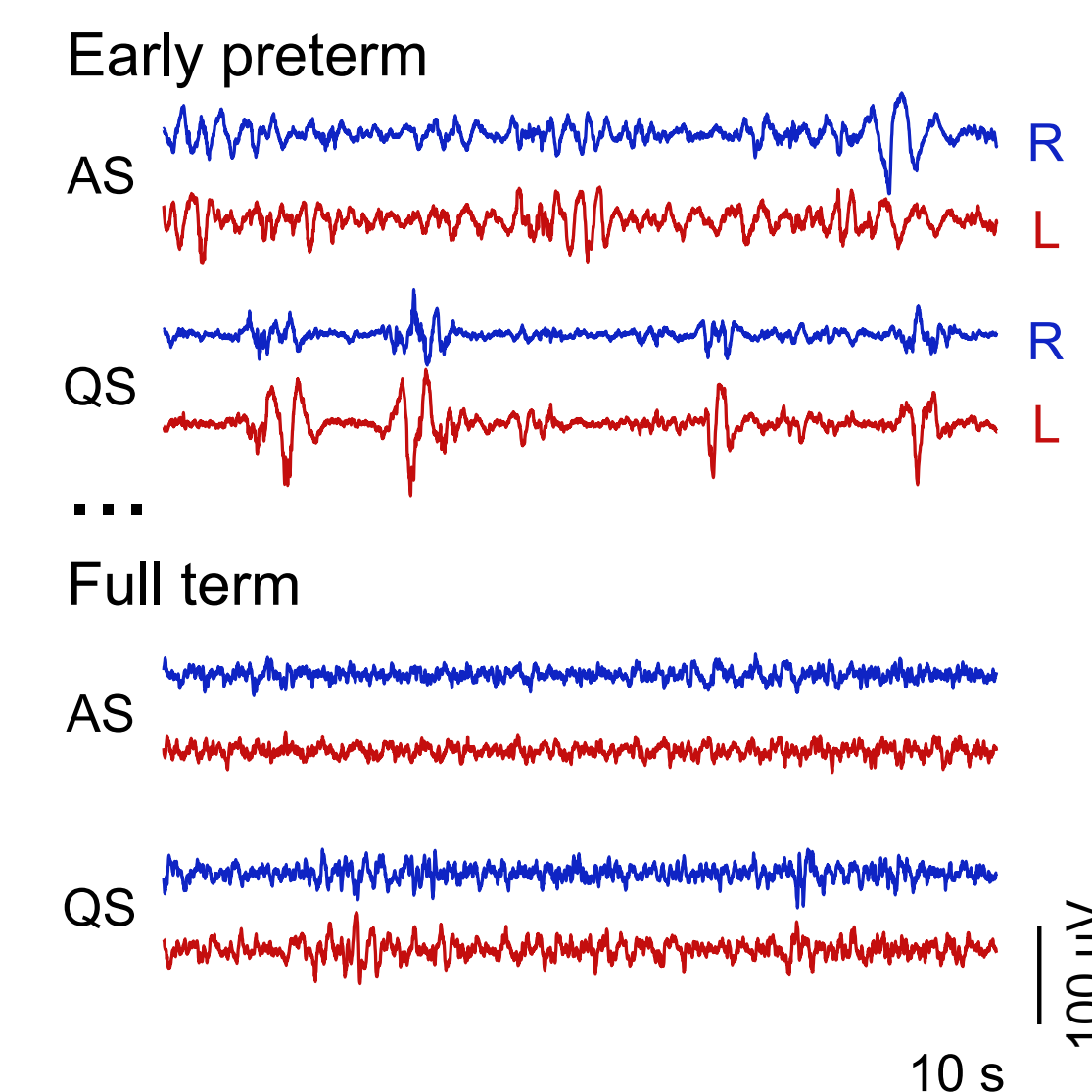
RCT2-NY (New York):
~120 recordings in 62 infants

RCT2-SA (San Antonio):
~80 recordings in 39 infants

Intervention

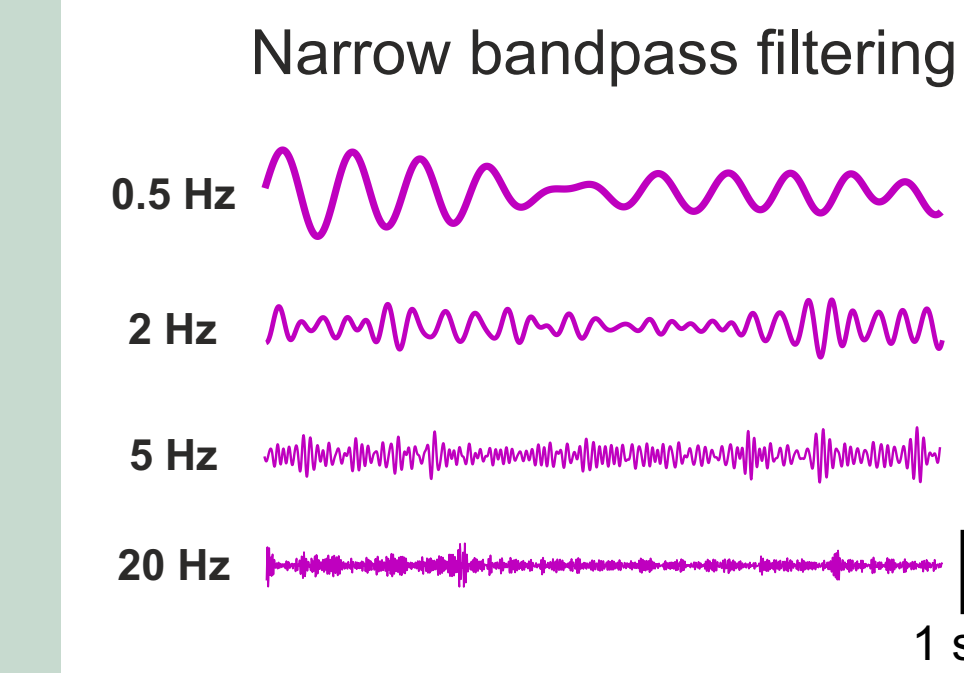
The mother-infant dyads received either standard care (SC) or Family Nurture Intervention (FNI).

FNI includes sustained touch, eye contact, deep vocal soothing, exchange of scent cloths, and skin-to-skin care.

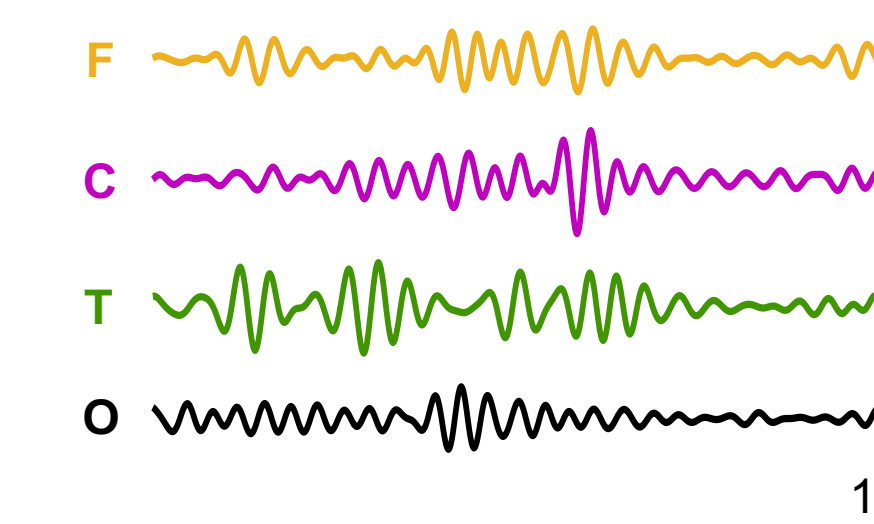
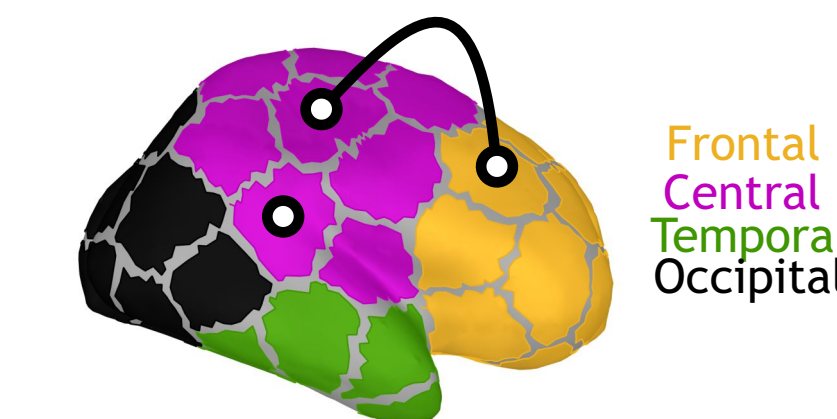


Methods

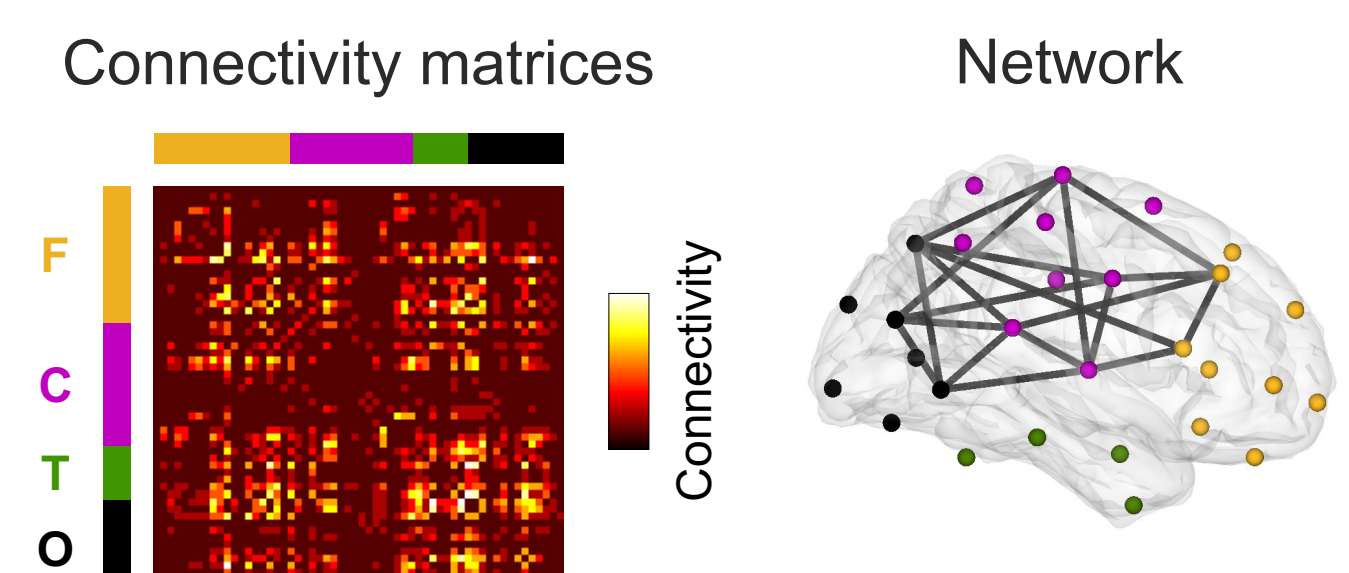
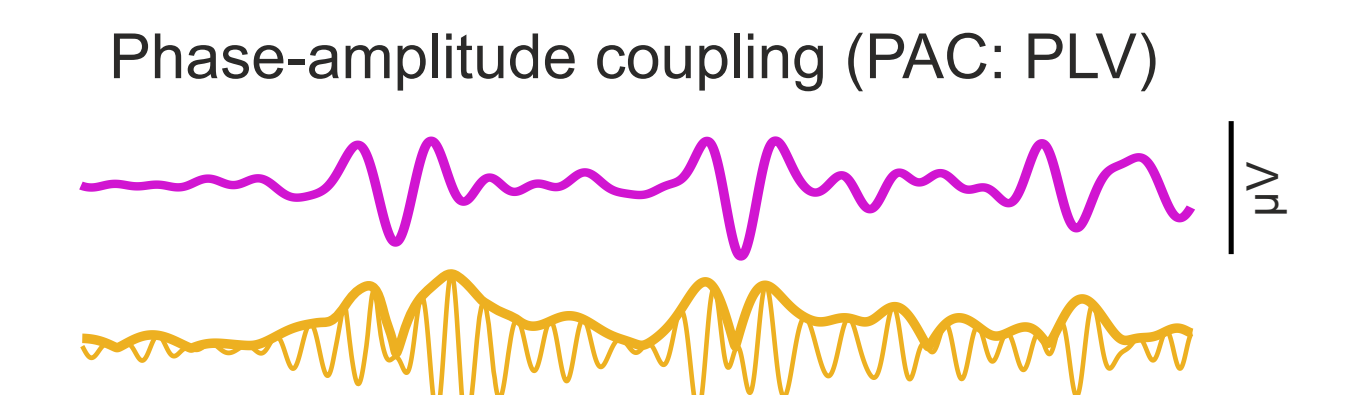
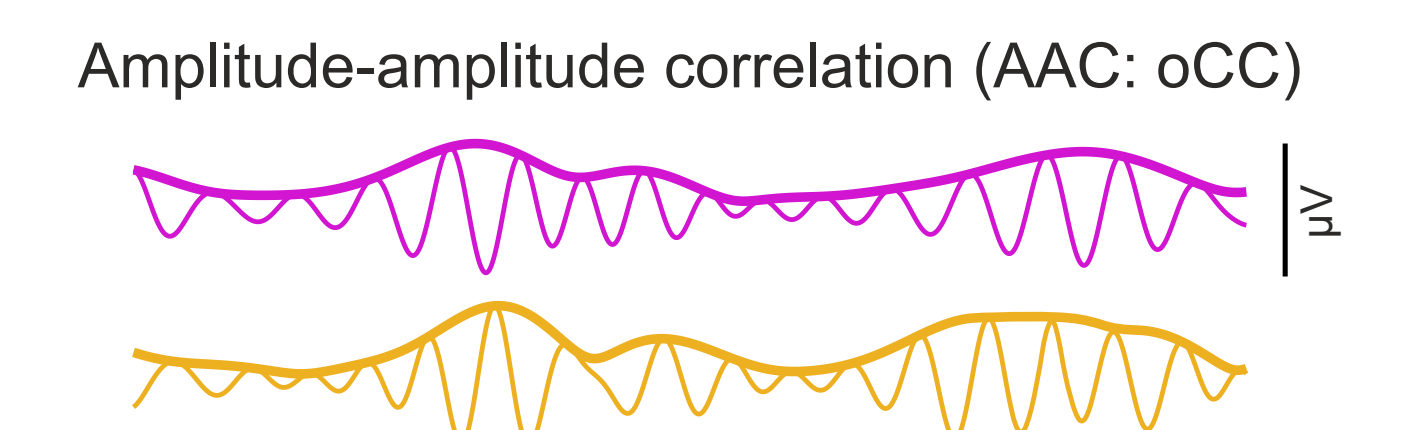
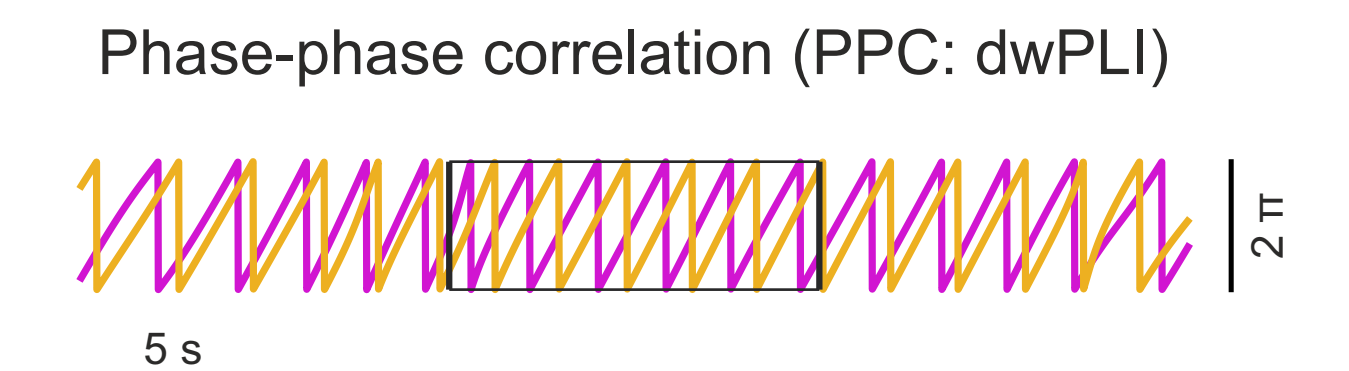
Preprocessing



Source reconstruction

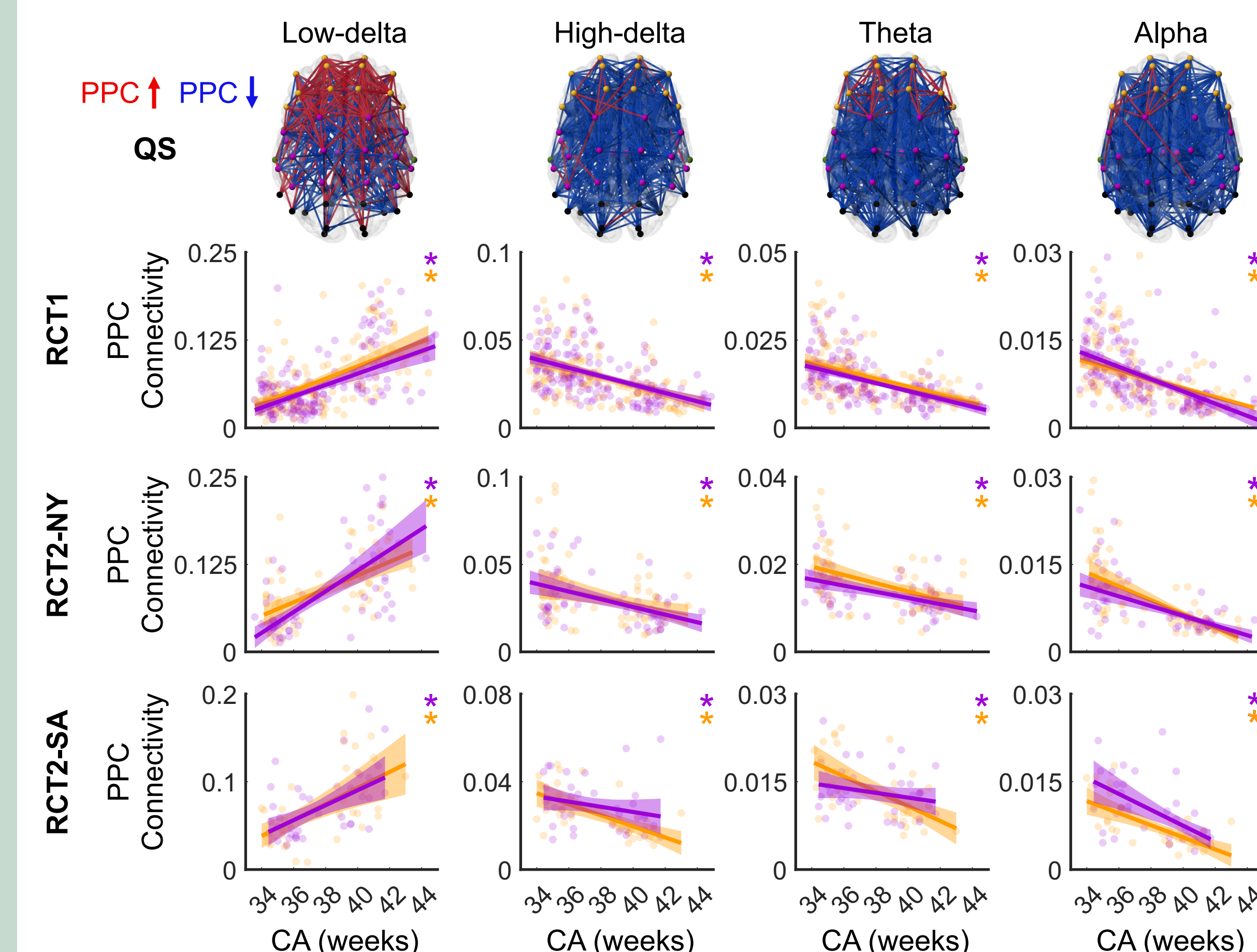


Connectivity analysis



Development of phase synchrony

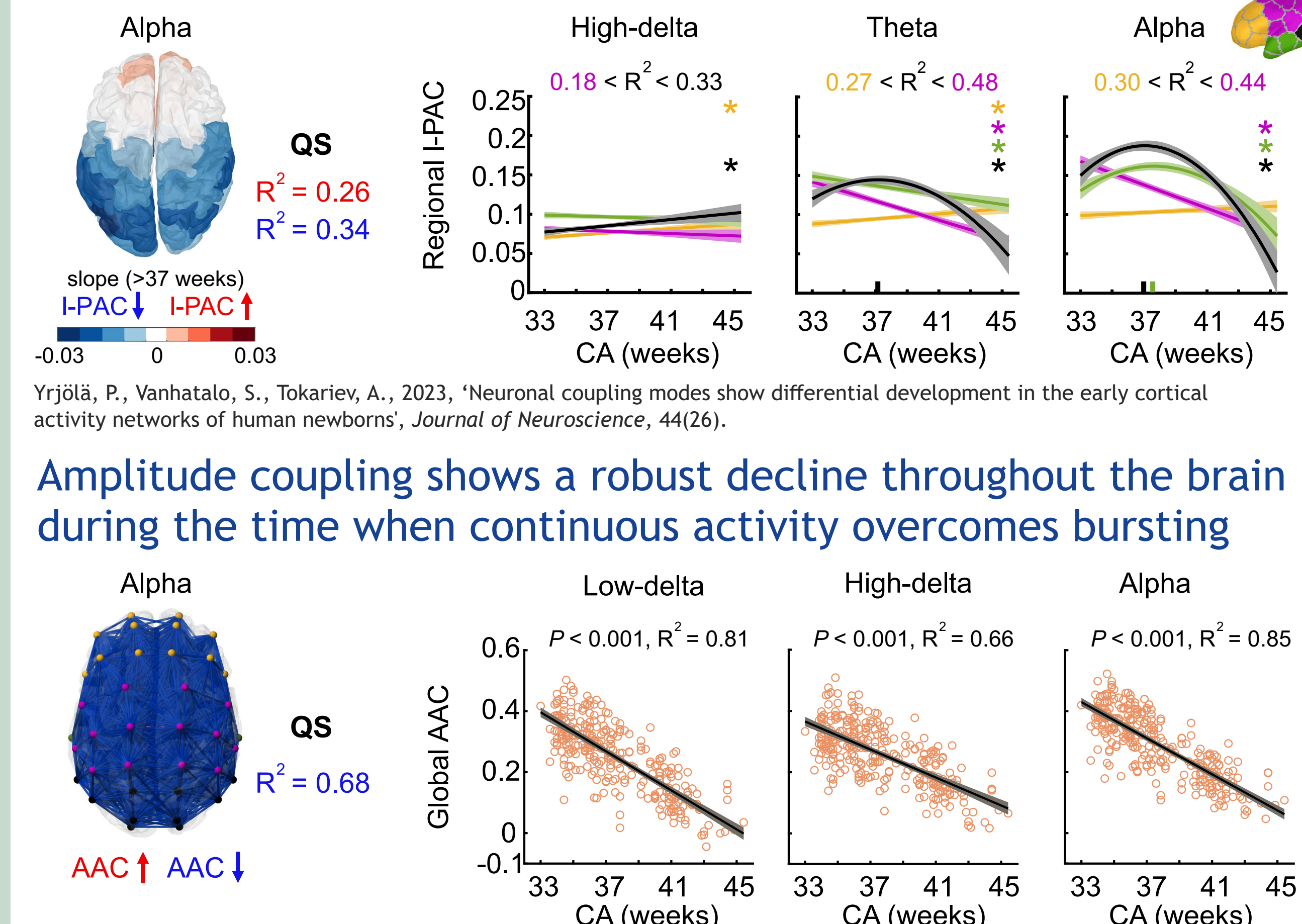
Phase coupling reveals distinct frequency-specific development of networks which are reproducible in multicenter trials



Yrjölä, P., Vanhatalo, S., Tokariev, A., 2023, 'Neuronal coupling modes show differential development in the early cortical activity networks of human newborns', *Journal of Neuroscience*, 44(26).

Development of bursting

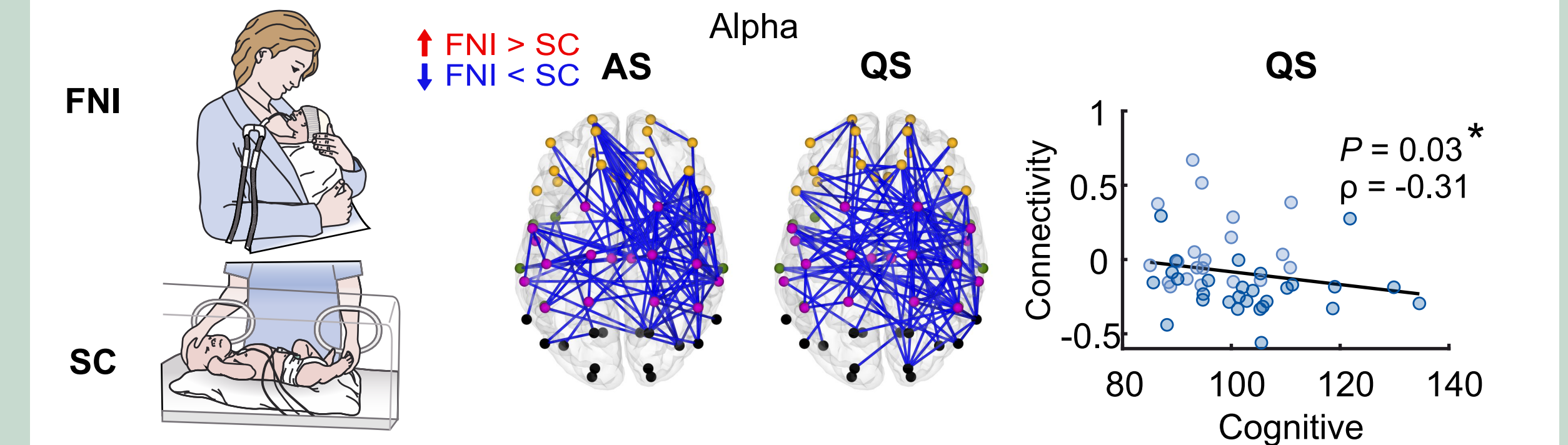
Phase-amplitude coupling develops quadratically and coincides with the emergence and decline of spontaneous bursting



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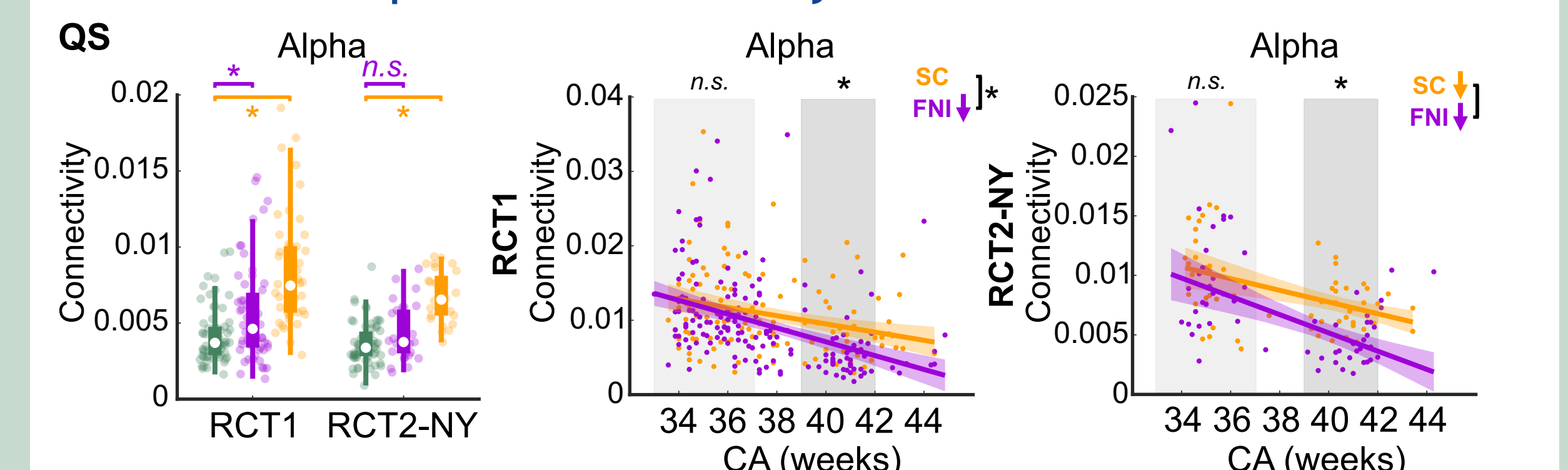
NICU-based intervention

Family Nurture Intervention reduces functional connectivity and leads to improved cognitive outcomes at 18 months



Yrjölä, P., Myers, M.M., Welch, M.G., Stevenson, N.J., Tokariev, A., Vanhatalo, S., 2022, 'Facilitating early parent-infant emotional connection improves cortical networks in preterm infants', *Science Translational Medicine*, eabq4786

FNI-related changes are replicable and render preterm brain networks comparable to healthy term-born controls



Yrjölä, P., Myers, M.M., Welch, M.G., Tokariev, A., Vanhatalo, S., 2023, 'Early development of cortical networks is modulated by Family Nurture Intervention: a multicenter replication study', *in preparation*

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