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Adults recognize pain in cries when currently involved in babies' care: investigations from behavior to brain responses

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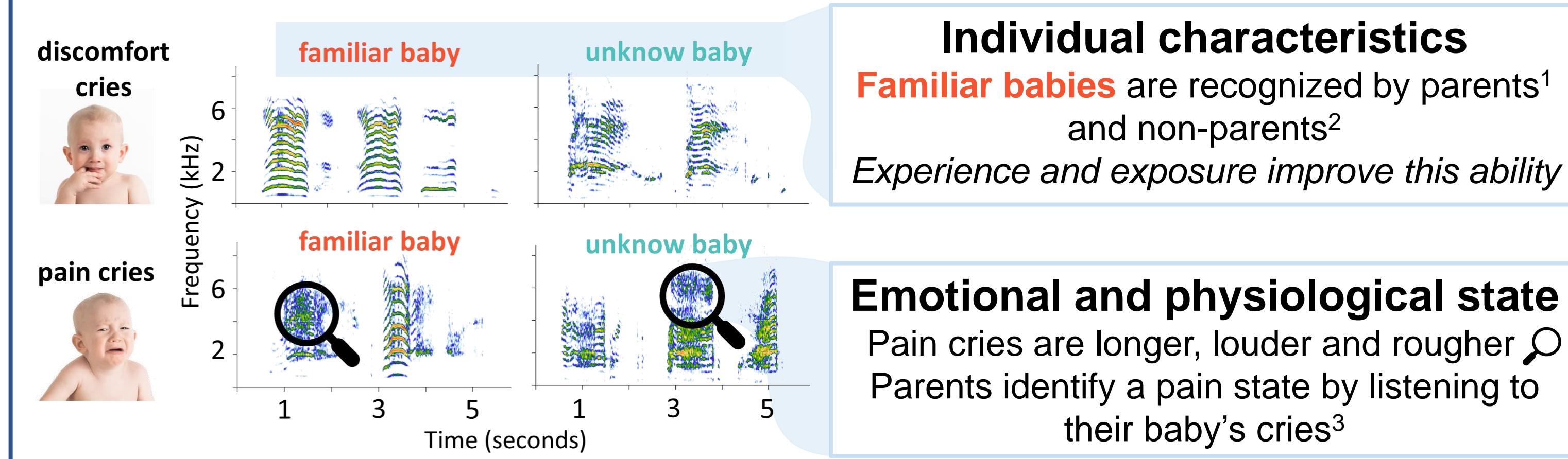
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Background: babies cries convey information through acoustic differences



Spectrograms (graphical representations) of cries from two different babies. Cries were recorded during bathing (discomfort cries) or during routine vaccination (pain cries).

Is the ability to recognize pain in cries shared between every adult or acquired with experience at caring for babies?

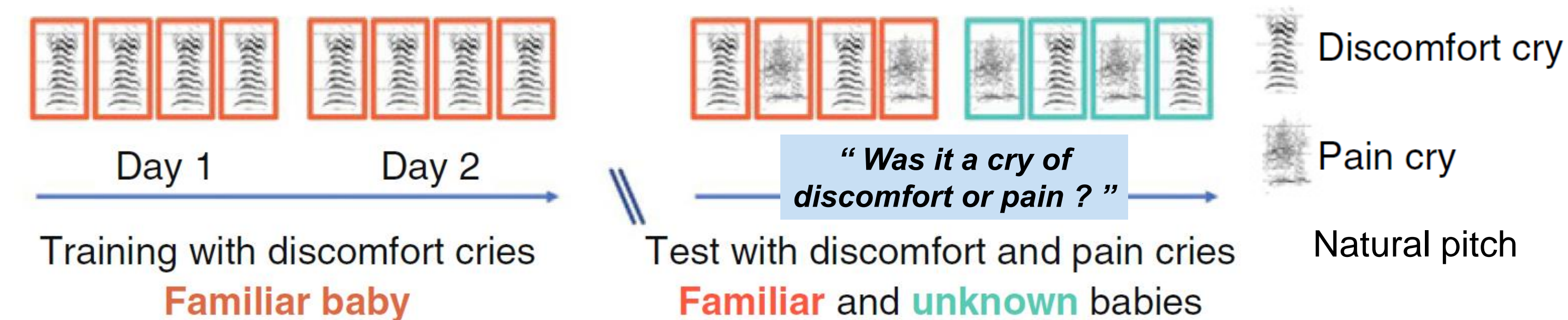
Can adults generalize and recognize pain in cries from every child?

Which brain areas are involved for pain recognition in cries?

Methods

Psychoacoustic experiment: 234 participants (133 women, 101 men) with various experience in babies care

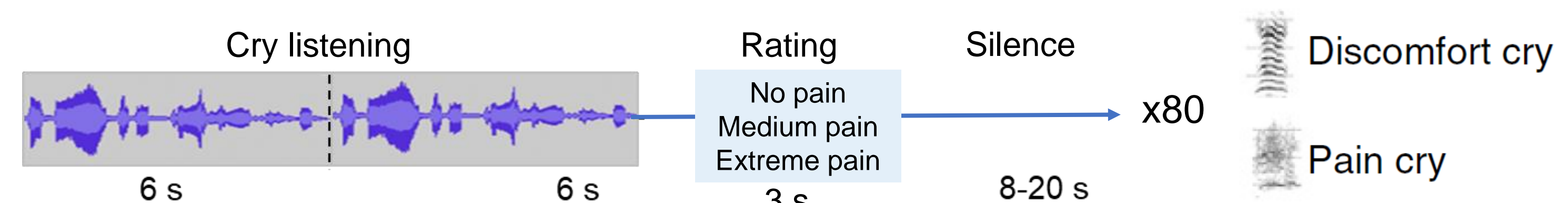
- Non parents with no experience, a moderate or a professional experience with babies
- Parents having a child younger than 2 years-old or older than 5 years-old



Adult subjects began by hearing discomfort cries from an assigned baby in two successive sessions. In a second step, subjects listened to successive sequences of cries from either their familiar baby or an unknown baby. The cries were either discomfort cries or pain cries. Subjects were asked to classify each cry as either « discomfort » or « pain » cry.

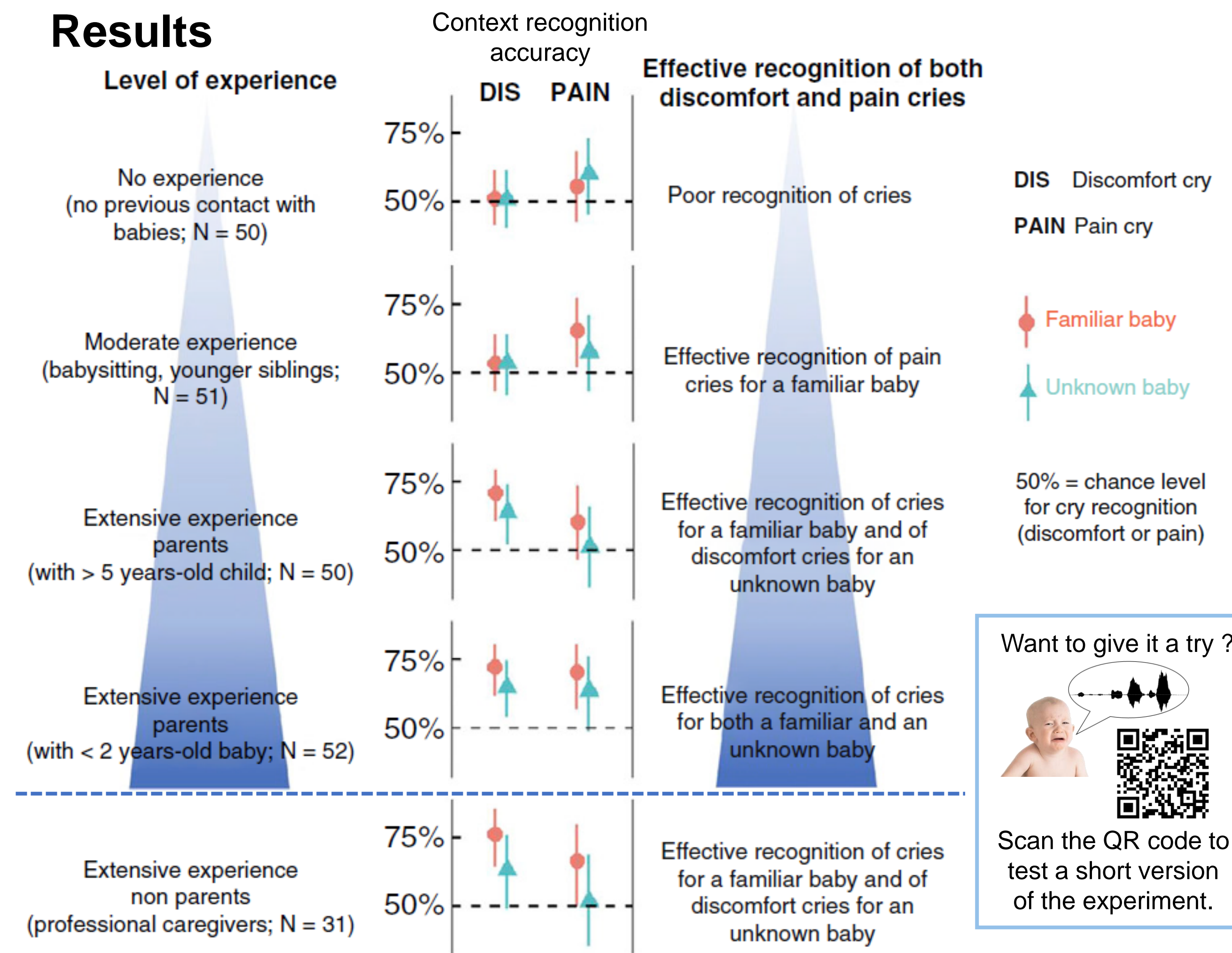
Bayesian mixed model

fMRI experiment: 80 participants (40 women, 40 men) parents and non-parents

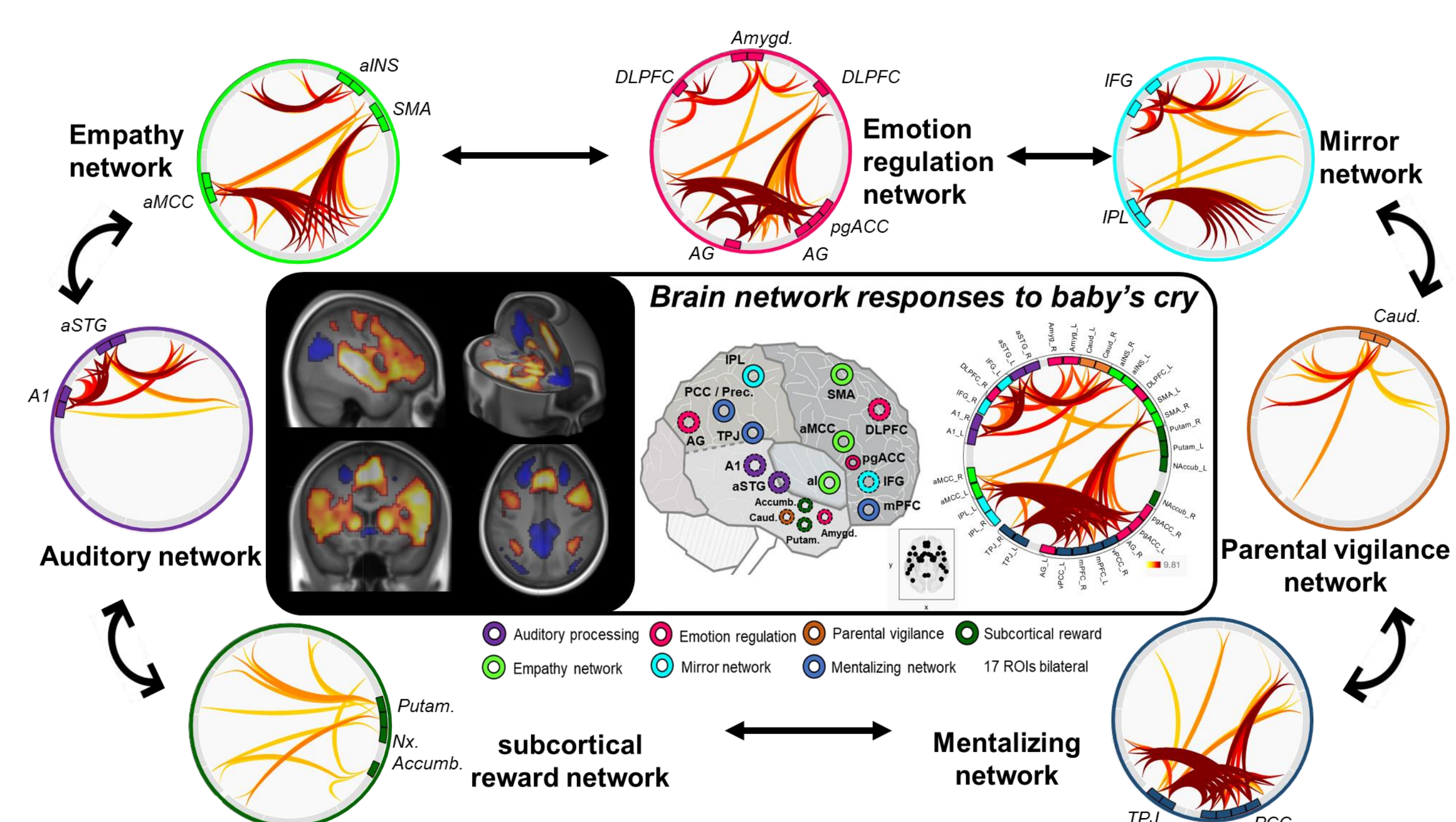


Brain activity and functional connectivity between nodes of the 'parental caregiving' connectome

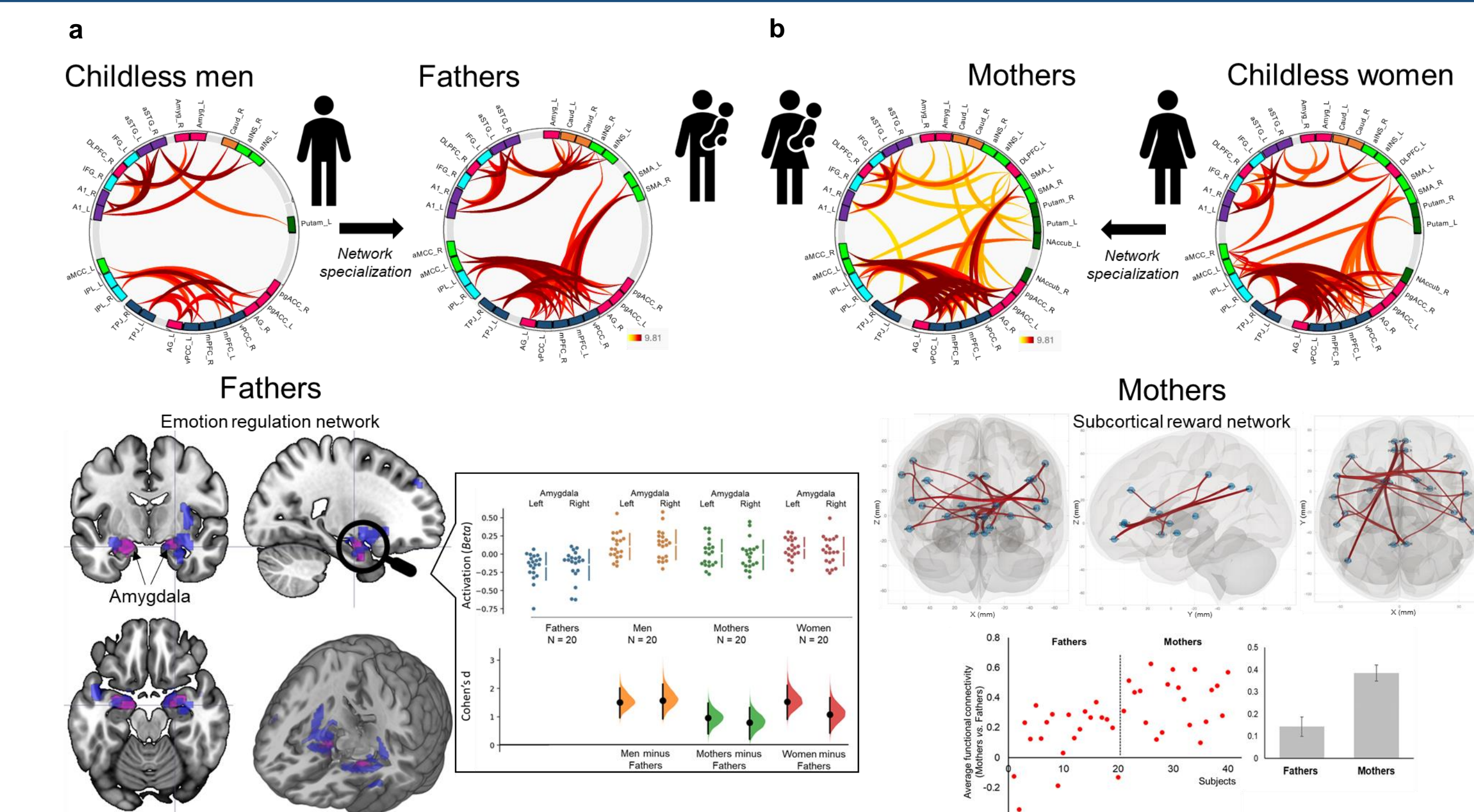
Results



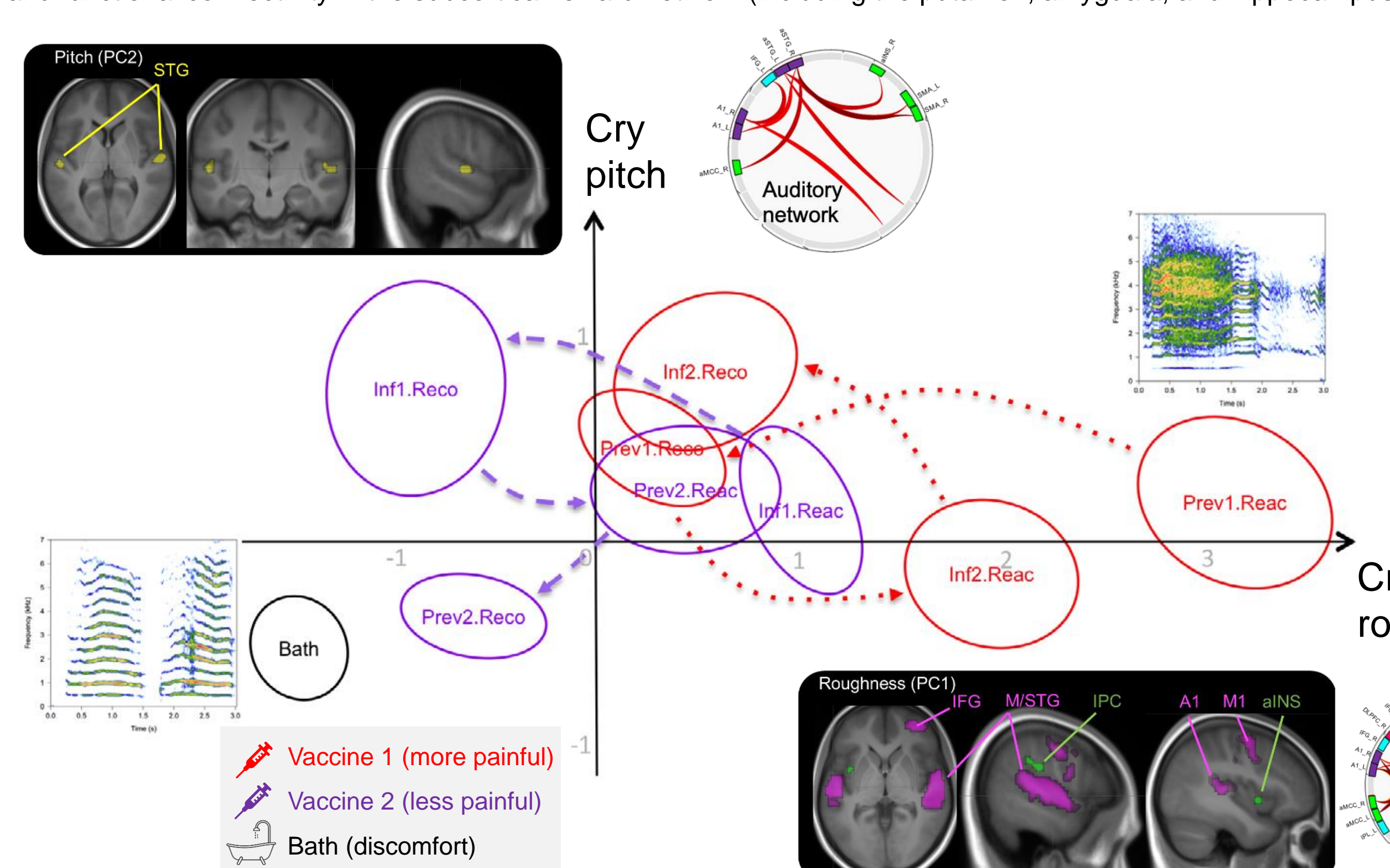
1. The ability of tested adults to recognize cries as cries of “discomfort” or “pain” depended on their experience with babies⁴. Inexperienced individuals randomly categorized both the familiar and unknown baby's cries, whereas parents currently raising a baby correctly identified the cries in both cases. Overall, the ability to identify cry is improved by prior and current experience with babies.



2. Brain responses to baby cries. Listening to cries results in the activation of extensive brain regions distributed according to seven functional brain networks: auditory, empathic, emotion regulation, mirroring, parental vigilance, subcortical reward and mentalization.

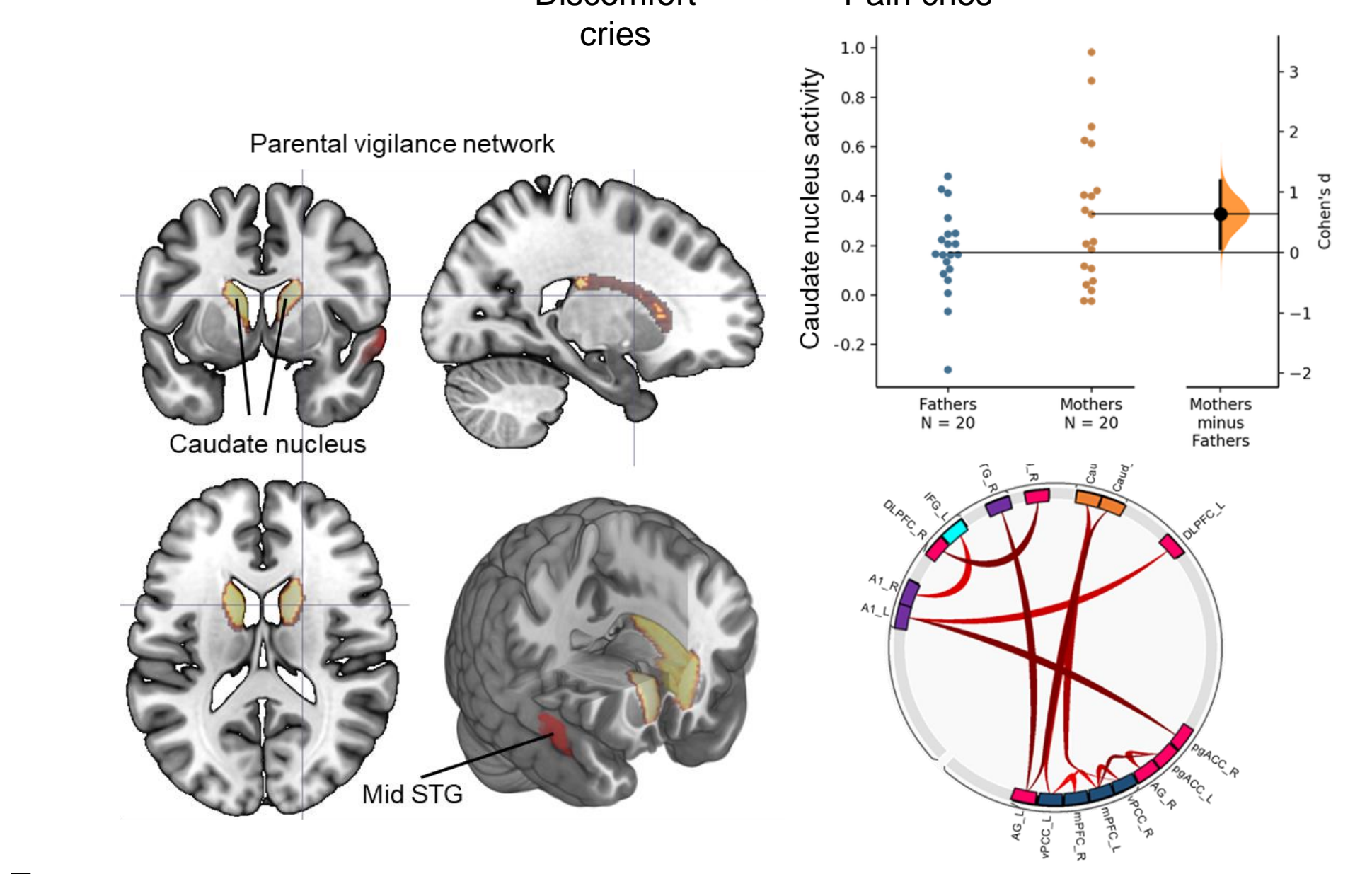
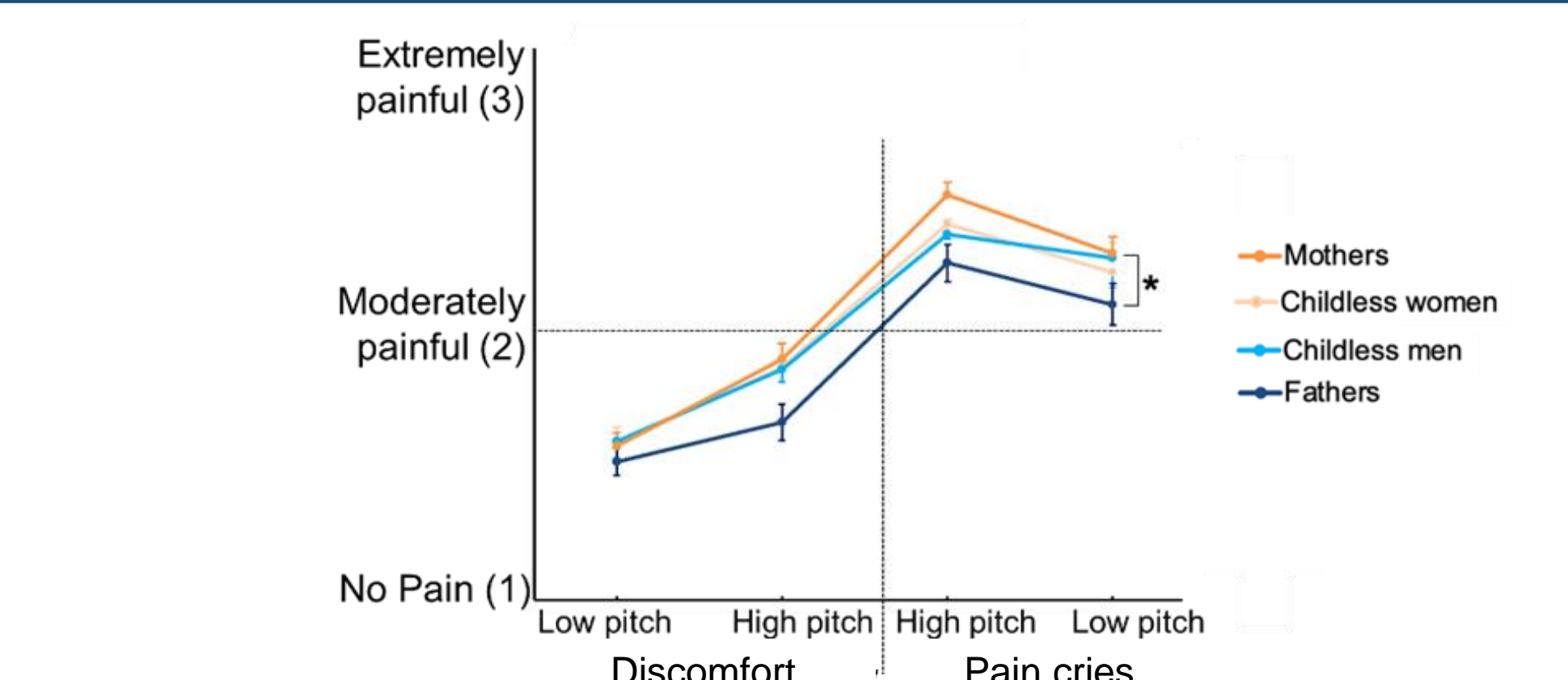


3. Parental specialization of the brain functional networks in response to cries. Childless adults show higher connectivity in the empathy network than parents. a. Fathers' brain show lower activity in the amygdala, the aINS and the IFG, and stronger functional connectivity in the emotion regulation network. b. Mothers' brain have higher activity and functional connectivity in the subcortical reward network (including the putamen, amygdala, and hippocampus).



4. Pain cries are characterized by acoustic roughness, which recruits the empathy brain network. Cries are represented in a two-dimensional acoustic space³. The harmonic structure of the bath cry indicating mild discomfort contrasts with the biphonation, subharmonics, and deterministic chaos characterizing the distress cry at the other extremity of the acoustic space. The presence of vocal roughness recruits the empathy brain network. The cry average pitch, a poor marker of pain, recruits mainly the auditory network.

References:
1. Gustafsson et al. Fathers are just as good as mothers at recognizing the cries of their baby. *Nat Commun* (2013).
2. Bouchet et al. Baby cry recognition is independent of motherhood but improved by experience and exposure. *Proc. R. Soc. B* (2020).
3. Koutseff, A. et al. The acoustic space of pain: cries as indicators of distress recovering dynamics in pre-verbal infants. *Bioacoustics* (2018).
4. Corvin et al. Adults learn to identify pain in babies' cries. *Current Biology* (2022).



5. Mothers overrate pain cries, with greater activation of the parental vigilance network. Adults rate cries with more vocal roughness as expressing more pain, while they give a low valence to the cry average pitch. Overall, fathers underrate pain compared to other categories of listeners. Conversely, mothers tend to overrate it, especially for the roughest and highest pitched cries. Pain cries induce greater activation of the parental vigilance network (caudate nucleus) and mid STG in mothers than in fathers. The functional connectivity between this network and the auditory, mentalizing and emotion regulation networks is also greater in mothers.

Conclusion
Previous experience in babies' care is necessary to recognize pain in cries⁴. Pain information encoded in the cries are decoded by empathic brain regions. Parenthood shapes the brain organisation and makes parents able to assess the pain conveyed by the cries of unknown babies. **Extensive experience is required to distinguish between pain and distress in babies' cries, and involves an adaptation of brain circuits.**

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