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## ▶ To cite this version:

Siloé Corvin, Isabelle Faillenot, David Reby, Nicolas Mathevon, Roland Peyron, et al.. Adults learn to identify pain in babies cries: investigations from behavior to brain responses. 16th International Meeting of the French Neuroscience Society, May 2023, Lyon, France. hal-04719293

## HAL Id: hal-04719293 https://hal.science/hal-04719293v1

Submitted on 3 Oct 2024

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P1.152

the familiar

baby (%)

# Adults learn to identify pain in babies cries: investigations from behavior to brain responses

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# Background: babies cries convey various information Individual characteristics Familiar babies are recognized by parents<sup>1</sup> and non-parents<sup>2</sup> Experience and exposure improve this ability **Emotional and physiological state** Pain cries are longer, louder and rougher $\wp$ Parents identify a pain state by listening to their baby's cries<sup>3</sup> 1. Spectrograms (graphical representations) of cries from two different babies. Cries were recorded during bathing

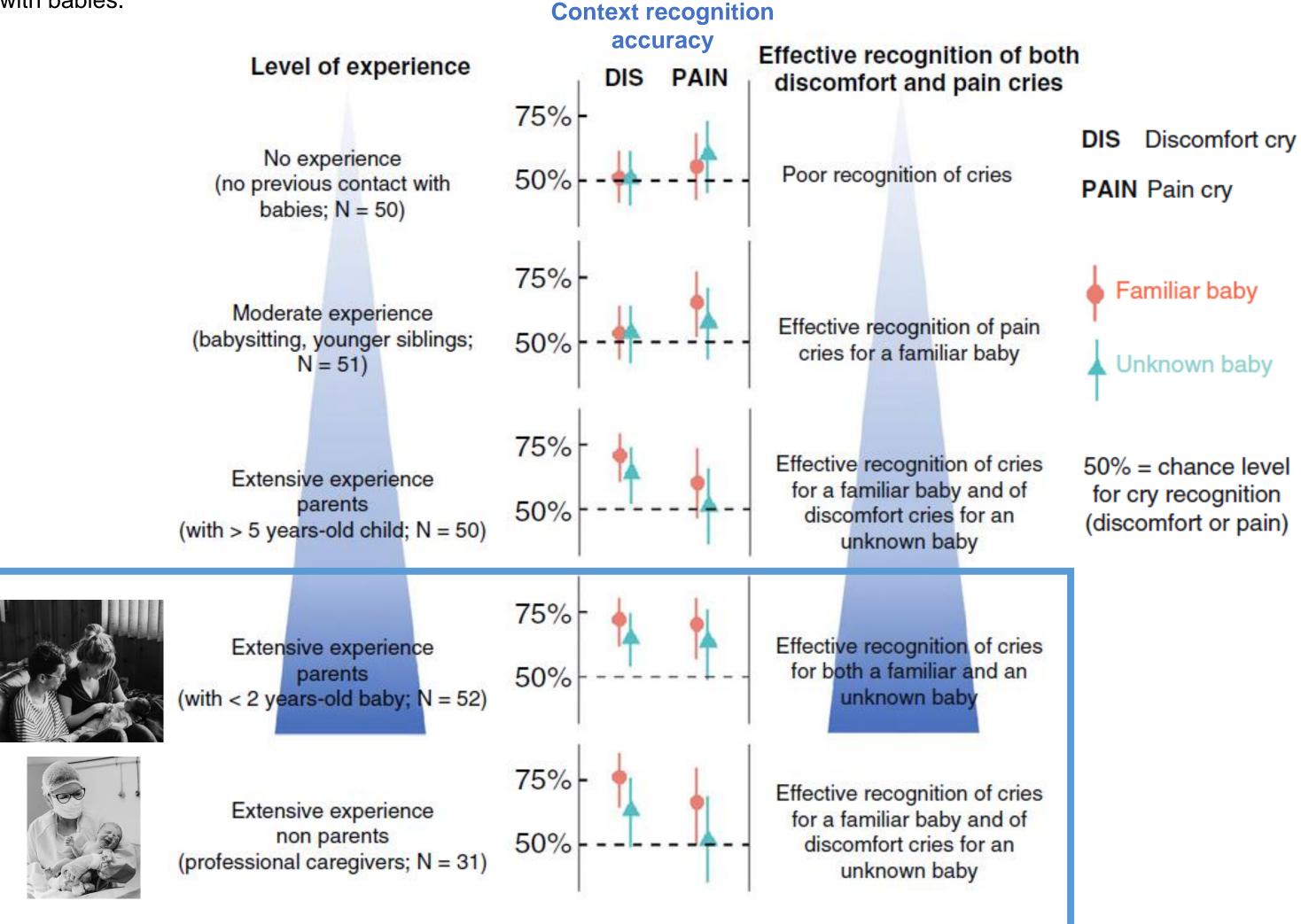
(discomfort cries) or during routine vaccination (pain cries). Probability of --- Chance level of 20% classifying cries as from 50

unknown

These two types of information interact together

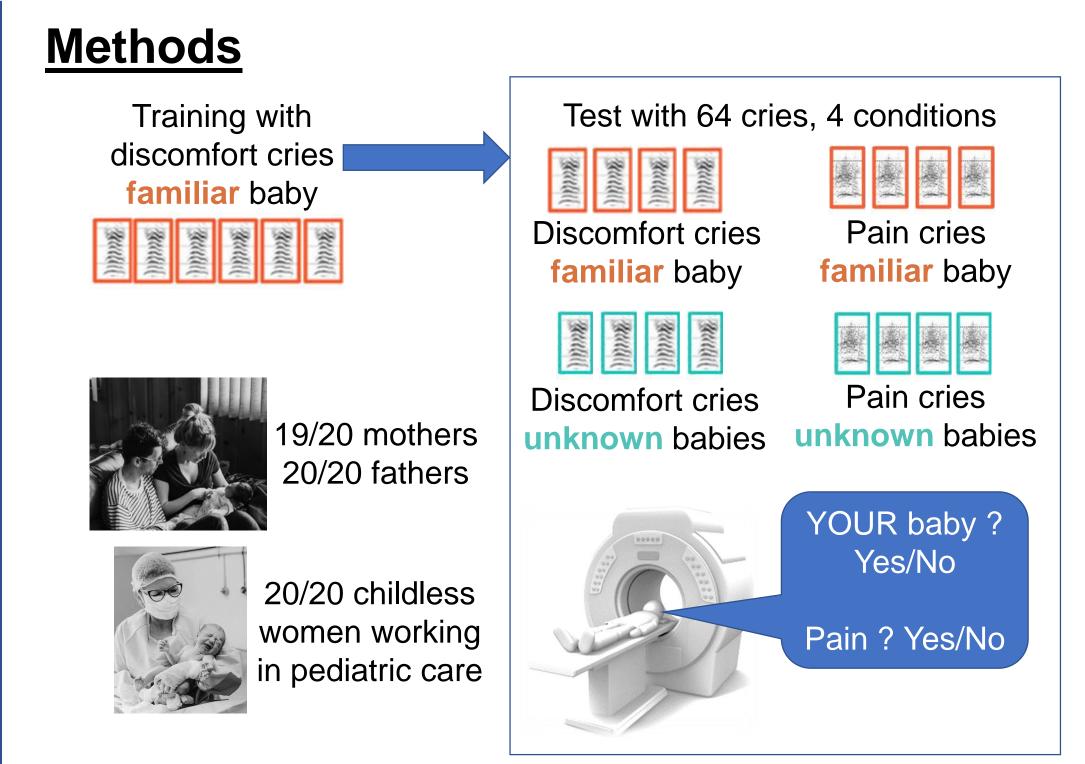
2. Adult listeners manage to recognize one given baby based on pain cries listening, after a short training on discomfort cries. They succeed better than chance but less than tested on discomfort cries. Individual vocal signature is shared but degraded in pain cries compared to discomfort cries.

3. The ability of adults to properly distinguish between a cry of "discomfort" or "pain" depend on their prior experience with babies<sup>4</sup>. Inexperienced individuals randomly categorized both the familiar and unknown baby's cries, whereas parents currently raising a baby were able to dissociate discomfort cries from pain cries for familiar baby and even for unknown babies. Overall, the ability to identify cry is improved by prior and current experience with babies.



What are the neural correlates of identifying these cries in expert participants?

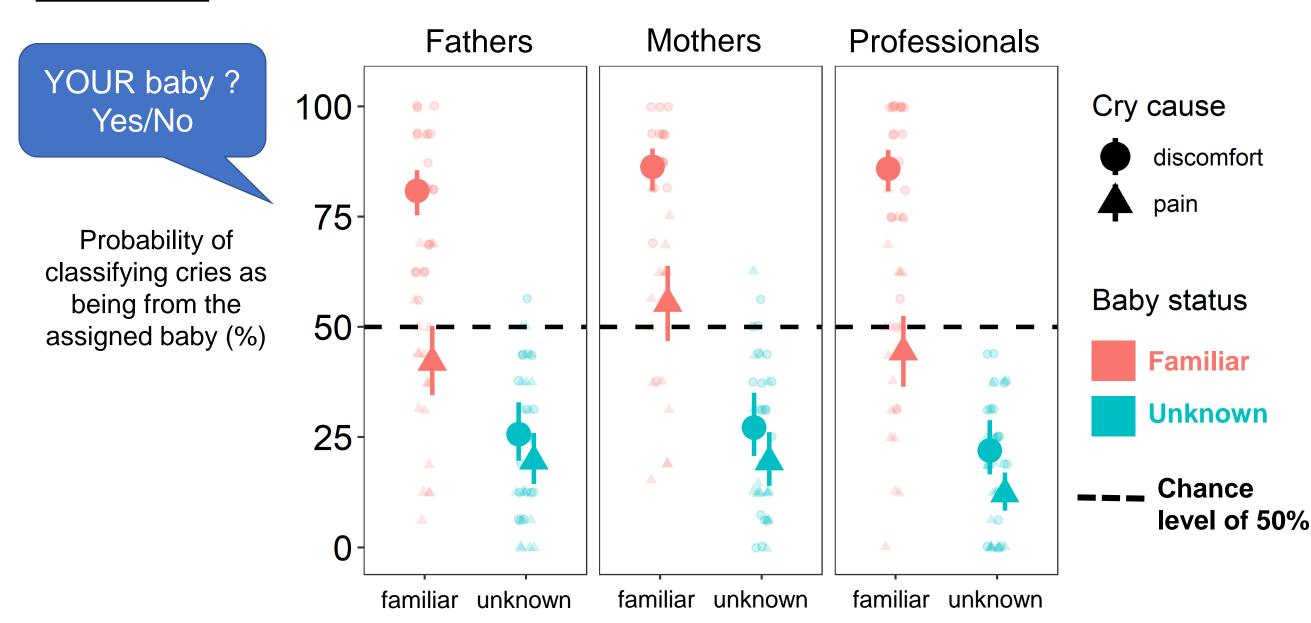
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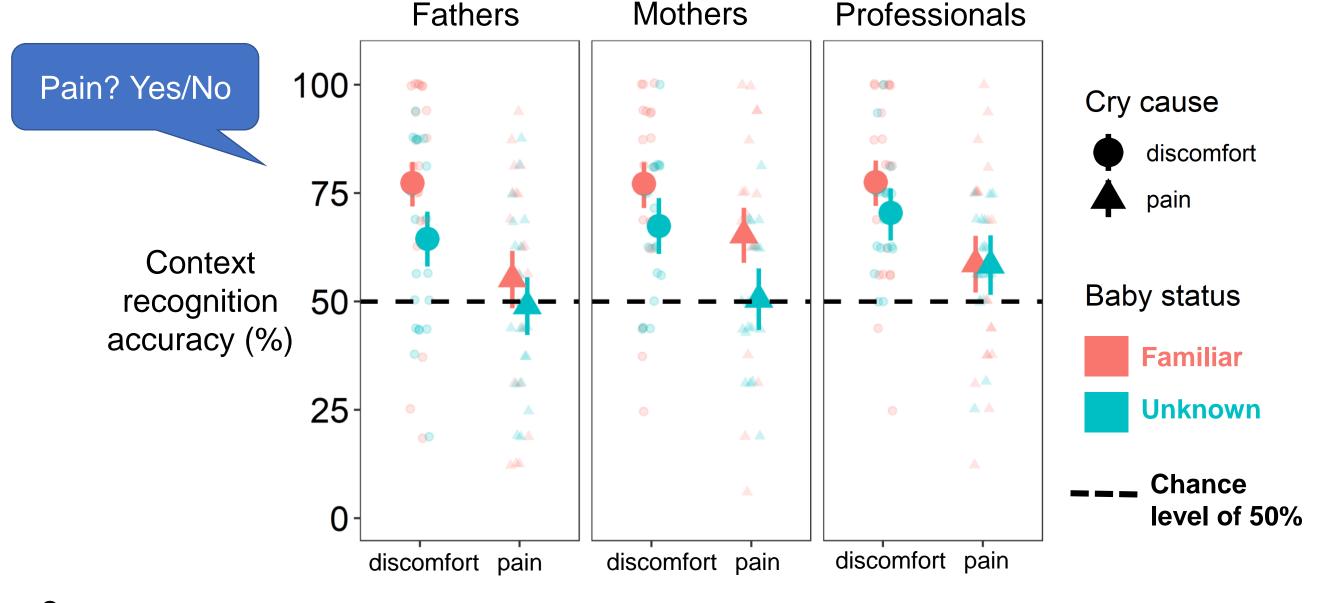
4. Experimental design. Adult subjects were first trained by hearing discomfort cries from an assigned baby. In a second step, subjects listened to cries from 4 conditions (familiar/unknown; discomfort/pain). After each cry, they had to tell if they recognized their baby or not, and if they recognized pain or not.

Bayesian mixed models and BOLD contrasts

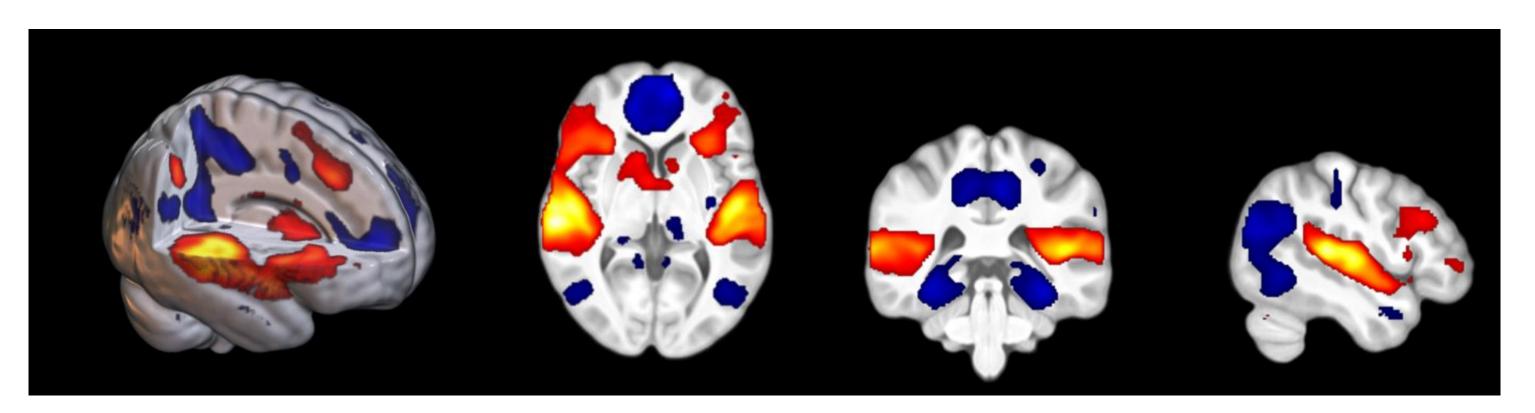
## Results



5. Adult listeners recognized very well their familiar baby based on discomfort cries, but not based on pain cries. Participants showed 84% of correct recognition (95% credible interval CI [81,87], 100% of the posterior distribution above the chance level) based on discomfort cries, but only 47% [43,52] based on pain cries listening. They correctly rejected cries of unknown babies (21% [18,24] of false-positive), either discomfort and pain cries.



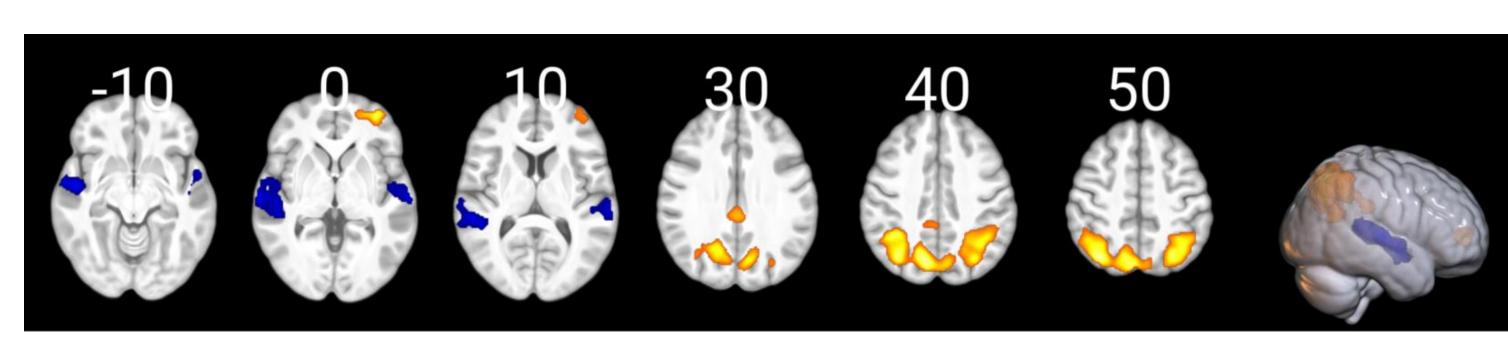
6. Pain cries were recognized slightly above chance, and less than discomfort cries. Participants showed on average 64% of correct recognition of cry's context (95% CI [61,67], 100% of the posterior distribution above the chance level). This was higher for discomfort cries (72% [70,75]) than for pain cries (56% [53,59]).



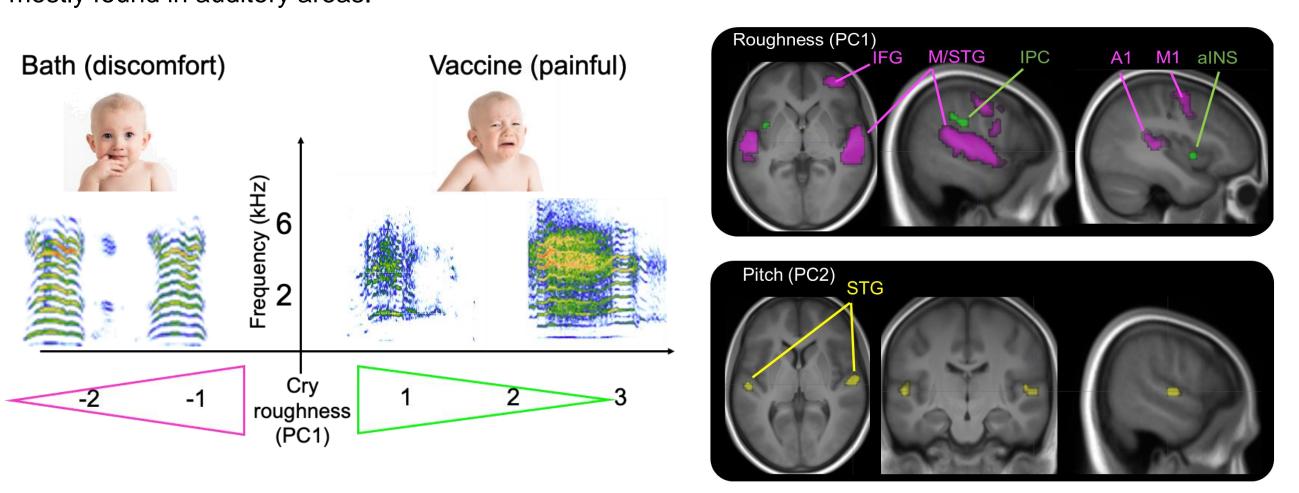
7. Cries listening involved activation in a large-scale brain circuit (including auditory, cognitive, attention, emotion regulation and mirroring brain networks). BOLD activations (in orange) were mainly observed bilaterally in the middle and superior temporal gyri (MTG, STG), in the angular gyri and supramarginal gyri (SMG). Decreased BOLD signal (in blue) was observed bilaterally in the superior frontal and middle occipital gyri.



8. Reaction time was significantly faster when giving the correct answer. Participants showed faster reaction times when giving a correct answer (green circles) compared to incorrect ones (red circles) for both questions (ANOVA, p<0,001 for the interaction between the condition and the given response).



9. Successful recognition of the assigned « familiar » baby activated brain areas known to be involved in perpective-taking and emotion regulation. BOLD activations (in yellow) were found in angular gyri bilaterally, the precuneus, the posterior part of the cingulate cortex and the left middle frontal gyrus. Deactivations (in blue) were mostly found in auditory areas.



10. Pain cries were characterized by acoustic roughness, which recruited the empathy brain **network.** Pain cries are associated with vocal roughness (biphonation, subharmonics, and deterministic chaos). Listening of rougher cries was associated with stronger brain activity in the bilateral anterior insula and the inferior parietal cortex (in green), whereas lower roughness was associated with activity in the bilateral auditory association cortex, premotor areas, and the right dorsolateral and inferior frontal cortex (in purple). The cry average pitch, a poor marker of pain, mainly recruited auditory areas (superior temporal gyrus, in yellow)

## Conclusion

Cries contain strong information on baby's identity allowing expert listeners to recognize one given baby. This identification relies on brain areas known to be involved in recognition of familiar features<sup>5</sup> (familiar faces, places, music...).

Pain cries are associated with acoustic roughness. Despite this acoustic specificity, identifying pain in cries is difficult for experts in babies care, both parents of young babies and professional caregivers, leading to no specific BOLD activation. However, acoustic roughness, specific to pain in cries, is linked to increased activity in brain areas involved in empathy.