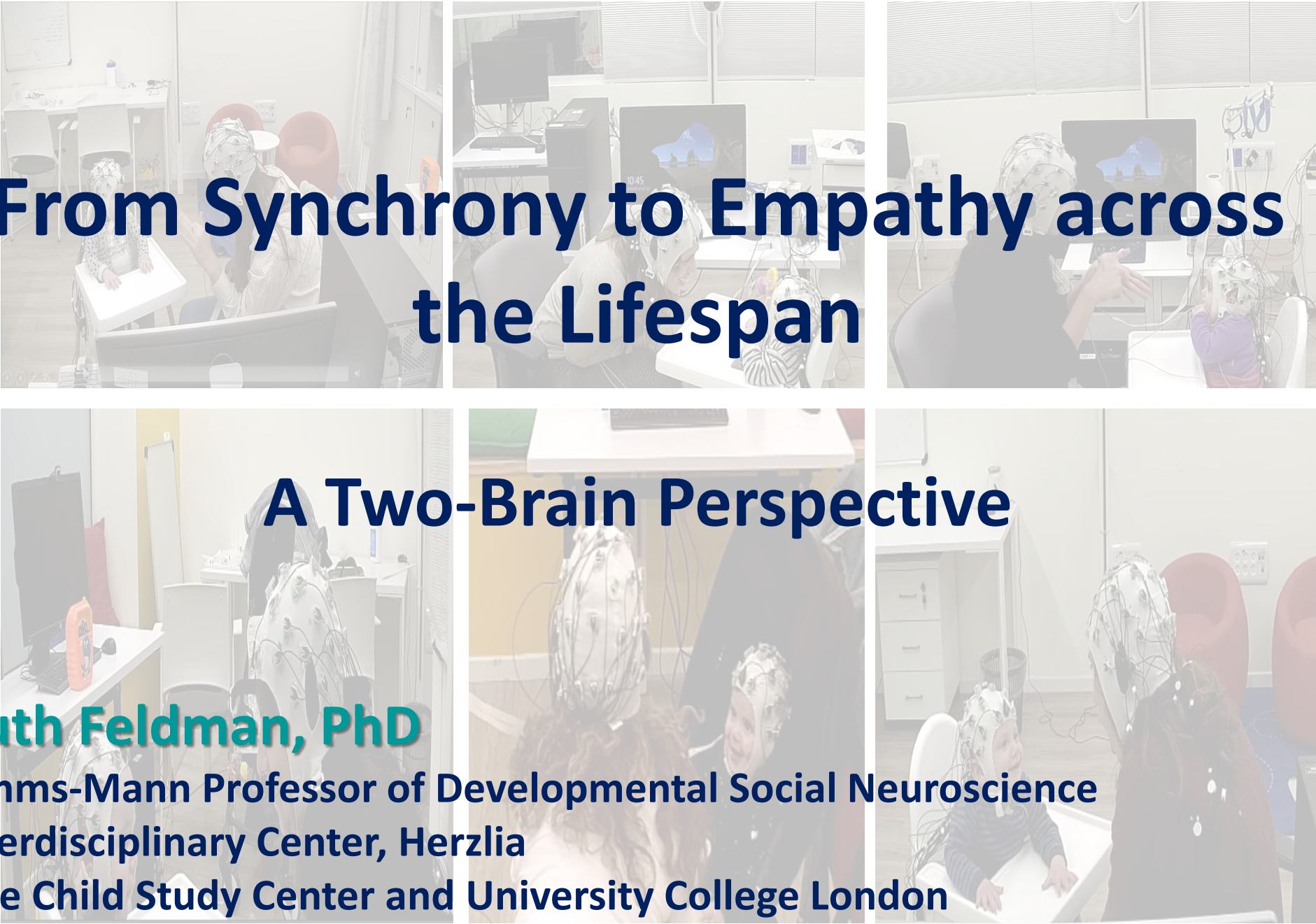




From Synchrony to Empathy across the Lifespan

A Two-Brain Perspective

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Interdisciplinary Center, Herzlia
Yale Child Study Center and University College London

The Newborn's First Social Encounter Sets the Stage for Resonance



An infant is born and immediately begins to search for the mother's face. It's programmed for social connection.

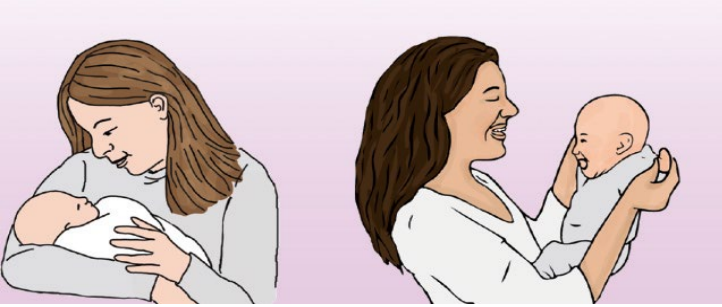
A mother first meets her baby. Like all mammals, the surge of oxytocin at birth triggers her maternal behavior.

From these building blocks their relationship will unfold.

But the human mother, unlike other mammals, not only expresses maternal behavior but also synchronizes them with her newborn's fleeting attention. She times her gaze, soft affectionate touch, and sing-song cooing to the infant's rhythms.

The baby feels - the world resonates with me. I'm safe.

The Development of Synchrony and the Arc of Resonance



Safety



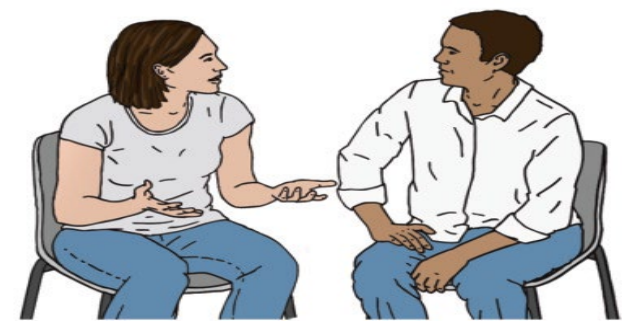
Coordination



Expansion



Empathic Dialogue

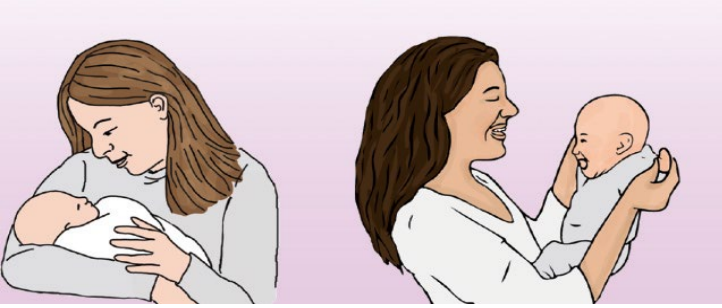


Adult-to-Adult Mutuality

Synchrony becomes more complex as children grow. The Arc of Resonance opens and progresses along its five junctions. As synchrony develops, infants internalize safety, learn to coordinate their social behavior with others, expand their play with symbol and imagination, engage in empathic dialogue that considers multiple perspectives, all the way to an adult-to-adult relationship of mutuality, intimacy, and respect.

This progression prepares their brain to coordinate with other brains in interbrain synchrony.

The Development of Synchrony and the Arc of Resonance



Safety



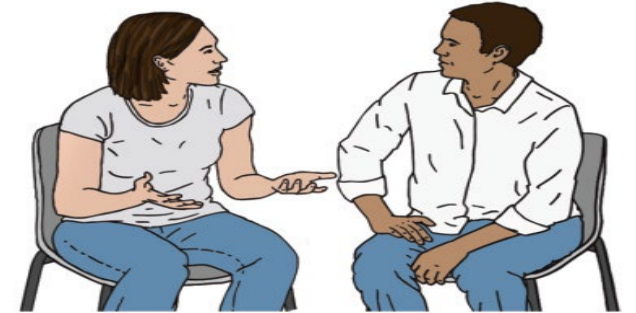
Coordination



Expansion



Empathic Dialogue

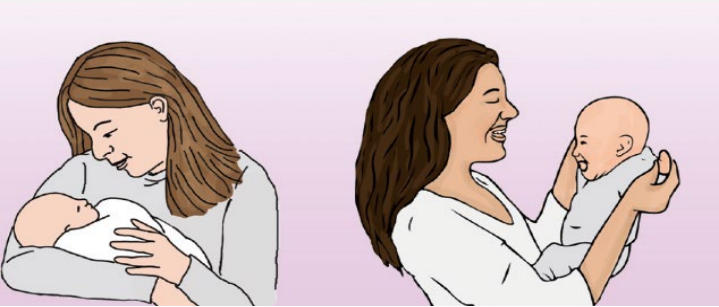


Adult-to-Adult Mutuality

Infants experience the Arc of Resonance with their fathers as well in ways that involve more physicality and exploration.



The Development of Synchrony and the Arc of Resonance



Safety



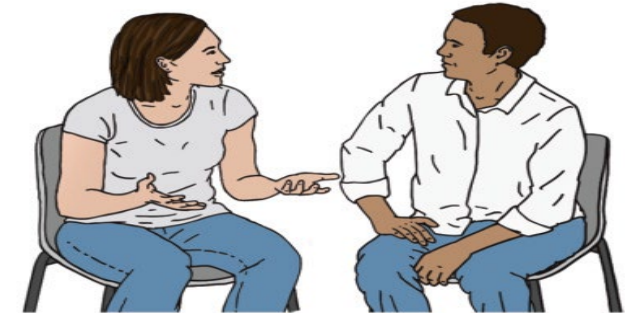
Coordination



Expansion



Empathic Dialogue



Adult-to-Adult Mutuality

The brain machinery imprinted by synchrony with the parents transfers to other close relationships and to humankind in general and sets the foundations for the human capacity for empathy.

Parents



Romantic Partners



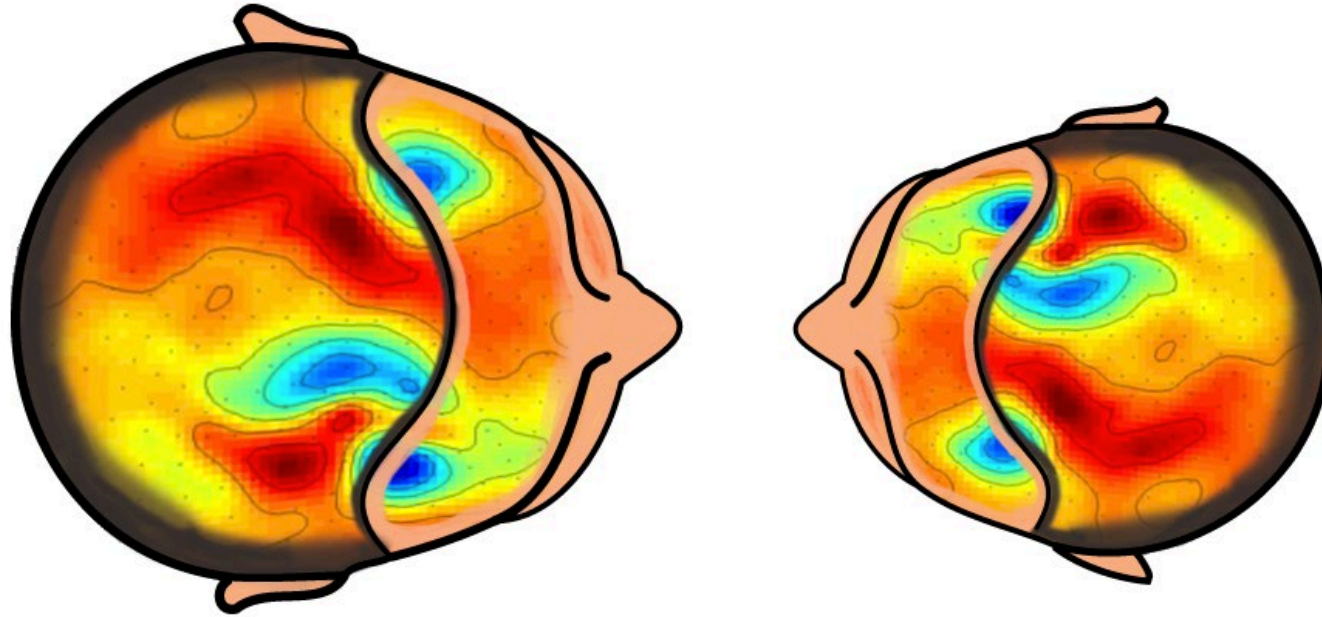
Friends



Fellow Humans



Behavioral Synchrony Builds the Infant Brain's Capacity for Inter-Brain Synchrony



The progression of synchrony and the Arc of Resonance prepare the infant's brain to coordinate with other brains during social moments and form a single resonating unit of **interbrain synchrony**. The infant becomes biologically capable of empathy through the ability to represent others' states and feelings in its own brain.

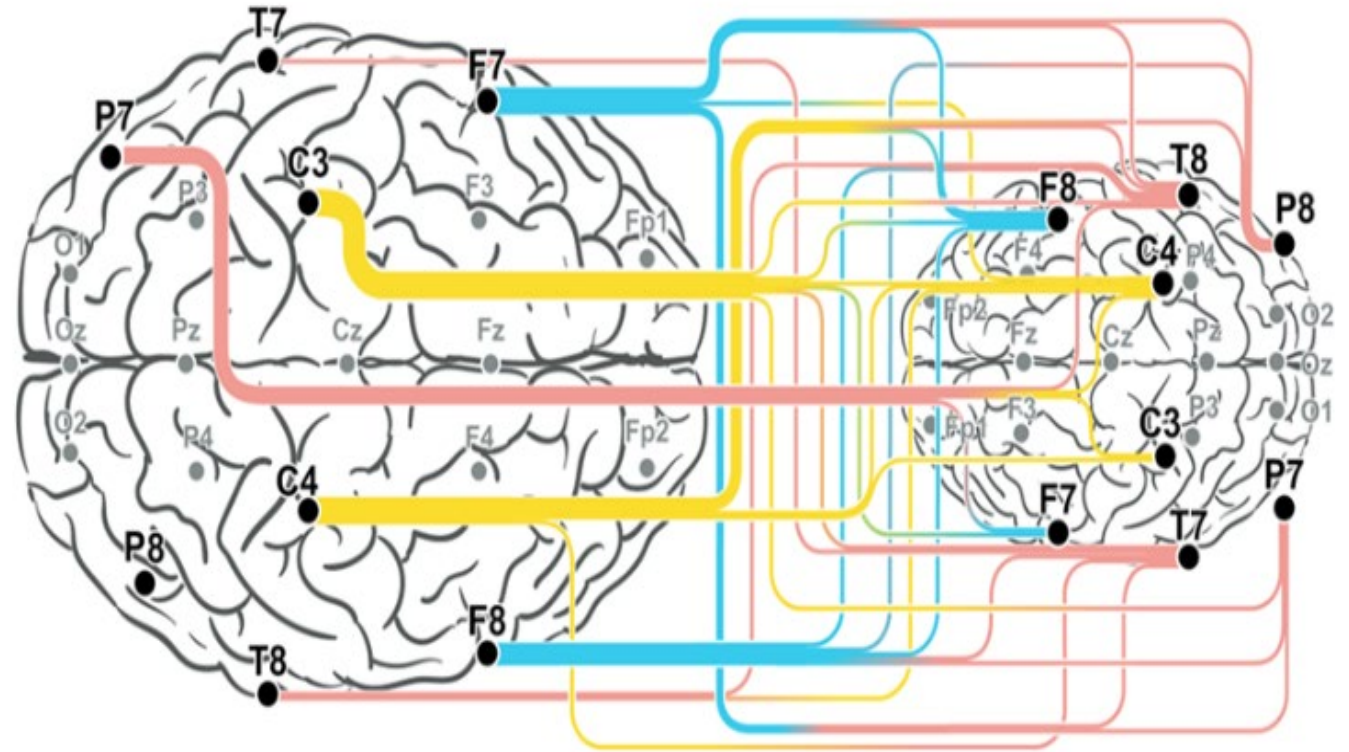
The Frontotemporal Interbrain Network

At around 3-4 months of age the fronto-temporal interbrain network begins to consolidate between the infant and the attachment figure.

It's a joint network that builds from the coordinated activations of parent and infant's brains during social interactions.

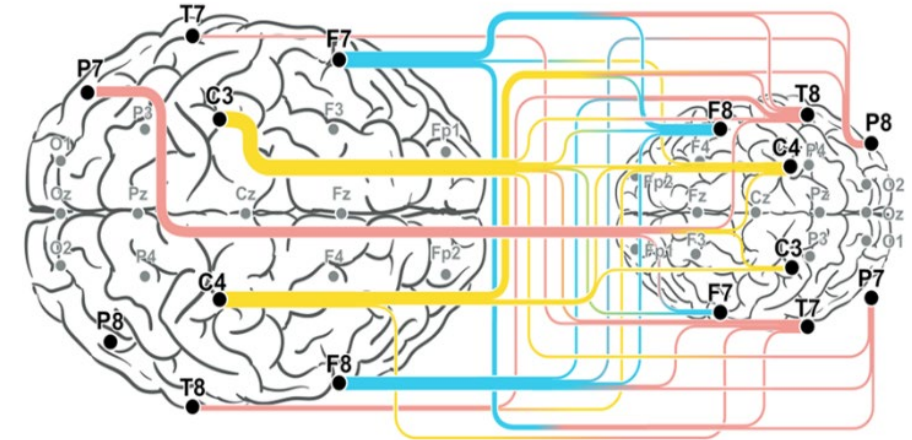
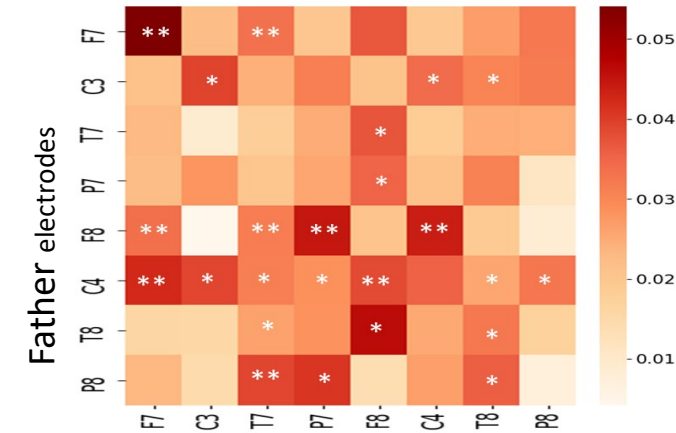
It synchronizes the partners' right and left frontal areas and right and left temporal areas in all possible combinations.

This two-person network will expand and, as children mature, fine-tune their capacity for empathy.



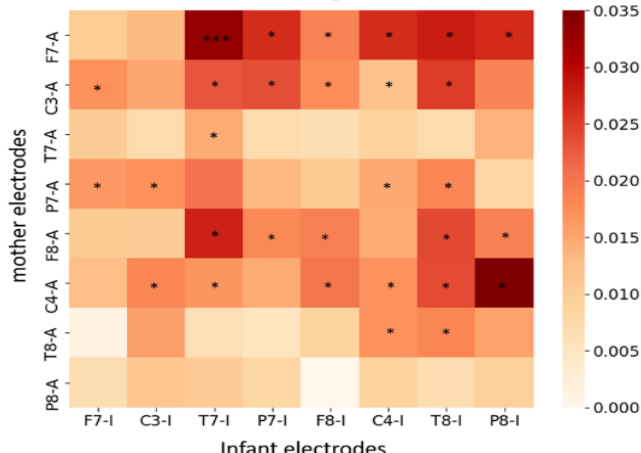
The Development of the Frontotemporal Interbrain Network in Infants' Interaction with Mother and Father

Father-Infant



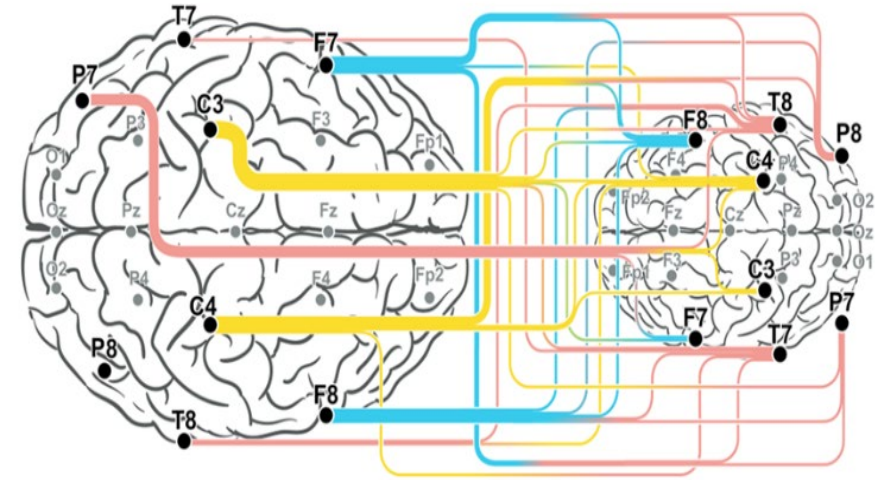
Infant electrodes

Difference in Connectivity values
Real F2F data- Surrogate data (wPLI)



The frontotemporal interbrain network activates during infants' interactions with both mother and father, connecting slightly different nodes. It builds on their behavioral synchrony and, across the lifespan, the higher the behavioral attunement the stronger the two-brain coordination.

In Preschool the Frontotemporal Interbrain Network Expands to Multiple Context



In preschool, the frontotemporal interbrain network expands to activate during play, book reading, and joint observation of emotional movies with mother and father.

The two brains begin to synchronize on multiple rhythms and faster rhythms. Infants synchronize primarily on theta rhythms. Preschoolers synchronize primarily on alpha rhythms while retaining the theta synchrony.

HUMAN BRAIN WAVES

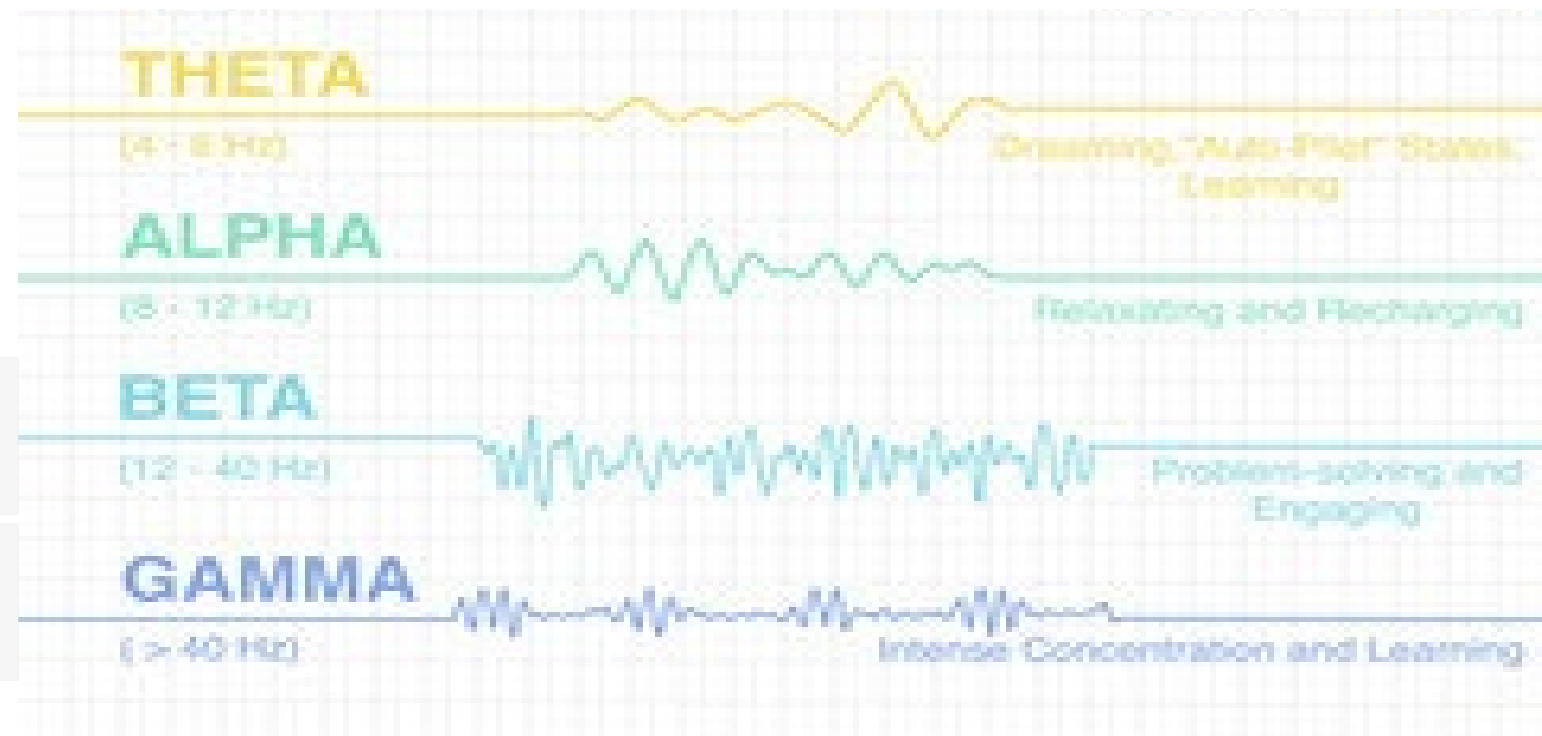
With development, interbrain synchrony incorporates more rhythms into the dialogue. Empathy expands

BABY BRAIN

ATTENTION

SOCIAL
ENGAGEMENT

INTENSE
LEARNING.
FEEDBACK



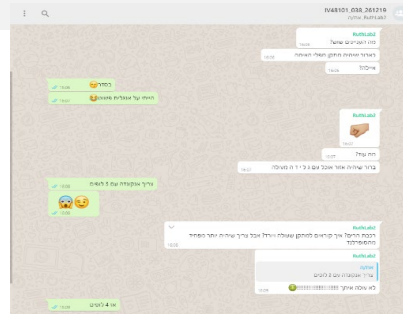
In Adolescence the Frontotemporal Interbrain Network Expands to Communication via Technology without Co-Presence



Face to Face



Video call

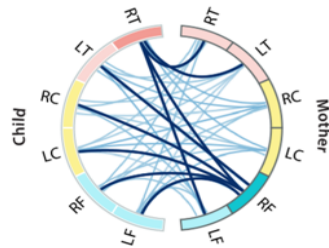
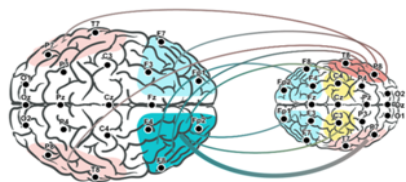


Texting (WhatsApp)

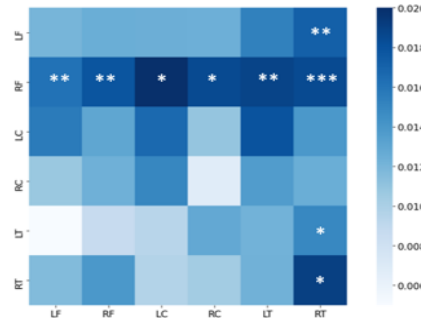
- Adolescent and parent synchronize on beta rhythms, retaining alpha and theta. Beta interbrain synchrony is strongest during face-to-face interactions and is substantially weaker – but still exists - during Zoom call and even texting. We see 9 active links in face-to-face compared with only 1 during Zoom.
- We should mind our youth's preference for technological communication that creates a thin human empathic experience that does not engage the entire social brain.

A

Face to Face Interaction

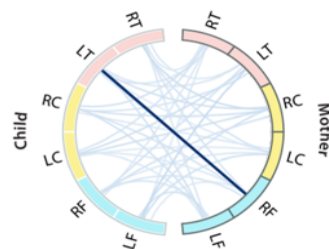
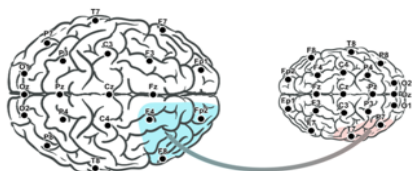


Difference in wPLI Connectivity values
Face to Face - Rest

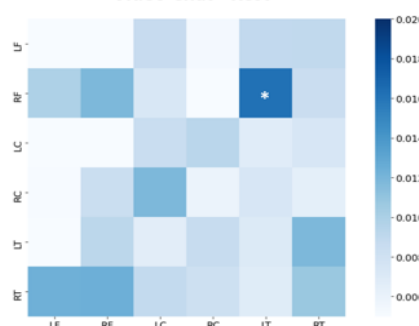


B

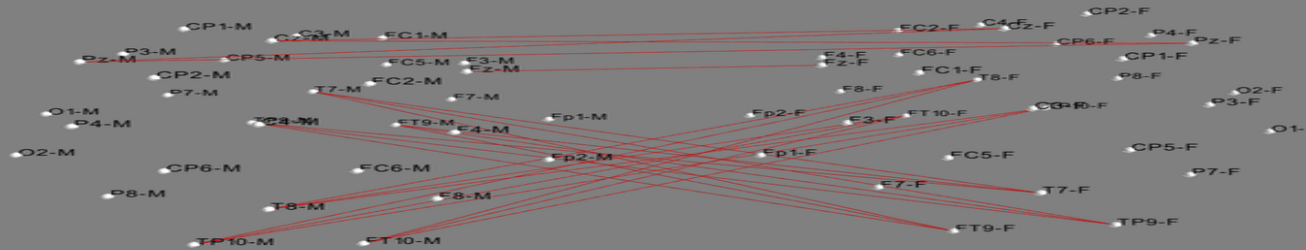
Video Chat Interaction



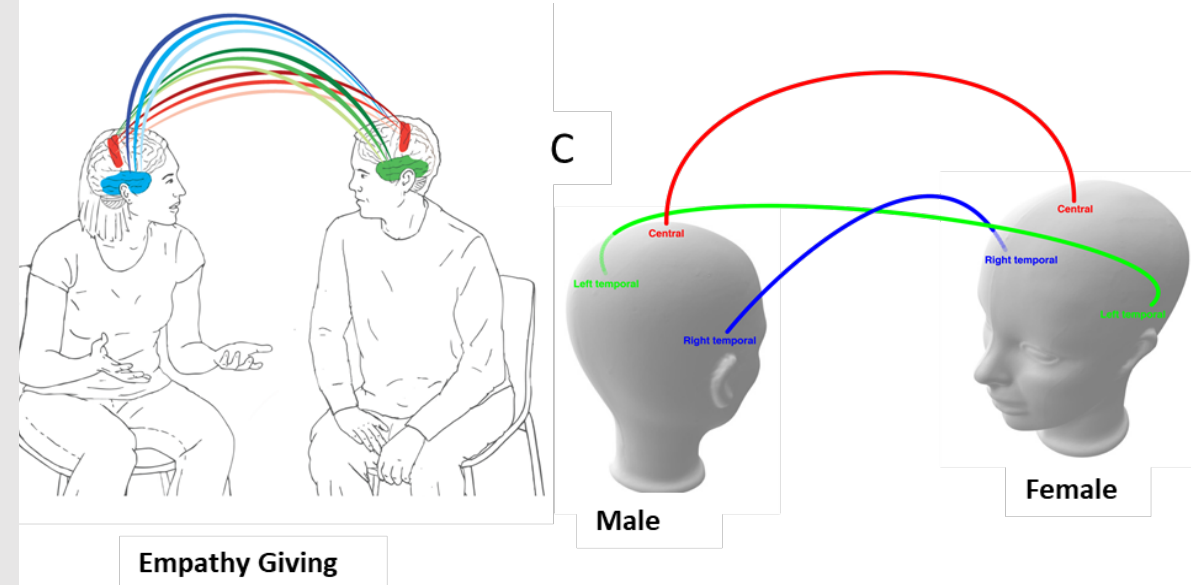
Difference in wPLI Connectivity values
Video Chat - Rest



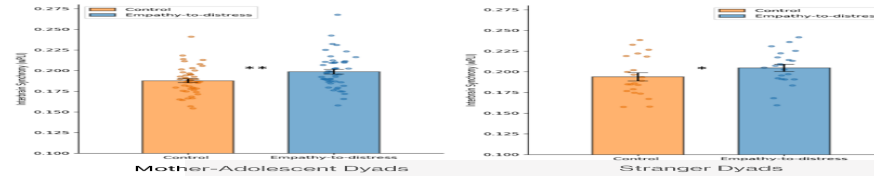
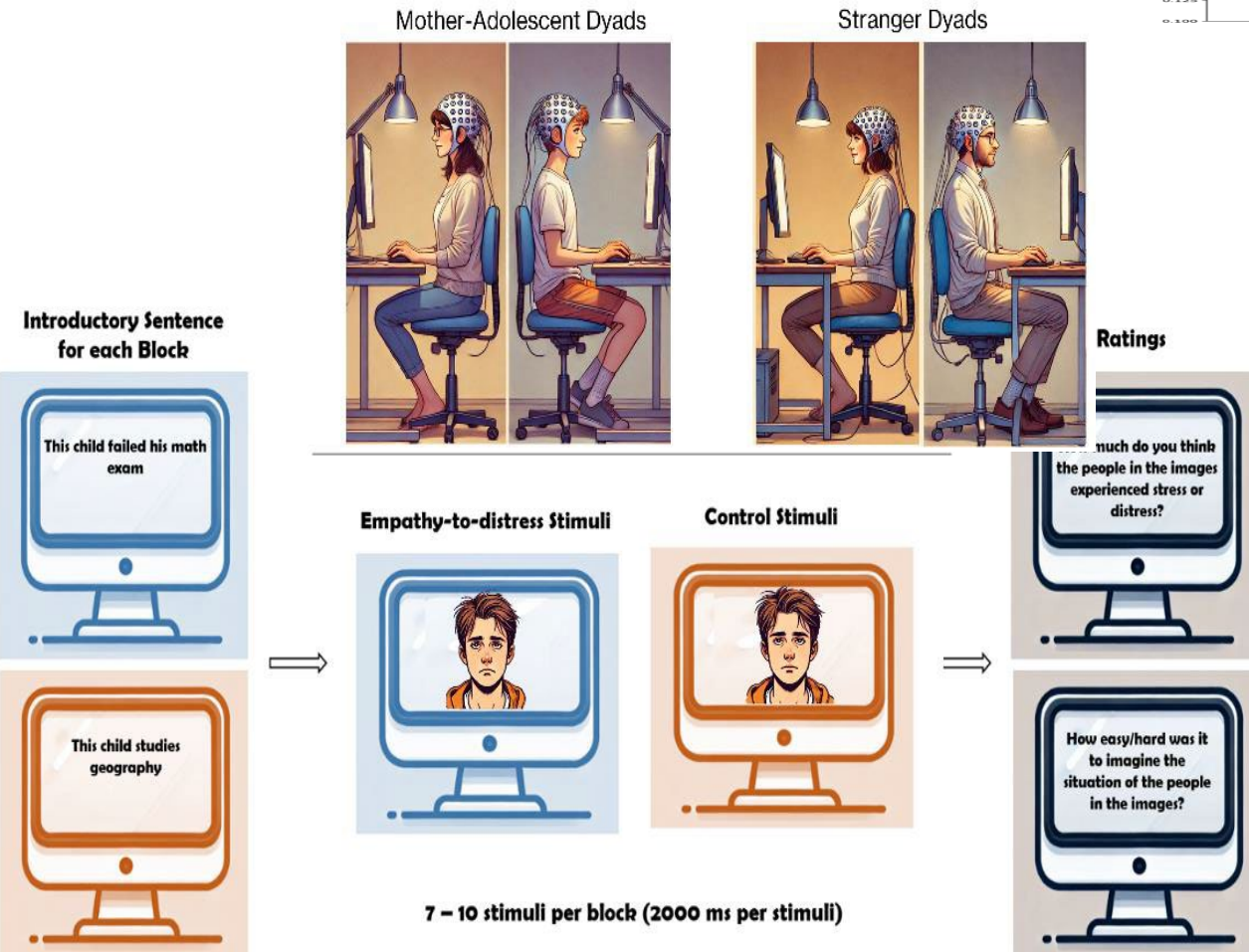
Multi-Site Multi-Rhythm Synchrony during Adults' Empathy Giving



- In adulthood, during an empathy-giving paradigm with romantic partners, close friends, and even strangers, our research showed that partners synchronized alpha, beta, and gamma rhythms in frontal, temporal, and central regions.
- Adults synchronize their brains in the two neural networks that sustain empathy; the fast “emotional resonance” network of mirroring and the slower “cognitive empathy” network of reflection and foresight.



Empathy Align Brains in Synchrony



- In a recent study, we presented partners with empathy-to-distress and control stimuli on screens from separate rooms.
- Following the empathy-to-distress, but not the control stimuli, the two brains synchronized from far, without social cues. Synchrony occurred at 1000-2000 ms post-stimuli, suggesting processes of cognitive empathy that function to understand the situation and devise a plan for help.
- Exposure to others' distress aligns brains in synchrony. Such alignment likely had evolutionary benefits by consolidating humans into social groups, increasing affiliation and trust, and improving joint action to threats.
- Our findings suggest that empathy may have enhanced humans survival and thriving through mechanisms of interbrain synchrony.

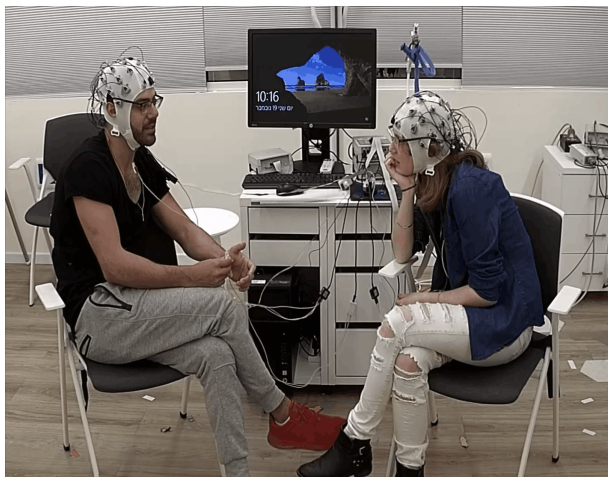
Conclusions

Baseline

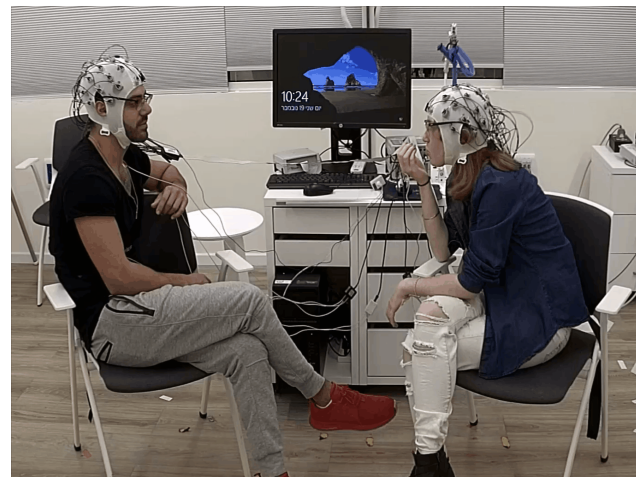


- The human brain acquires the neural basis for empathy in the context of a synchronous parent-child relationship where the child experiences resonance and its signals are empathically echoed.
- Empathy functions as a social glue by binding brains together.
- Helping parents provide better synchrony to their infants in various high-risk contexts, such as premature birth, postpartum depression, or early adversity, will provide children with better foundations for empathy. Synchrony will tune their human-specific neural empathic response, which requires not only resonance with others' distress but finding active ways to alleviate their suffering.

Partner 1 gives empathy



Partner 2 gives empathy





Thank you!

- **THE SIMMS-MANN FOUNDATION, THE BEZOS FAMILY FOUNDATION, THE IRVING B. HARRIS FOUNDATION**