Neurobehavioral evidence of interoceptive sensitivity in early infancy using a novel Infant Heartbeat Task (iBEAT)

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ABSTRACT

Interoception, the sensitivity to visceral sensations, is fundamental to self-awareness (*1*,*2*). Despite the known role that interoception plays in cognition and mental health across the lifespan (*3*), the developmental origins of interoceptive sensitivity remain unexplored. We developed novel measures of interoception in infancy, and present the first ever demonstration of interoceptive sensitivity at 5 months of age, coupled with electrophysiological markers, to show that (a) infants display an implicit sensitivity to interoceptive signals, and (b), that this sensitivity is responsive to socio-emotional processing demands, as in adults (*4*). The novel *Infant Heartbeat Task (iBEAT)*, employs preferential looking to assess whether infants are able to differentiate synchronous from non-synchronous cardiac rhythms. Infants viewed an animated character, moving either in synchrony or asynchrony with the infant's own heartbeat, during continuous eye- tracking (Fig. 1A). A clear visual preference for the asynchronous stimulus emerged at the group level, M_{ASYNCH} = 5194ms, SD=2697, M_{SYNCH} = 4170ms, SD=2167, t(28)= -3.267, p=.0029, indicating that infants displayed an implicit sensitivity to interoceptive signals, and an ability to integrate these interoceptive signals with external visual-auditory stimuli (Fig. 1B).

We then measured Heartbeat Evoked Potential (HEP; *5*) amplitude in the same infants whilst they viewed short video clips of emotional and non-emotional facial expressions. HEP amplitude was higher (p=.019, T_{SUM} =577.0) for infants who showed a greater discrimination between synchronous and asynchronous cardiac rhythms during the Infant-HDT in a midline cluster (P2, POz, Pz) in the parietal ROI (Fig. 2). Lastly, we also investigated and report significant emotion-specific modulations in HEP amplitude. Taken together these findings demonstrate that infants' state interoceptive processing is dynamic, flexible and responsive to task demands, and that their experiences of emotions appear to be closely influenced by their visceral reactions.

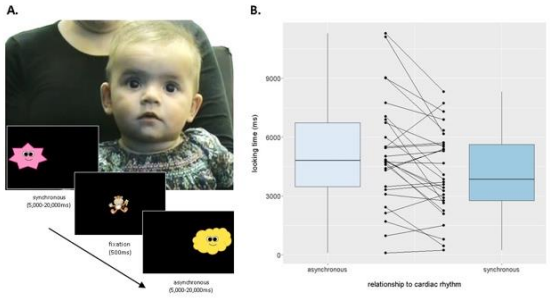

Figure 1 (A) iBEAT task. (B) Average looking times (ms) to stimuli that were asynchronous or synchronous with infants' own cardiac rhythm. Strip-chart points indicate pairs of raw data points from individual infants (N=29), reflecting individual differences

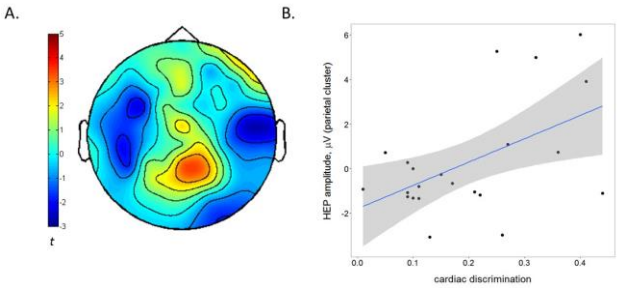

Figure 2(**A**) Topographical representation of parietal cluster. (**B**) Scatterplot illustrating the positive correlation between cardiac discrimination and HEP amplitude (N=22).

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