The newborns' brain detects utterance-level prosodic contours

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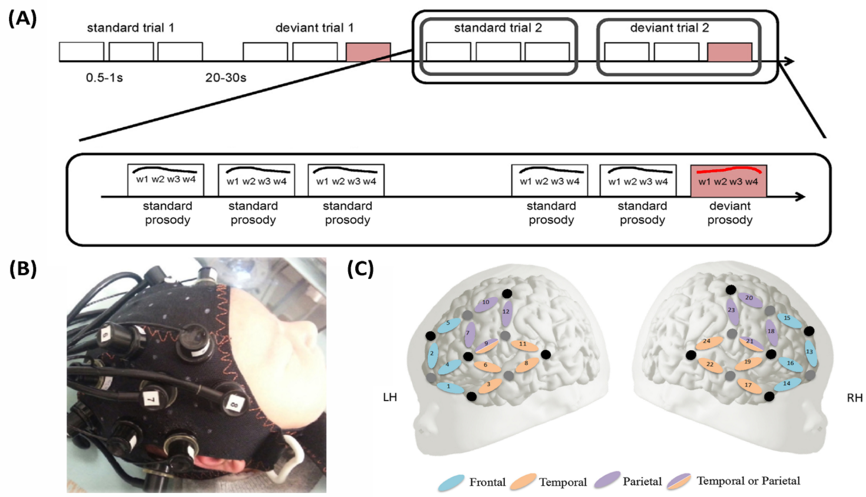
Introduction. Infants' prenatal experience with speech mostly entails prosody due to the filtering effect of the mother's womb (Gerhardt et al. 1990). How prosody perceived in utero influences early speech perception remains to be understood. In this study, we asked whether it allows infants to recognize and discriminate utterance-level prosodic contours at birth. *Methods.* The current study investigated this question using near-infrared spectroscopy (NIRS) in 1-5-day-old French-exposed newborns (*n*=25). We used a paradigm (Figure 1) similar to the newborn NIRS study of Benavides-Varela & Gervain (2017) testing newborns' ability to detect word order violations in the absence or presence of prosody. We used the same 4-word-long ungrammatical sequences as utterances (e.g. *et appelle de aller*) as in Benavides-Varela & Gervain (2017). Ungrammatical sequences were chosen to avoid potentially familiar word combinations biasing infants' performance. The sequences were recorded with well-formed declarative utterance prosody by a professional actress. (Trained speakers are able to achieve natural-sounding prosody with nonsense sequences.) Each such sequence was presented three times identically in a Standard Block. Each Standard Block was followed by a Deviant block, in which the same sequence was repeated twice with the same prosody as before, and a third time carrying a prosodic violation (Figure 1A). This deviant prosodic contour was obtained by time-reversing the original one, and super-imposing it on the intact segmental information with word order, and all other properties preserved. The resulting prosodic contour was thus time-reversed, unfamiliar to the infants and ill-formed in French (and universally, as energy increased in it). We compared newborns' (*n*=25) hemodynamic responses to the Standard and Deviant Blocks using a 24-channel NIRS probe (Figure 1B), which queried the frontal, temporal and parietal areas bilaterally (Figure 1C), i.e. the areas known to respond to speech and language (e.g. Peña et al. 2003, Gervain et al. 2008, Benavides-Varela & Gervain 2017). *Results and Conclusion*. The obtained grand average results are shown in Figure 2. A cluster-based permutation tests revealed a difference between Standard and Deviant Blocks with oxyHb concentrations for the Deviant condition being greater than for the Standard one in a spatial cluster including channels 17, 19, 21, 22, and 24, i.e. the parietal-temporal areas in the RH (Figure 2). These results suggest that newborns are already capable of detecting utterance-level prosodic violations at birth. The localization in right parieto-temporal areas of the differential response confirms previous results regarding the right lateralization of speech prosody since birth. This is a key ability for newborns to start breaking into their native language. Future investigations will allow us to disentangle whether discrimination in the current study was based on familiarity, i.e. experience with speech prosody prenatally, the ill-formedness of the time-reversed contours or simply a detection of change.

Figure 1.



(A) Experimental design (adapted from Benavides-Varela & Gervain, 2017). **(B)** Picture of a neonate with the cap located upon the head (right view). **(C)** Probe configuration overlaid on a schematic neonate brain.

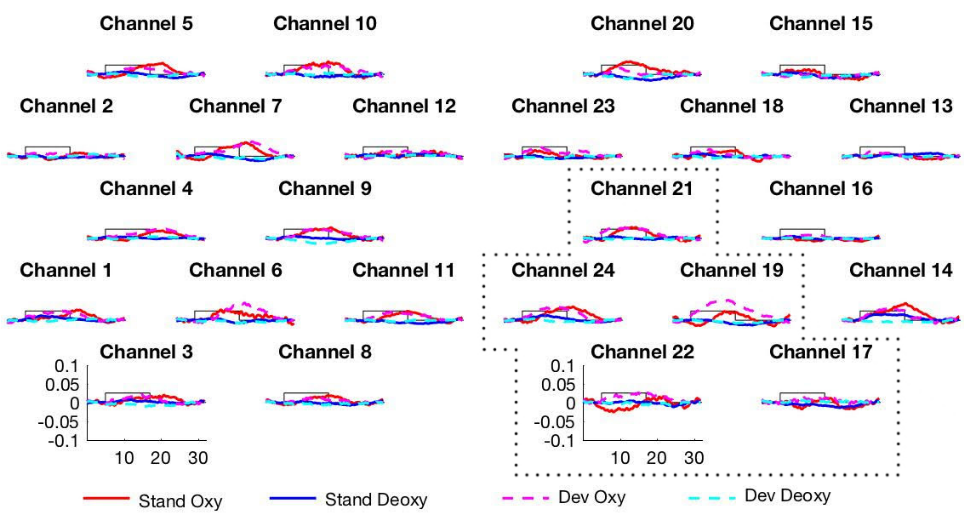


Figure 2. Grand average results. The x axis represents time in sec. The y axis shows concentration change in mmol × mm. The curves indicate grand average responses for standard (oxyHb: continuous red line, deoxyHb: continuous blue line) and deviant blocks (oxyHb: dashed pink line, deoxyHb: dashed turquoise line). The rectangle along the x axis indicates time of stimulation. The ROI obtained through the permutation test is encircled using dotted lines.

References

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