Study: Newborns whose mother spoke in a mix of languages during pregnancy are more sensitive to a range of sound pitches

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It's well established that babies in the womb hear and learn about speech, at least in the third trimester. For example, newborns have been shown
to already prefer the voice of their mother, recognize a story that had been repeatedly told to them while in the womb, and tell apart their mother's native language.

What wasn't known until now was how developing fetuses learn about speech when their mother speaks to them in a mix of languages. Yet this is common: there are 3.3 billion bilingual people (43% of the population) worldwide, and in many countries, bilingualism or multilingualism is the norm.

"Here we show that exposure to monolingual or a bilingual speech has different effects at birth on 'neural encoding' of voice pitch and vowel sounds: that is, how information about these aspects of speech has been initially learned by the fetus," said Dr. Natàlia Gorina-Careta, a researcher at the Institute of Neurosciences of the University of Barcelona, and the joint first author of a new study in Frontiers in Human Neuroscience.

"At birth, newborns from bilingual mothers appear more sensitive to a wider range of acoustic variation of speech, whereas newborns from monolingual mothers seem to be more selectively tuned to the single language they have been immersed in."

**Study done in polyglot Catalonia**

Gorina-Careta and colleagues did their study in Catalonia, where 12% of the population habitually uses both Catalan and Spanish. They recruited the mothers of 131 one- to three-day old newborns (including two pairs of twins) in Sant Joan de Déu Barcelona Children's Hospital as volunteers.

Of these mothers, 41% replied in a questionnaire that they spoke exclusively Catalan (9%) or Spanish (91%) during their pregnancy,
including when talking to their growing bump. The other 59% had spoken in two languages (at least 20% of the time for the second language): either Spanish and Catalan or a combination of one of these with languages such as Arabic, English, Romanian, or Portuguese.

"Languages vary in the timing aspects of speech, such as rhythm and accentuation, but also pitch and phonetic information. This means that fetuses from bilingual mothers are expected to be immersed in a more complex acoustic environment that those from monolingual mothers," said Dr. Carles Escera, a professor at the same institute and one of the two corresponding authors.

The researchers placed electrodes on the babies' foreheads to measure a particular type of electrophysiological brain response—the frequency-following response (FFR)—to repeated playback of a carefully selected sound stimulus, 250 milliseconds long and composed of four stages: the vowel /o/, a transition, the vowel /a/ at a steady pitch, and /a/ rising in pitch.

/o a/ sound

"The contrasting vowels /o/ and /a/ belong to the phonetic repertoire of both Spanish and Catalan, which is partly why we chose them," explained joint first author Dr. Sonia Arenillas-Alcón from the same institute. "Low frequency sounds like these vowels are also transmitted through the womb reasonably well, unlike mid- and high- frequency sounds that reach the fetus in a degraded and attenuated manner."

The FFR measures how precisely the action spikes produced by neurons in the auditory cortex and the brainstem mimic the sound wave features of the stimulus. A more distinctive FFR is evidence that the brain has been more effectively trained to pick up precisely that sound. For example, the FFR can be used as a measure of the degree of auditory
learning, language experience, and musical training.

The authors showed that the FFR to playback of the /o a/ sound was more distinctive, that is, better defined and with a higher signal-to-noise ratio, in newborns from monolingual mothers than in newborns from bilingual mothers.

**Possible tradeoff**

These results suggest that the brains of fetuses of monolingual mothers had learned to become maximally sensitive to the pitch of just language. In contrast, the brains of fetuses of bilingual mothers seem to have become sensitive to a wider range of pitch frequencies, but without generating the maximal response to any of them. A trade-off may thus exist between efficiency versus selectivity in learning about pitch.

"Our data show that prenatal language exposure modulates the neural encoding of speech sounds as measured at birth. These results emphasize the importance of prenatal language exposure for the encoding of speech sounds at birth, and provide novel insights into its effects," said Escera.

Joint corresponding author Dr. Jordi Costa Faidella, an associate professor at the same institute, cautioned, "Based on our results, we cannot make any recommendation to multilingual parents. The sensitive period for language acquisition lasts long after birth, and thus postnatal experience may well overshadow the initial changes undertaken in the womb. Future investigation into how a bilingual language environment modulates sound encoding during the first years of life will shed more light into this issue."

**More information:** Exposure to bilingual or monolingual maternal

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