BABIES HANDS MOVE

TO THE RHYTHM OF LANGUAGE

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Supplementary information (including quicktime movie) to accompany

Petitto, L. A., Holowka, S., Sergio, L. and Ostry, D. "Language Rhythms in Babies' Hand Movements." NATURE. September 6, 2001.

Photo: Jeffrey de Belle

HANOVER, N.H. - For 100 years vocal babbling sounds like "ba, ba, ba" universally uttered by healthy babies at around 7 months have attracted intense scientific fascination, as baby babbling has been understood to mark the developmental moment when a young child embarks on the road to producing language. But new insight into why this behavior exists in young babies was found on the hands of hearing babies acquiring natural signed languages. According to a study published in the September 6, 2001 issue of *Nature*, the lead author, Laura Ann Petitto, a Professor in the Department of Education and the Department of Psychological and Brain Sciences at Dartmouth College, said that the findings provide a fresh answer to an age-old question: how do babies begin the remarkable process of acquiring language?

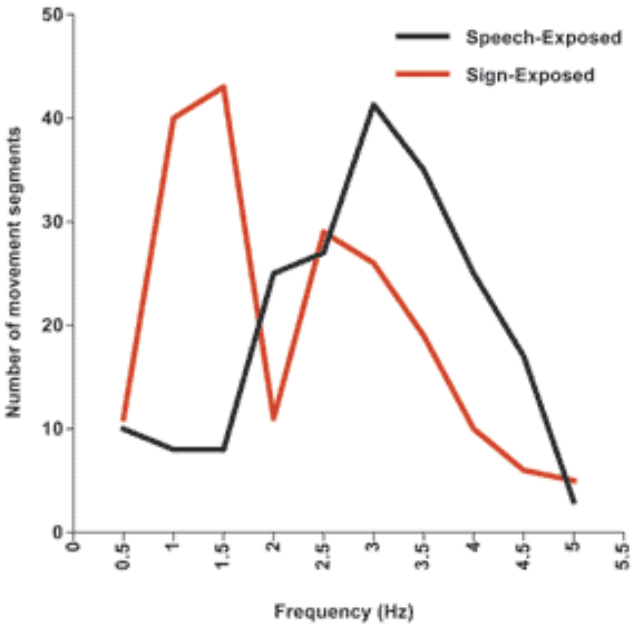
Petitto, who conducted the study with McGill University (Montreal, Canada) students and colleagues Siobhan Holowka, Lauren Sergio (now an assistant professor at York University), and Professor David Ostry (also at Haskins Laboratories in New Haven, Conn.), studied the hands of hearing babies born to profoundly deaf parents and discovered that they produced a class of hand activity that possessed specific rhythmic patterns found in natural language that was distinct from other uses of their hands, and only this class was "babbling," albeit *silent* and on the hands. The results of the study, titled "Language Rhythms in Babies' Hand Movements," support the idea that babies are born with sensitivity to highly specific rhythmic patterns found in natural language--a sensitivity that is so powerful that a baby can find and produce the rhythms of language on the hand as equally as is possible on the tongue. They further suggest the tantalizing idea that the baby's sensitivity to the specific rhythms of language is a key mechanism that launches the process of human language acquisition, permitting it to discover and to produce the bite-sized syllables in babbling, words, phrases, and beyond.

For decades, the traditional view has been that babbling, and by extension human language, emerges exclusively from our ability to control the mouth. Yet a different view has recently come from those who say that babbling results from the baby's sensitivity to specific patterns at the heart of language, like the sing-song patterns that bind syllables, the tiny units of language, into words and sentences.

As the strongest possible test of these two ideas, Petitto and colleagues studied six *hearing* babies: Three received no significant exposure to spoken language, only signed language from profoundly deaf parents. The other three were exposed to spoken language. To be clear, all babies were hearing. Thus, the two groups were equal in all developmental respects, with the only difference found in the form of the language input they received (by hands or by mouth). Because the sign-exposed hearing babies are not using their mouth for language, the traditional view predicts that their hand activity should be independent of any language learning and therefore they should produce hand activity that are fundamentally similar to the hearing babies exposed to speech. If, however, babies are born with a sensitivity to specific rhythmic patterns that are universal to the world's languages, even signed ones, then a baby exposed to signed language should produce some hand activity that is different from a baby exposed to spoken language.

Photo above shows Professor Petitto with a 10 month old infant that participated in the study

The Petitto group used a novel way of investigating the beginnings of language. All of the babies' hand activity was recorded using an optoelectronic position-tracking system (Optorak) that recorded three-dimensional information of their hands when they were approximately ages six, ten and 12 months. During 60-minute play sessions, sensors tracked the location and path movement of light emitting diodes (LEDs) on the babies' hands (shown here in the photo). Computer programs then performed calculations regarding the positions, speed, and cycles of hand and arm movements (relative to time) of the LEDs, which were done "blind" to videotape reference to the babies' hands. Independently, videotapes were made for viewing but only after these measurements were made. Because Petitto's team used the precise method of measurement afforded by Optotrak technology, they were able to overcome the problems associated with the subjective classification of baby hands when only viewing videotapes that have plagued research on this topic for decades.



The findings revealed that hearing SIGN-exposed babies (shown in Figure in red) produced two types of hand activity while the hearing SPEECH-exposed babies (shown on Figure in black) produced primarily one type. Movement frequencies (in Hertz) were calculated for all babies' rhythmic hand activity showing that the sign-exposed babies produced a *low-frequency* rhythmic activity; here, the hands moved in undulating bursts of around one complete movement cycle per second. In addition, these sign-exposed babies produced another type of *high-frequency* rhythmic activity whereby the hand moved in undulating bursts of around two and a half complete movement cycles per second. The high-frequency rhythmic hand activity was also observed in the speech-exposed babies, but they used this class of hand activity nearly exclusively.

In the videoclip provided on the right, you will first see a 10 month old SPEECH-exposed hearing boy producing one example of the high frequency hand movements mentioned above, and then you will see one example of a 10 month old SIGN-exposed hearing girl producing an example of the low frequency hand movements. While the naked eye using videotape analysis alone may perceive the two babies' hand movements as being similar, the Optotrak technology reveals the stunning ways in which these two babies' hand movements are systematically different, and it further reveals the linguistic principles that bind one class of hand movments (i.e., the baby girl's) but not the other (i.e., the baby boy's). Indeed, when Optotrak technology was used to measure the LEDs visible here on the babies' hands, it yielded the pattern of data like those shown in the Figure above. Note that these movies have been compressed and therefore do not show the absolute rate of movement of the babies' hands.		
	Click above to see small 1 mb Quicktime movie of handmovements	**Click above to see the same Quicktime movie in a larger format. This movie is 8mb**

Of note, only the sign-exposed babies produced low-frequency hand activity largely within a tightly restricted space in front of their bodies that corresponded to the strict location where signs must occur in natural signed languages. Speech-exposed babies produced most of their high-frequency hand activity *outside* of this crucial linguistic location. When the Petitto team lifted the "blind" and actually viewed videotapes of the babies' hands made during the opotoelectronic measurements, they found that only the low-frequency hand activity of the hearing babies exposed to signed language was linguistic babbling on the hands; it indeed had the same properties as was observed in earlier studies by Petitto and colleagues of profoundly deaf babies acquiring signed language.

Remarkably, this dramatic distinction between the two types of hand movements could only have occurred if babies find it important and can make use of the rhythmic patterns underlying human language.

***P**ractical & Educational Implications*: This discovery points to the centrality of the rhythmic patterns that underlie human language and suggests ways that parents and educators can exploit this natural proclivity in children to aid the language learning process: The sing-song way in which delighted parents speak to their baby, and the playful rhyming games common to nursery rhymes at home and in school, are clearly more important for a child's developing brain than we ever imagined, and they provide an important tool for the young child to discover the grammar and structure of her native language.

***F**uture Directions*: The Petitto team has now turned to understand the physical properties of the sing-song rhythms that parents produce with language when communicating with their babies. Like the songs of adult birds to their chicks in the nest, the group wants to understand just how fine-tuned nature has made the relationship between a human baby's sensitivity to the rhythmic patterning of language and the rhythmic patterning that their parents use as babies grow in early life.

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The photos of this baby boy both above and here were taken by Photographer Jeffrey de Belle. Here they show this 6 month old hearing speech-exposed boy producing a series of hand movements.

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