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SCIENCE WATCH

Outside language looking in

Deaf people with no language exposure provide a window into basic cognition.

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Counting comes so naturally to most people that we might be tempted to assume that it's instinctual. But researchers who study homesigners—profoundly deaf people who grow up without any access to sign language or spoken language—know better.

Homesigners spontaneously invent gesturing systems known as homesigns to communicate, but these systems lack many of the traits found in established languages. What's more, this lack seems to result in other nonlinguistic deficiencies—they don't seem to understand the concept behind counting, for instance.

"Homesigners present an interesting case study," says Elizabet Spaepen, a psychology doctoral student who is studying the area with Marie Coppola, PhD, at the University of Chicago. "They deal with the same numerate culture that we do. They absolutely have the pressure to learn numbers, but they don't."

For researchers, these homesigners offer a glimpse into the mind without structured language. In this uncharted workshop, they're discovering that language does a lot more than just provide a word bank; it helps organize the mind's underlying architecture.

Missing input

For centuries, linguists and psychologists have found that probing the mind for clues to understanding language can be a tedious task. But probing the hinterland for the right minds to study can be just as difficult.

In a rural village just outside Estelí, a city in northern Nicaragua, Spaepen and Coppola are tracking down a lead. A local special needs organization has tipped them off to a young deaf boy living nearby. But in Nicaragua, one of the poorest countries in the world, finding a specific person can be a needle-in-a-haystack affair. Nobody has an exact address, says Spaepen. Instead, you direct your taxi driver to, say, the house next to the chicken coop.

Pulling up to the house, the researchers see a very pregnant woman sweeping in the doorway. They inquire about the young

deaf boy, but the woman explains that his family has moved; she doesn't know where. But just as dejection sets in, the woman tells them about her niece, who also happens to be deaf and lives just a few miles away. So the woman leads the pair over a winding dirt path to her sister's house, where they meet 5-year-old Maria—a perfect subject for their research on homesigners.

Coppola has spent more than a decade traveling to Nicaragua, studying homesigners and helping the deaf community there access educational programs. Spaepen has traveled with her twice—once in early 2006, when they met Maria, and again in March 2007—conducting research for her dissertation. In many of these rural communities, the profoundly deaf don't have anyone to teach them sign language. Instead, they communicate with their families and those around them with invented gestures—pointing, basic hand shapes to represent objects and directed pointing to indicate movement. They're usually well-integrated into society, Spaepen says. They hold jobs, have friends and spend time with their families. They don't receive any formal education, but only about 30 percent of children in Nicaragua do.

But if you dig deeper, there are interesting pockmarks in their cognitive abilities. In her tests, Spaepen asked the homesigners, helped by the interpretive gestures of family members, to count with their fingers to a certain number, say, seven. This approach failed miserably. The homesigners, who are cognitively normal, couldn't understand the task, even though they use these hand shapes to indicate numbers when communicating. So Spaepen tried a new tack. She presented them with cards with images of hands holding up one finger, two fingers, three fingers, etc., and asked them to put them in order. The homesigners were able to put 1 through 4 in order, but tripped up with numbers larger than that. Spaepen tried the same experiment again, using cards with dots instead of fingers. She got the same results. The homesigners seemed to represent approximate quantities when it came to larger numbers, not specific numerical values.

"They do know what the hand shapes are," Spaepan says. "They just don't have a principled way of ordering them."

And she thinks a lack of language has something to do with that.

Language, she says, does two things for our numerical cognition. First, it provides an order for numbers, known as a count list. Linguistically, we learn that our verbal representation of a single unit, "one," is followed by another verbal representation, "two," which is followed by "three," and so on. The words themselves are ordered, which in turn provides a structure for enumerating objects. Second, language provides symbols for these numbers. We learn than "seven" not only represents the sequential increment after "six," but also summarizes the quantity of seven discrete units. You don't have to count up to seven to know what the abstract concept of "seven" symbolizes.

"Counting seems so trivial to us because of our [linguistic] input, but it's not trivial at all," Spaepen explains. "Our research suggests language may be critical to creating a concept like ‘exactly seven.'"

Creating space

Language appears to be critical to other areas of cognition, as well. For instance, concepts like "above," "below" and "inside of" seem almost as instinctual as counting, but that doesn't appear to be the case. People who study homesign have noticed that young homesigners rarely develop gestures for specific spatial terms. If they want to describe a cup on top of a table, with one hand they'll shape their hand like a cup and point it in the cup's direction. By comparison, structured sign-language users might place the cup shape on top of their other hand, outstretched and flat, to illustrate the relationship. But homesigners never seem to abstract the concept "on top of" away from their blunt demonstrations.

Dedre Gentner, PhD, wanted to know whether homesigners actually lacked these spatial concepts or if they just didn't translate them into gestures. The Northwestern University psychologist teamed up with two researchers who were in Istanbul at the time, Asli Ozyürek, PhD, and özge Gürcanli, to study a population of young homesigners, ages 4 to 6, using an experiment she'd previously used with Chicago-area preschool children. In that study, Gentner and then-graduate student Jeff Loewenstein, PhD, placed a card with a star—"the winner"—on top of a box, on a shelf inside the box or at the bottom of the box.

She then showed the children a second box and told them that they could find an identical card in the second box in the very same place.

For some of the kids, she would explicitly state where she was putting the star in the first box—"I'm putting the winner in the middle of the box"—whereas with others, she would say something less specific, such as "I'm putting the winner right here." Then she watched for how well the children did at finding the winner in their boxes.

The kids who heard the specific spatial term found the winner on their first try 72 percent of the time. The other children found the card only 45 percent of the time—not statistically different from chance, says Gentner. Spatial language makes a difference, she concluded.

Ozyürek, a psychologist at the Max Planck Institute for Psycholinguistics in Nijmegen, Netherlands, and Gürcanli, now a grad student at Johns Hopkins University, repeated this experiment with Turkish homesigners and hearing Turkish children—this time using no spatial language to test just intrinsic spatial abilities. Gentner and her colleagues analyzed the data and found that the homesigners performed no better than chance, while the hearing children found the winner about 60 percent of the time. "There seems to be a real advantage to having spatial terms," Gentner says.

Brain language

Yet despite these deficits, homesigners are able to communicate fairly effectively with their gesture systems, says Susan Goldin-Meadow, PhD, another University of Chicago psychologist who has studied homesign for 20 years. Their gesturing is much simpler than established sign languages, but it does certainly contain elements of language, such as distinct parts of speech and a consistent syntax. Goldin-Meadow has even identified

complex linguistic properties in homesign such as morphology—which means it has discrete, meaningful units that can be combined and modified to adjust meaning—supporting the claim that the mind tries to cobble together language even without linguistic input.

"Homesigners can do much more linguistically than numerically," she says.

And they share many interesting characteristics, such as a common syntax where nouns immediately proceed verbs, creating phrases such as "grape eat."

This observation leads Goldin-Meadow to suggest what she admits is an outrageous claim: Maybe homesign is a direct reflection of the mind's own language, straight from the brain to the fingers.

On the other hand, she says, it's possible that the similarities among homesign cultures are just a function of gesturing itself—convergent solutions to a common problem.

But even with the promise of unlocking the language of the mind, most researchers would rather these children grow up with access to sign language.

To that end, they are helping to establish language centers and setting up educational resources in these communities. In the late 1970s, a vocational school for deaf people opened in Nicaragua, providing the first real opportunity for them to come together as a community. Though instruction at the school was limited to spoken Spanish and lip-reading—both to virtually no effect—the students communicated with each other, each using his or her own homesign system, planting the seeds for common language.

In 1995, linguist Judy Kegl, working with local advocacy organizations, established the Escuelita de Bluefields on Nicaragua's eastern coast to bring together deaf students and deaf teachers—with the stipulation that no outside sign language be used at the school to allow the local nascent sign language to mature uninfluenced. A decade later, Coppola, along with University of Chicago students Leslie Bermingham and Raedy Ping, founded Manos Unidas, a group of researchers, educators and community members who help Nicaraguan families of deaf children pay tuition for deaf schools and invest in deaf adults' vocational training.

In the past 30 years, a formalized Nicaraguan Sign Language has developed, built out of the various local homesigns that have been shared and consolidated over generations. Today, it's used by more than 1,000 people and spreading rapidly throughout Nicaragua, giving language—and its consequent access to abstractions about numbers and space—to those who never would have experienced it.

"We'd actually love it if our [research] population no longer existed," says Spaepen.