makes it unlikely that Germany can eliminate the disease anytime soon, he says.

A practical question is which diseases newly arriving refugees should be screened for in order to catch and treat infections early. Screenings vary by country, and many are probably not cost-effective because the diseases are rare even in the migrant population, Kern says. ECDC is developing guidelines, but Kern says countries should only screen for diseases they are prepared to treat; that would rule out testing for hepatitis C, for which treatment costs about €50,000.

The bigger challenge is how to ensure that refugees don't get sick after their arrival. Many have made perilous journeys, and they are often housed in overcrowded facilities with unsanitary conditions; sometimes clean water is in short supply. Those conditions favor the spread of diseases such as hepatitis A, cholera, and typhoid fever, says Hakan Leblebicioğlu, an infectious disease specialist at Ondokuz Mayıs University in Samsun, Turkey, who has studied the health of the more than 2.7 million Syrian refugees living in his country.

Many refugees also arrive unprotected from deadly diseases, because war and unrest have interrupted vaccination programs in their home countries. In Syria, polio broke out in unvaccinated children in 2013, triggering fears that the disease could return to Europe. Some countries responded by vaccinating newly arriving Syrian kids. Measles struck a refugee encampment in Calais, France, earlier this year; 13 cases were confirmed before a large scale vaccination campaign stopped the virus. Migrants probably didn't import the virus, however. In a paper published last month in *Eurosurveillance*, researchers reported that the index case had arrived in France more than a month before getting sick, and that the virus's genotype matched strains circulating in Spain and the United Kingdom, suggesting that a volunteer working in the camp touched off the outbreak.

The health disparity doesn't end after migrants become permanently settled in their new country. "We have collections of Somali communities around our hospital in Hammersmith that have higher rates of tuberculosis than in Somalia," Hargreaves says. "Technically they have access to a first-class health service"—they just don't always use it. Finding out why is as important as diagnosing and treating disease, Carballo says. "We need more behavioral epidemiology or social epidemiology," he says. "We need to know much more about the extent to which people from different backgrounds access health and how to lower the barriers for them." ■

PHOTO: REUTERS/OSWALDO RIVAS

LINGUISTICS

How sign languages evolve

Young sign languages develop in predictable ways, offering clues to the evolution of linguistic complexity

By **Catherine Matacic**, *in New Orleans, Louisiana*

Simi Etedgi leans forward as she tells her story for the camera: The year was 1963, and she was just 15 as she left Morocco for Israel, one person among hundreds of thousands leaving for the new state. But her forward lean isn't a casual gesture. Etedgi, now 68, is one of about 10,000 signers of Israeli Sign Language (ISL), a language that emerged only 80 years ago. Her lean has a precise meaning, signaling that she wants to get in an aside before finishing her tale. Her eyes sparkle as she explains that the signs used in the Morocco of her childhood are very different from those she uses now in Israel.

In fact, younger signers of ISL use a different gesture to signal an aside—and they have different ways to express many other meanings as well. A new study presented at the Evolution of Language meeting here last month shows that the new generation has come up with richer, more grammatically complex utterances that use ever more parts of the body for different purposes.

Most intriguing for linguists: These changes seem to happen in a predictable order from one generation to the next. That same order has been seen in young sign languages around the world, showing in visible fashion how linguistic complexity unfolds. This leads some linguists to think that they may have found a new model for the evolution of language.

"This is a big hypothesis," says cognitive scientist Ann Senghas of Barnard College in New York City, who has spent her life studying Nicaraguan Sign Language (NSL). "It makes a lot of predictions and tries to pull a lot of facts together into a single framework." Although it's too early to know what the model will reveal, linguists say it already may have implications for understanding how quickly key elements of language, from complex words to grammar, have evolved.

Sign languages, like spoken ones, have established systems for combining stable words or signs into meaningful sentences. Because they evolved apart from spoken languages—often when previously isolated deaf individuals came together—they are more than just signed versions of their spoken counterparts. Most have been around for centuries. But a few, like ISL and NSL, have emerged only in recent decades, offering linguists a unique opportunity to watch how languages evolve in real time.

Linguist Wendy Sandler of the University of Haifa in Israel first explored this evolution while studying Al-Sayyid Bedouin Sign Language (ABSL) in the early 2000s. ABSL, used by roughly 150 villagers in Israel's Negev desert, was born in the 1930s, when several deaf descendants of the village's founder invented a system of signs to communicate with each other. Because their deafness was hereditary, soon almost everyone had at least one deaf relative and almost everyone was signing.

Once the community of signers reached a critical mass, the language started becoming more complex: People in the first generation could link words, but not in consistently

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New sign languages emerge and change when deaf individuals come together in larger communities, as with this class of Nicaraguan Sign Language users.

meaningful ways, whereas people in the second and third generations had full systems for marking complex sentences, conversational asides, and clauses, as Sandler reported in *Gesture* in 2012.

Further, Sandler realized that as the speakers refined their language, they were slowly enlisting different parts of the body to express more and more complex thoughts. Whereas first generation signers relied primarily on their dominant hands, second generation signers added their heads and third generation signers added their faces, all for specific linguistic purposes. Those in the fourth generation recruited their nondominant hands and their upper bodies, tilting them to the right or left to convey additional meanings.

Could the same thing be happening in other signed languages? To find out, Sandler and colleague Rose Stamp turned to ISL, a language born as deaf immigrants converged on what is now Israel before World War II. Sandler and Stamp divided 15 native ISL signers into three age groups: those 18–30 years old, those 31–50 years old, and those, like Etedgi, older than 50. Then the researchers video recorded their subjects narrating a short life story. The researchers analyzed 2-minute segments from each video, marking the movement of key body parts with special coding software. They collected more than 7000 data points and compared movements among signers.

The linguistic structures showed a clear trend: They became more complex from one generation to the next. To Sandler's surprise, the signers recruited body parts in the exact same order as the ABSL signers. "As I saw the relationship [unfold] between different parts of the body and linguistic complexity, I was thinking, 'I can't believe it!'" she says. For example, when younger signers wanted to signal an aside, they no longer leaned their entire bodies forward like Etedgi. Instead, they tilted their bodies to one side and then tilted their heads to the opposite side. A similar head tilt is used in ABSL. Even more intriguing, some of these changes also appear in NSL, a 40-year-old language from halfway around the world.

The use of new body parts and the increasingly detailed division of bodily labor "allow us to see [the addition of linguistic functions] with stunning clarity," Sandler says. Spoken languages of course don't involve the body. But, Sandler says, "it is reasonable to assume that the same [linguistic] functions would have emerged at the dawn of spoken language as well, because they are basic to communication."

The use of new parts also makes language more efficient: The youngest ISL signers can express themselves much faster than the oldest—153.2 signs per minute compared with 103.5 signs per minute.

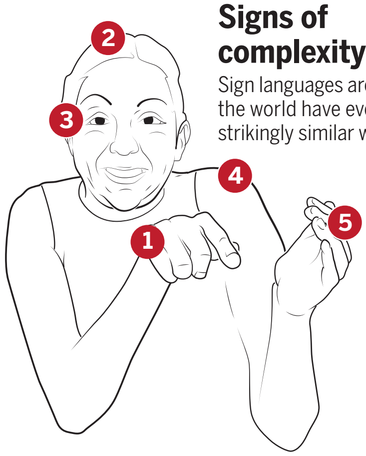
The findings also show that social interaction is essential for language evolution. When a new generation establishes a system for signing, Sandler says, it stays more or less the same as its members age. Her work has shown that when young signers enter a community, they add complexity through experimentation with their peers in what she calls "a social game." The more players, the more innovations.

This evolution takes time, notes evolutionary linguist Marieke Schouwstra of the University of Edinburgh, and so "contradicts certain views of the emergence of language." Some researchers have argued that a single mutation powered the "leap" from an animal-like communication system to something uniquely human (*Science*, 22 November 2002, p. 1596), and that some level of complexity was necessary from the outset. "This work shows that that's definitely not the case," Schouwstra says.

The evolutionary process may also be inevitable, reflecting the workings of our brains, Senghas says. "If there are systematic ways that we see it happening across all languages," she says, "that means there are similar ways of packaging information in all of our brains. That's what language is." ■

Signs of complexity

Sign languages around the world have evolved in strikingly similar ways.



1 Hands Signers start by making signs with their dominant hands.

2 Head They add the head for indicating topics and questions.

3 Facial expression The face comes next. The squint here signals a relative clause.

4 Torso Signers then use their upper bodies to show whom or what they are talking about.

5 Nondominant hand Finally, signers use their other hand for topic continuity and classification.

DIAGRAM: V. ALTOUNIAN/*SCIENCE*

FUNDING

No deadline, fewer requests

National Science Foundation trial spurs drop in proposals

By **Eric Hand**

The National Science Foundation (NSF) in Arlington, Virginia, has found a potentially powerful tool for tamping down the workload created by some 48,000 grant proposals annually: It can simply eliminate deadlines.

Last week, NSF officials revealed that proposals to four geoscience grant programs dropped by 59% after they eliminated deadlines in favor of anytime submissions, evaluated on a rolling basis. "We've found something that many programs around the foundation can use," said Roger Wakimoto, NSF's assistant director for geosciences, at a 13 April advisory panel meeting.

The no-deadline experiment is part of a multifaceted NSF effort to manage the agency's workload (*Science*, 4 December 2015, p. 1143). In 2011, NSF's geoscience division decided to try it first with a small grant program for earth science instruments and facilities; after the switch, the number of proposals dropped by more than 50%. Last year, Alex Isern, head of the surface earth processes section within geosciences, expanded the approach to four other programs. The number of proposals plummeted, from 804 in 2014 to just 327 in the 11 months from April 2015 to March.

Isern says scientists like the flexibility. Geologist Paul Bierman of the University of Vermont in Burlington believes the switch produces better proposals by creating a "filter for the most highly motivated people, and the ideas for which you feel the most passion." When on review panels, he found that half of proposals appeared to have been rushed to meet a deadline. "My hope is that this has taken off the bottom 50%," he says.

Other NSF program managers might try the idea, says Carol Frost, head of the earth sciences division. She has one concern, however: If proposals drop and success rates rise, programs might lose a talking point for bigger budgets. "One of the arguments … has been, 'Look, we have such proposal pressure, give us more money,'" she says. The experiment, she notes, provides evidence that proposal pressure can easily be controlled. ■

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Catherine Matacic (April 21, 2016)

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Editor's Summary