Z numeracy

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This paper presents evidence about numerical abilities among users of an emerging sign language called Zinacantec Family Homesign (or "Z"): a first-generation sign language that began with a profoundly deaf child born in 1976, the fourth daughter in a Tzotzil (Mayan) speaking indigenous family living in a rural Mexican village. Over the next 13 years three further siblings were born into the family, the first and last also deaf. They were later followed by several hearing children of the next generation. Altogether they form a cohort of seven native signers, of whom three are deaf. Systematic research on Z began in 2008 with the original four siblings, by then all young adults, whose exclusive means of communication is the emerging sign language. It later grew to encompass younger members of the sign-language community, who also use spoken Tzotzil to communicate with other members of the community.

Numeracy—or perhaps less contentiously, arithmetic—involves cognition, symbolic systems, a variety of possible representational technologies, and many sociocultural practices. Psychologists have argued for different kinds of cognitive systems linked to quantity and numerosity, some shared among different animal species [7, 13], and others more specifically linked to human abilities. In particular, they posit an "approximate magnitude system" (or "number sense") [6] linked to an evolutionarily early ability to estimate, often with just a glance [12], relative quantities of objects, without exact numbers [1]. There is also a "parallel individuation" system which allows direct and immediate perception of small quantities—3 or 4, or a few more [10], reflected in spoken languages with only a small number of "numerals" [5]. Qualitatively different is an abstract and potentially systematic capacity to conceive of and operate upon exact large numbers, perhaps infinitely large. Such an abstract capacity has been argued to be language dependent, relying on systematic notational systems that only symbolic linguistic conventions can provide ([2], [3], [4], but see [11]). Finally, there are societal practices that themselves require the manipulation of large and abstract quantities, linked to such human institutions as agriculture, land tenure, and commerce.

For a new sign language like Z, a crucial diagnostic of emerging complexity and expressive capacity can thus be argued to be the tools a "language" offers for manipulating large exact numbers. This paper reports the results of research on Z numerosity, beginning with the appreciation of relative quantities, moving through a counting system apparently partially borrowed from gestural technologies for representing numeric sequences in the surrounding speech community [14], to a convincing facility for exact calculation involving large numbers among the otherwise illiterate adult signers, whose livelihoods depend in part upon their ability to manipulate money. (Contrast [15].) The paper presents both semi-experimental and ethnographically situated natural interaction to demonstrate the resources Z signers (and Z itself) marshal for achieving numerosity.

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