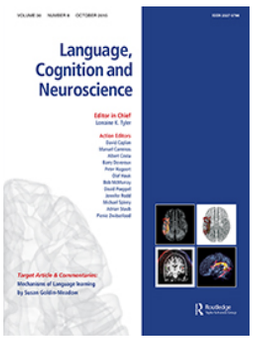

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REPLY

Establishing and accounting for the resilient properties of language

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Two issues feature in this set of commentaries—issues about establishing the resilient properties of a language, and issues about accounting for them. Homesigners (deaf individuals who generate gesture systems without usable input from a conventional language model) are crucial not only in establishing the existence of resilient properties of a language, but also in setting some constraints on the types of explanations that will work to account for them; the most obvious is that input from a conventional language is not essential for these properties to arise in human communication. But there are other constraints. For example, homesigners produce gestures that are structured along linguistic lines, but they receive in return the co-speech gestures that their hearing family members produce; these gestures are structured around speech, which makes the structure inaccessible to the homesigner. The resilient properties of a language can thus arise in a system that is at the same time produced for others but not received from others. The give-and-take aspect of communication may be less important to the structure of a language than previously thought (cf. Tomasello, 2009).

Everett (2015) is, however, not convinced that there is anything to explain. For example, he believes that the homesign studies do nothing more than show that children readily adopt symbols and use these symbols to represent objects because they, unlike other animals, have a strong need to communicate. I do not deny that humans have a strong need to communicate, but what impresses me about homesign is that it is *structured* communication. There are several points worth making about the structure found in homesign.

First, the structures found in homesign resemble structures found in natural language. They did not have to – there are other ways of structuring information. But they do, presumably because they are fashioned by people.

Second, the structures found in homesign are often not needed for a communication partner to understand the gestures. For example, homesigners tend to produce a gesture for the object of an action before the gesture for the action verb (an Object-Verb (OV) order, e.g. *water–drink,* as opposed to *drink–water*). It is obvious from shared context (cf. Forrester & Thomas, 2015) that the water is the object of drink, not the other way around. Nonetheless, homesigners all use OV order in their gesture sentences. (As an aside in response to Everett, the OV order cannot be reduced to *new* and *old* categories of information, see Goldin-Meadow & Mylander, 1984, 50–51.) Everett asserts that it is easier to select one order and run with it, rather than waffle between two orders. But there are no data to back up this assertion.

Third, the structures found in homesign are not found in the natural gestures that non-human primates use to communicate (Cartmill, Beilock, & Goldin-Meadow, 2012), nor are they found in the gestures, signs, or symbols non-human primates produce when taught a communication system. Relevant to the preceding point, even when taught a sign language, a chimpanzee does not use consistent order to convey relational information (Terrace, Petitto, Sanders, & Bever, 1979). It does not appear to be easier for a chimp to follow a single order than to produce random orders – at the least, this is a bias that is unique to humans.

Fourth, the structures found in homesign are not found in the gestures that speakers spontaneously produce when they talk. Again, in terms of order, an individual's co-speech gestures do not follow a consistent order, even though the gestures they produce when they are asked not to talk (their silent gestures) do (Goldin-Meadow, McNeill, & Singleton, 1996).

In terms of accounting for the resilient properties of language, as Forrester and Thomas (2015) point out, these properties need not be traceable to innate structures, although here it is important to be clear about what we mean by *innate.* Innateness has been addressed repeatedly and elegantly in many disciplines, particularly ethology (e.g. Lehrman, 1970; Mayr, 1974; McClintock, 1980), and as many as 17 definitions of innateness have been proposed (Wimsatt, 1986). The most common definition assumes that the development of innate behaviours is guided by a genetic programme. But we can also think about the development of innate behaviours as being

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resilient, or buffered against certain kinds of experience (Alcock, 1988; Goldin-Meadow, 1982).

The resilient properties of language do not have to be learned directly from linguistic input, suggesting that children come to communication with constraints that narrow down the range of possible outcomes in language development – they guide the child's search through the environment for relevant data. Although this narrowing, or canalisation, is often attributed to genetic causes (Waddington, 1957), canalisation can also be caused by the environment (Gottlieb, 1991a). For example, exposure to a particular stimulus at one point in development can make an organism not only more susceptible to that stimulus at later points in development, but also *less* susceptible to other stimuli; that is, it buffers the organism against those stimuli, thereby narrowing the range of possibilities open to the organism (Gottlieb, 1991b). In order for acquisition to be universal when the environment is playing a canalising role, the relevant aspect of the environment must be reliably present in the world of each member of the species. In a sense, the environment must be considered as much a part of the species as its genes. I am agnostic as to whether the resilient properties of language are grounded in genes or environment. What is clear is that human children are constrained to develop communication systems with linguistic structure, even when they do not have a model for that structure.

But we still need to figure out the mechanisms responsible for the development of the resilient properties of language. We obviously cannot manipulate the conditions of child language learning to do so, but we can take other approaches; for example, we can model the data computationally, as Forrester and Thomas (2015) suggest, and we can focus on selected comparisons across species, cultures, and clinical populations. But, as the comments point out, these comparisons need to be carefully drawn. For example, Forrester and Thomas (2015) note that comparisons of typical and atypical development do not always reveal the hidden properties of typical development. I agree, but it is also important to point out that this concern is particularly problematic when we find deficiencies in the atypical population relative to the typical population. The focus in the homesign studies is on the *presence* of a behaviour in an atypical population, which underscores the fact that the missing ingredient (in this case, linguistic input) is *not* essential for the development of the resilient properties of language.

There are a number of possible explanations for the resilient properties of language. Forrester and Thomas (2015) suggest that they may be structured as they are because they reflect the requirements of the task; for example, regular verbs have an advantage over irregular verbs in all of the simulation conditions that Forrester and Thomas examined, perhaps because the task favours regularisation. But, of course, it is the human mind that defines the task. Chimpanzees do not necessarily interpret the task in the same way – indeed, the proclivity towards consistent patterns (as found in regular verbs) may be just what distinguishes us from other primates.

At the other extreme, Everett (2015) notes that the structures found in homesign go well beyond the communicative task, as none is specific to language. McClelland (2015) puts it more charitably when he suggests that the resilient properties of language may be 'reflections of robustness of the cognitive structures underlying language, and perhaps even of the world these cognitive structures reflect'. I am quite comfortable with the idea that the resilient properties of language are cognitive structures brought to bear on communication. But a number of important questions still need to be addressed. Why do we bring just these cognitive structures, and not others, to bear on communication? There are things that homesigners know that they do *not* incorporate into the structural aspects of their systems; see Section 1.2 in the original article, which describes properties of objects like texture, hardness, temperature, and weight that are easy to represent with the hand (Lederman & Klatzsky, 1987), but are not incorporated into the morphological structure of homesign. And why do not non-human primates bring these structures to bear on communication? Hierarchy is an excellent example; as Everett (2015) points out, hierarchy is a tool for cognitive efficiency that is found in many species. Why then do not chimpanzees, particularly those who are being taught a language, display hierarchical structure in their communications? Homesigners do it, albeit quite simply (Hunsicker & Goldin-Meadow, 2012), even though they are not learning a language from someone else.

Another possibility suggested by Evans (2015) is that the resilient properties of language are an outgrowth of our 'social smarts'. The claim is that humans have evolved a specific type of social instinct that enables the resilient properties of language to get off the ground. Evans points out that the form a communicative act takes must be transparent enough for the signaller's communicative intention to be recovered by the recipient (a requirement that is particularly true when the communication system is not shared within a community, as in homesign). The communication must be understood by someone, and thus might be designed with the recipient in mind. However, the point I find striking is that homesigners introduce more structure than is needed to get their message across to the recipient. Take the example mentioned earlier – that homesigners adhere to an OV gesture order even when their communication partners do not need the order to understand the sentence. In fact, we have asked hearing individuals to view OV versus Verb-Object (VO) gesture sentences and rate them for ease of comprehensibility; the two orders were rated equally comprehensible, suggesting that this type of ordering does not matter to the recipient (Goldin-Meadow & Mylander, 1984, 94–97). Moreover, the homesigners' mothers do not

respond any more positively or appropriately to their child's OV gesture sentences than to their VO sentences (Goldin-Meadow & Mylander, 1983, 1984, 99–102). Finally, Evans (2015) suggests that the resilient properties of language might be built on the interactional capacities of other great apes. But we know that this explanation is not sufficient since the other great apes do not incorporate the resilient properties of language into their communication systems, even when they have models for those systems.

Evans (2015) also suggests that the resilient properties of language may be shaped by the body. An obvious design space for a communication system, one that facilitates recipient design, is the human body. The body could provide structure to the resilient properties of language, particularly as manifested in gesture. Along similar lines, Everett (2015) argues that 'gestures are sufficiently motivated by communicational needs that it makes little sense to attribute them to the genes as language-specific biological endowment'. But we have to be careful here. We cannot reduce the resilient properties of language in a gestural homesign system to structure growing out of the body precisely because co-speech gesture, which is also produced by the body, does *not* display the resilient properties of language (Goldin-Meadow et al., 1996; Goldin-Meadow & Mylander, 1983, 1998; Goldin-Meadow, Mylander, & Franklin, 2007; Hunsicker & Goldin-Meadow, 2012). Linguistic structure is not inevitable when the hands are used to communicate – some other pressure must also be at play.

I end by underscoring Feldman's (2015) call for clinicians to bring our findings to bear on practice. Even if a child comes to language learning ready to learn the resilient properties of language, that child needs to learn the particular language to which she is exposed. The linguistic input the child receives, and the gestures she produces, will both play a role in how quickly the child acquires the particulars of her language. And if a child has brain injury or is delayed for any one of a number of reasons, we can look to linguistic input and gesture as effective methods for getting around that delay. It has always been my belief that good clinicians instinctively make use of gesture when diagnosing language delay and deciding when and how best to intervene. We can now offer good evidence for this practice, while at the same time recognising that more work needs to be done to determine how these interventions are best implemented (Goldin-Meadow et al., 2014).

Disclosure statement

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