

UNRAVELLING DIGITAL INFINITY

CHRIS KNIGHT & CAMILLA POWER

*School of Social Sciences, Media and Cultural Studies, University of East London,
Docklands Campus, London E16 2RD*

'The passage from the state of nature to the civil state produces a very remarkable change in man, by substituting justice for instinct in his conduct, and giving his actions the morality they had formerly lacked. Then only, when the voice of duty takes the place of physical impulses and right of appetite, does man, who so far had considered only himself, find that he is forced to act on different principles, and to consult his reason before listening to his inclinations'.

Jean-Jacques Rousseau, *The Social Contract* (1973 [1762]: 195).

1.1. Digital minds in an analog world

Language has sometimes been described as a 'mirror of mind'. Chomsky attributes this idea to 'the first cognitive revolution' inspired by Descartes among others in the seventeenth century. 'The second cognitive revolution' – triggered in large measure by Chomsky's own work – is taken to have been a twentieth century rediscovery of these earlier insights into the nature of language and mind. In 1660, the renowned Port Royal grammarians (Arnauld and Lancelot 1972 [1660]: 27) celebrated

'this marvelous invention of composing out of twenty-five or thirty sounds that infinite variety of expressions which, whilst having in themselves no likeness to what is in our mind, allow us to disclose to others its whole secret, and to make known to those who cannot penetrate it all that we imagine, and all the various stirrings of our soul'.

If this 'marvelous invention' reflects some part of human nature, then on Cartesian first principles it must correspond to some innate mechanism in the biological mind/brain. Chomsky (2005) calls it 'discrete infinity'. Or as Pinker (1999: 287) puts it: 'We have digital minds in an analog world. More accurately, a part of our minds is digital.'

But if 'a part of the mind is digital', how did it ever get to be that way? Under what Darwinian selection pressures and by what conceivable mechanisms might a digital module become installed in an otherwise analog primate brain? Can

natural selection acting on an analog precursor mechanism transform it incrementally into a digital one? Is such an idea even logically coherent?

If these were easy questions, the ‘hardest problem in science’ (Christiansen and Kirby 2003) might long ago have been solved. Chomsky concludes that the transition to ‘Merge’ – the irreducible first principle of ‘discrete infinity’ – was instantaneous, commenting that ‘it is hard to see what account of human evolution would not assume at least this much, in one or another form.’ Note that *whatever* the account of human evolution, the assumption of instantaneous language evolution must stand.

Chomsky (2005: 11-12) writes:

‘An elementary fact about the language faculty is that it is a system of discrete infinity. Any such system is based on a primitive operation that takes n objects already constructed, and constructs from them a new object: in the simplest case, the set of these n objects. Call that operation Merge. Either Merge or some equivalent is a minimal requirement. With Merge available, we instantly have an unbounded system of hierarchically structured expressions. The simplest account of the “Great Leap Forward” in the evolution of humans would be that the brain was rewired, perhaps by some slight mutation, to provide the operation Merge, at once laying a core part of the basis for what is found at that dramatic “moment” of human evolution....’

Merge, then, is more than an empirical necessity: it is a logical one. It is the procedure central to any conceivable system of ‘discrete infinity’. Merge is recursive: it means combining things, combining the combinations and combining these in turn – in principle to infinity. Chomsky suggests that a ‘slight mutation’ might have allowed the evolving brain of *Homo sapiens* to do this for the first time. No matter how we imagine the physical brain, the transition to Merge is instantaneous, not gradual. This is because discrete infinity – ‘the infinite use of finite means’ – either is or is not. What sense is there in trying to envisage ‘nearly discrete’ objects being combined in ‘nearly infinite’ ways? A moment’s thought should remind us that when objects are subject to even limited blending, the range of combinatorial possibilities crashes to a limited set. In short, for Merge to work, the elements combined must be abstract digits, not concrete sounds or gestures. Combining a sob with a cry would not be an example of Merge. Neither would we call it Merge if a chimpanzee happened to combine, say, a bark with a scream (Crockford and Boesch 2005).

1.2. *Analog minds in a digital world*

One way to escape the conundrums inseparable from this position – conundrums foundational to all our debates and very well documented by Botha (2003) – might be to keep the essential idea but reverse the underlying philosophy. Humans have analog minds in a digital world. More accurately, just *a certain part* of our world is digital. We are at one with our primate cousins in being immersed in ordinary material and biological reality – Pinker’s ‘analog world’. But unlike them, we have woven for ourselves an additional environment that is digital through and through. This second environment that we all inhabit is sometimes referred to as the ‘cognitive niche in nature’, but the evolutionary psychologists who invented this expression (Tooby and DeVore 1987) did so for their own special reasons. Adherents of the ‘cognitive revolution’ but attempting to weld Chomsky with their own mentalist version of Darwin, they were committed to minimizing the intrinsically social, cultural and institutional nature of the digital representations made available to our brains. The expression ‘cognitive niche’ may have explanatory value, but not if the purpose is to deny the existence of what social anthropologists and archaeologists term ‘symbolic culture.’ Contrary to those who coined the expression, the ‘cognitive niche’ actually doesn’t exist ‘in nature.’ No one has ever found such a niche in nature. As Tomasello (1999) points out, the niche in question exists only as an internal feature of human symbolic culture.

So what exactly is this thing called ‘symbolic culture’? Following the philosopher John Searle (1996), let’s begin by drawing a distinction between ‘brute facts’ and ‘institutional facts’. Birth, sex and death are facts anyway, irrespective of what people think or believe. These, then, are brute facts. Legitimacy, marriage and property are facts only if people believe in them. Suspend the belief and the facts correspondingly dissolve. But although institutional facts rest on human belief, that doesn’t make them mere distortions or hallucinations. Take two five-pound banknotes and place them on the table. Now exchange them for a single ten-pound note. The identity of the two amounts is not merely a subjective belief: it’s an objective, indisputable fact. But now imagine a collapse of confidence in the currency. Suddenly, the facts dissolve.

It is crucial to Searle’s philosophy that institutional facts are not necessarily dependent on verbal language: one can play chess, use an abacus or change money without using language. The relevant digits are then the chess pieces, beads or coins that function as markers in place of any linguistic markers.

Digital facts of this kind – the intricacies of the global currency system, for example – are patently non-physical and non-biological. They are best conceptualized as internal features of an all-encompassing game of ‘let’s pretend’. Needless to say, the existence of such facts presupposes a brain with certain innate capacities, syntactical language being one possible manifestation of these capacities. But explaining distinctively human cognition by invoking ‘language’ is circular and unhelpful: it is precisely language that we need to explain.

Institutional facts develop ontogenetically out of the distinctively human capacity for mindreading, joint attention and pretend-play (Leslie 1987; Tomasello 2006). Extended across society as a whole, ‘let’s pretend’ may generate a whole system of ritual and religion (Durkheim 1947 [1915]); Huizinga 1970 [1949]; Knight 1999; Power 2000). The morally authoritative intangibles internal to a symbolic community – that is, to a domain of ‘institutional facts’ – are always on some level digital. This has nothing to do with the supposedly digital genetic architecture of the human brain. The explanation is less mystical. It is simply that institutional facts depend entirely on social agreement – and you cannot reach agreement on a slippery slope. By definition, anything perceptible can be evaluated and identified through direct sensory input. But institutional intangibles are by definition inaccessible to the senses. They can be narrowed down and agreed upon only through a process in which abstract possibilities are successively eliminated. ‘Discrete infinity’ captures the recursive principle involved.

The sound system of a language – its phonology – is prototypically digital. It is no more possible to compromise between the *t* and the *d* of *tin* versus *din* than to compromise between 11:59 and 12.00 on the face of a digital clock. Of course, categorical perception is common enough in nature (Harnard 1987). But the meaningless contrastive phonemes of human language comprise only one digital level out of the two that are essential if meanings are to be conveyed at all. Combining and recombining phonemes – ‘phonological syntax’, as it is called by ornithologists who study the digital phenomenon in songbirds – would be informationally irrelevant if it did not interface with a second digital level, which is the one necessary if *semantic* meanings are to be specified. No animal species has access to this second level of digital structure. It would therefore be inconceivable and in principle useless anyway for an animal to make use of syntactical operations – whether Merge or anything else – in order to interface between the two digital levels. The explanation is that animals inhabit just their own biological world and therefore don’t have access to the extra digital level. It

is the nature and evolution of the entire second level – the level of symbolic culture – that has proved so difficult to explain. Explaining ‘the Great Leap Forward’ as an outcome of ‘Merge’ is a parsimonious solution (Chomsky 2005), but only in the sense that explaining it as an outcome of divine intervention might seem persuasive in terms of parsimony although less so in terms of testability.

1.3. *A Darwinian solution*

The alternative (Knight 2000) is to conceptualize the language capacity as one special manifestation of a ‘play capacity’ continuous with its primate counterparts but let loose among humans in a manner not open to other primates. The development of ‘let’s pretend’ and the development of language in children are widely recognized as isomorphic. They have the same critical period, the same features of intersubjectivity and joint attention, the same triadic (*‘Do you see what I see?’*) referential structure and the same cognitive expressivity and independence of external stimuli. It is unlikely that these parallels are a pure coincidence (Bruner et al. 1976; Leslie 1987; McCune-Nicolich and Bruskin 1982).

‘Digital infinity’ corresponds to what developmental psychologists might recognize as a children’s game – in this case, ‘let’s play infinite trust’. Take any patent fiction and let’s run with it and see where it leads. Metaphorical usage is an example of this. A metaphor ‘is, literally, a false statement’ (Davidson 1979). By accepting and sharing it, we construct it as truth on a higher level – truth for ‘our own’ joint purposes of conceptualization and communication. As fictional public representations become conventionalized and reduced to shorthands, one possible trajectory is that they crystallize out as linguistic signs. Grammatical markers and associated constructions are historical outcomes of processes of grammaticalization that are now well understood – processes that are essentially metaphorical (Meillet 1903; Heine et al. 1991; Gentner et al 2001).

To evolve a grammar, in other words, humans must be trusting enough to accept falsehoods from one another. Animals cannot afford to do this. Their hard-to-fake signs – reliable signals on the model of human laughs, sobs, cries and so forth – are deception-resistant and evaluated for quality on an analog scale. Regardless of details of cognitive architecture, ‘honest fakes’ are *in principle* impossible to interpret in that way. Meaningless and valueless in themselves, they would read ‘zero’ on any costly signaling scale. Linguistic signs are ‘honest fakes’ – literal irrelevancies and falsehoods, significant only as cues to the

intentions underlying them. Since communicative intentions are intangibles, processing them has to be digital by reason of conceptual necessity, not because the brain or any part of it is innately digital.

‘Animals,’ Durkheim (1947 [1915]: 421) long ago observed, ‘know only one world, the one which they perceive by experience, internal as well as external. Men alone have the faculty of conceiving the ideal, of adding something to the real. Now where does this singular privilege come from?’ Maynard Smith and Szathmáry (1995) offered a bold answer to Durkheim’s question, citing Rousseau and viewing the puzzle of language origins as inseparable from the wider problem of explaining the emergence of community life based on social contracts. Their ‘major transitions’ paradigm is ambitious and conceptually unifying, assuming no unbridgeable chasm between natural and social science. The same applies to the paradigm being developed by Steels and his colleagues (Steels 2006; Steels et al. 2002), who use robots to show how lexicons and grammars – patterns far too complex to be installed in advance in each brain – spontaneously self-organize through processes of learning, recruitment, social co-ordination and cumulative grammaticalization. By maintaining continuity with primate cognitive evolution while introducing novel social factors, we can continue to apply basic principles of Darwinian behavioural ecology to account for the emergence of distinctively human cognition and communication.

Pinker (1999: 287) concludes his book on ‘the ingredients of language’: ‘It is surely no coincidence that the species that invented numbers, ranks, kinship terms, life stages, legal and illegal acts, and scientific theories also invented grammatical sentences and regular past tense forms’. Confusing correlation with causation, Pinker here treats the supposedly digital concepts intrinsic to human nature as responsible for the legalistic distinctions of language and culture. Note, however, that the digital concepts he actually mentions here – whether linguistic or non-linguistic – belong without exception to the realm of *agreements* and *institutions*. Is there any evidence that a language faculty could operate at all outside such institutional settings? Reversing Chomsky – and correspondingly reversing the whole idea of ‘digital minds in an analog world’ – we may conclude that ‘doing things with words’ (cf. Austin 1978 [1955]) is invariably more than just activating a biological organ. To produce speech acts is to make moves in a non-biological realm – a realm of facts whose existence depends entirely on collective belief.

‘Analog minds in a digital world’ is fully compatible with Darwinian evolutionary theory. ‘Digital minds in an analog world’ is not compatible at all.

Installation of an innate digital mind – whether instantaneous or gradual – is a *deus ex machina* with nothing Darwinian about it. A model of language evolution, to qualify as scientific, cannot invent fundamental axioms as it goes along. It cannot invoke currently unknown physical or other natural laws. It should be framed within a coherent, well-trying body of theory; it should generate predictions that are testable in the light of appropriate empirical data; and it should enable us to relate hitherto unrelated disciplinary fields. Whereas the *deus ex machina* approach rigidly rejects reference to any part of social science, the play/mindreading/joint attention paradigm (Tomasello 1996, 1999, 2003, 2006) has the potential to link the natural and social sciences in a theory of everything.

References

- Arnauld and Lancelot (1972 [1660]). *Grammaire générale et raisonnée, ou la grammaire de Port-Royal. Réimpression des éditions de Paris, 1660 et 1662.* Genève: Slatkinem.
- Austin, J. L. (1978 [1955]). *How to Do Things with Words.* Oxford: Oxford University Press.
- Botha, R. (2003). *Unravelling the Evolution of Language.* Oxford: Elsevier.
- Bruner, J. S., A. Jolly and K. Sylva (eds) (1976). *Play: Its role in development and evolution.* New York: Basic Books.
- Chomsky, N. (2005). Three factors in language design. *Linguistic Inquiry* 36(1): 1-22.
- Christiansen, M. H. and S. Kirby, (2003). Language evolution: the hardest problem in science? In M. H. Christiansen and S. Kirby (eds), *Language Evolution.* Oxford: Oxford University Press, pp. 1- 15.
- Crockford C. and Boesch C. (2005). Call combinations in wild chimpanzees. *Behaviour* 142(4): 397-421.
- Davidson, R. D. (1979). What metaphors mean. In S. Sacks (ed.), *On Metaphor.* Chicago: University of Chicago Press, pp. 29-45.
- Durkheim, É. (1947 [1915]). *The Elementary Forms of the Religious Life. A study in religious sociology.* Trans. J. W. Swain. Glencoe, Illinois: The Free Press.
- Harnad, S. (1987). *Categorical Perception: The groundwork of cognition.* Cambridge: Cambridge University Press.
- Gentner, D., Holyoak, K. J., and Kokinov, B. N. (eds.), (2001), *The Analogical Mind: Perspectives from cognitive science.* Cambridge, MA: MIT Press.
- Heine, B., U. Claudi and F. Hünemeyer (1991). *Grammaticalization: A conceptual framework.* Chicago and London: University of Chicago Press.
- Huizinga, J. (1970 [1949]). *Homo Ludens. A study of the play element in culture.* London: Granada.

- Knight, C. (2000). Play as precursor of phonology and syntax. In Knight, C., M. Studdert-Kennedy and J. R. Hurford (eds), *The Evolutionary Emergence of Language. Social function and the origins of linguistic form*. Cambridge: Cambridge University Press, pp. 99-119.
- Leslie, A. (1987). Pretence and representation: The origins of 'theory of mind'. *Psychological Review* 94: 412-426.
- Maynard Smith, J. and E. Szathmáry (1995). *The Major Transitions in Evolution*. Oxford: W. H. Freeman.
- Meillet, A. (1903). *Introduction à l'étude comparative des langues indo-européens*. Paris: Hachette.
- McCune-Nicolich and C. Bruskin (1982). Combinatorial competency in play and language. In K. Rubin and D. Pebler (eds), *The Play of Children: Current Theory and Research*. New York: Karger, pp. 30-40.
- Pinker, S. (1999). *Words and Rules. The ingredients of language*. London: Weidenfeld and Nicolson.
- Power, C. (2000). Secret language use at female initiation. Bounding gossiping communities. In C. Knight, M. Studdert-Kennedy and J. R. Hurford (eds), *The Evolutionary Emergence of language: Social function and the origins of linguistic form*. Cambridge: Cambridge University Press, pp. 81-98.
- Rousseau, J.-J. (173 [1762]). The social contract. In Jean-Jacques Rousseau, *The Social Contract and Discourses*. Trans. G. D. H. Cole. New edition. London & Melbourne: Dent, pp. 179-309.
- Searle, J. R. (1996). *The Construction of Social Reality*. London: Penguin.
- Steels, L. (2006). Experiments on the emergence of human communication. *Trends in Cognitive Sciences*, 10(8): 347-349.
- Steels, L., F. Kaplan, A. McIntyre, and J. van Looveren (2002). Crucial factors in the origins of word meaning. In A. Wray (ed.), *The Transition to language* Oxford: Oxford University Press, pp. 252-271.
- Tomasello, M. (1996). The cultural roots of language. In B. J. Velichkovsky and D. M. Rumbaugh (eds), *Communicating Meaning. The evolution and development of language*. Mahwah, NJ: Erlbaum, pp. 275-307.
- Tomasello, M. (1999). *The Cultural Origins of Human Cognition*. Cambridge, MA: Harvard University Press.
- Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*. Cambridge, MA: Harvard University Press.
- Tomasello, M. (2006). Why don't apes point? In N. J. Enfield and S. C. Levinson (eds), *Roots of Human Sociality: Culture, cognition and interaction*. Oxford & New York: Berg, pp. 506-524.
- Tooby, J. and I. DeVore (1987). The reconstruction of hominid behavioral evolution through strategic modeling. In: W. G. Kinzey (ed.), *The Evolution of Human Behavior: Primate models*. Albany: State University of New York Press, pp. 183-237.