THE MOVING TARGET ARGUMENT AND THE SPEED OF EVOLUTION

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This paper discusses problems associated with the "moving target argument" (cf. Christiansen & Chater 2008, Chater et al. 2009, see also Deacon 1997: 329, Johansson 2005:190). According to this common argument, rapid language change renders biological adaptations to language unlikely. However, studies of rapid biological evolution, varying rates of language change and recent simulations pose problems for the underlying assumptions of the argument. A critique of these assumptions leads to a richer view of language-biology co-evolution.

1. Introduction

Are languages a "moving target" for biological evolution? According to Christiansen and Chater (2008) there could not have been any biological adaptations to language because languages change rapidly whereas biology needs stable targets to adapt to. This argument features prominently in the debate on the origins of language (e.g. Deacon 1997: 329, Johansson 2005: 190, Chater et al. 2009). The following three points highlight the structure of the argument:

(1)   Premise 1   Biological evolution is slow.
      Premise 2   Language change is rapid.
      Premise 3   Slow biological adaptation needs stable targets.
      Conclusion   Biology could not have adapted to language.

2. The Uniformitarian Principle and some associated problems

The moving target argument covertly assumes that the rates of biological and cultural change we observe today are similar to the rates of change in the past. This inference has often been called the Uniformitarian Principle. The notion of "Uniformitarianism" goes back to Charles Lyell's *Principles of Geology* (1830) where he states that the processes which alter the shape of the earth remain

unchanged through time. The principle has also been stated within the context of linguistics by Labov (1972: 275):

> "[T]he forces operating to produce linguistic change today are of the same kind and order of magnitude as those which operated in the past (...)"

The view that cultural (and likewise linguistic) change is a much faster process than biological evolution is common. For example, Dawkins (2006 [1976]: 190) states that "fashions in dress and diet, ceremonies and customs, art and architecture, engineering and technology, all evolve in historical time in a way that looks like highly speeded up genetic evolution" and with respect to language he says that languages seem to evolve "at a rate which is orders of magnitude faster than genetic evolution" (ibid. 189).

Dawkins' use of 'historical time' implicitly contrasts with 'geological time', which is thought to be the domain of evolution. This idea goes back to Darwin, who thought of evolution as something that cannot be observed by humans and that works on non-historical timescales:

> "We see nothing of these slow changes in progress, until the hand of time has marked the long lapse of ages, and then so imperfect is our view into long past geological ages, that we only see that the forms of life are now different from what they formerly were." (Darwin 1909–14., ch. 4)

However, during the past years more and more cases have been discussed in which biological evolution is observable "in real time" – the literature on this is extensive and constantly growing. A number of these cases will be reviewed here to show that rapid evolution is much more frequent than sometimes assumed:

- A very famous example of rapid evolution is the ongoing co-evolution of virulence in the myxoma virus and defense against the virus in Australian rabbits (Dwyer et al. 1990).
- An experiment was able to show that bacteria are able to develop resistance to certain temperatures after 200 generations (Bennet et al. 1990) – a timescale of just months.
- In a captive population of chinook salmons, the egg size decreased within 5 generations (Heath et al. 2003). Selection pressure on offspring survival selects for larger eggs whose offspring are more likely to survive. If this pressure disappears in captivity, egg size may change rapidly.
- Ritchie & Gleason (1995) describe song patterns of flies of the *Drosophila willistoni* sibling species group. They find differences in frequencies and interval pulses of song patterns which – given that the

involved species are closely related – are likely to be the result of rapid evolution due to sexual selection.

- Klerks & Levinton (1989) suggest that the evolution of metal resistance of an invertebrate to a metal-polluted site in Foundry Cove (New York) could have succeeded in 1 to 4 generations – 30 years after the onset of the pollution.
- O'Steen et al. (2002) were able to show how populations of guppies rapidly adapt to their environment: guppies in high-predation areas rapidly evolved better escape abilities than guppies in low-predation areas. This change happened in a period of between 15 and 20 years.

These are some of the many cases of rapid evolution mentioned in the literature. One could object that many of these changes are not due to natural conditions because they are in some ways connected to human intervention. There are, though, good examples of rapid evolution where humans play no role, most notably the Darwin's finches of the Galápagos Islands which rapidly changed their beak size after a climatic event occurred that devastated a major food resource (Grant & Grant 1993). One could also object that the examples do not pertain to human evolution. However, a number of human genetic traits show the signature of selection within the last few thousand years (Wang et al. 2006).

Taken together, these examples highlight the fact that evolution does not always proceed slowly:

> "Our ideal world requires a constancy of evolutionary rate in all lineages. But rates are enormously variable." (Gould 1983: 363)

Since there is still considerable dispute as to what exactly determines the speed of evolution, it seems best to remain agnostic, with rapid evolution being seen as a possibility which should not be ignored.

3. The rate of cultural and linguistic change

These examples have shown that biological adaptation need not be slow. What about language change? Language change – and cultural change in general – seems to be almost entirely rapid. However, there are exceptions. For example, Diamond (1997) mentions the extremely slow cultural evolution (or sometimes the apparent lack of any evolution at all) in certain parts of the world due to detrimental geographical factors. A case in point is Tasmania, where there have not been any major technological advances for hundreds or even thousands of years. Also, there may be periods of time where the rate of evolution is different. For example, there is a huge gap between the Oldowan and the Acheulean stone producing techniques (cf. Johansson 2005), a transition which took approximately one million years.

Turning to language, linguists have discussed varying rates of change in the context of a critique of lexicostatistical methodology. A major criticism of lexicostatistics was the fact that it assumed constant rates of change (e.g. Teeter 1963). While Lees (1953) claimed that lexical retention rates cluster around a universal constant, Guy (1983) observed that Lee's sample is highly biased. In a classic paper, Bergsland & Vogt (1962) showed that some languages – in particular Icelandic, Armenian, Georgian and Greenlandic Eskimo (Inuit) – have higher retention rates than predicted by Lees' constant, while Blust (2000) shows that rates of change differ within the Austronesian language family. After splitting off from Proto-Malayo-Polynesian, some languages retained 58% of the Proto-Malayo-Polynesian vocabulary, whereas other languages retained only 5.2% after the same length of time.

Additional examples for varying rates of change come from the literature on phylogenetic modeling of languages: Although somewhat controversial, researchers have turned to estimate the 'half-life' of words (cf. Pagel 2007). Some of the words are estimated to have 'half-lifes' of approximately 70,000 years, which is similar to the rate of evolution of some genes (Burger et al. 2007). Other words are replaced faster. The varying rates of lexical displacement can be illustrated by looking at cognate sets: Where English speakers say "bird", Italians say "uccello", the French say "oiseau", the Spanish "pajaro", the Germans say "Vogel", the Greeks say "pouli" and Latin speakers said "avis". These forms do not form a cognate set as opposed, for instance, to "two" which has not been replaced in any of the Indo-European languages (Pagel 2009).

However, there are many examples of language change that seem rather rapid: vowels constantly shift; German is in the process of losing its genitive case marker; 'cool' and 'uber' change with almost every generation of kids. These examples constitute very interesting changes – but they do not constitute major changes. Most of the rapid changes of linguistic systems we can think of are changes in the inventory of categories: certain linguistic categories disappear, two categories might merge or one category might split into two.

There are, though, major changes that can be observed, e.g. the change of Nonthaburi Malay as an agglutinative language to a language of an isolating type, or the ongoing emergence of tonal contrasts in Korean. However, these shifts from one language type to another (agglutinative to isolating, non-tonal to tonal) usually need much more time and proceed in an incremental, step-by-step fashion over long periods. For example, Proto-Indo-European had a case system and while most European languages underwent specific changes (e.g. certain cases have been lost), all European languages retain a case system (with the notable exception of the marginal system in English).

When I speak of 'major' and 'minor' changes, I do not intend to imply that this is a qualitative distinction. I put forth the hypothesis that most of the fast changes we observe are among the more minor changes, while big changes need time – partly because they are constituted by a number of sequential small changes.

This hypothesis needs to be tested with large-scale typological databases, but crucially, it is a testable claim.

4. Biological adaptations for changing targets

To my knowledge no one has yet considered the implications of the work of Kashtan et al. (2007) for language evolution. Contrary to Christiansen and Chater's claim that biology could not have adapted to a moving target, Kasthan et al. (2007) find that "temporally varying goals can substantially speed evolution compared with evolution under a fixed goal" (ibid. 13711). As they point out, it might be expected that changing goals make evolution more difficult (ibid. 13711) but their model turns out to show that this is not necessarily the case.

They also find that "the more complex the problem at hand, the more dramatic the speedup afforded by temporal variations" (ibid. 13711). This is interesting with respect to language evolution because if anything can be thought of as a complex trait, it is language. If we believe Kashtan et al. (2007) that a moving target even increases the rate of evolution, the moving target argument can not only be criticized on the grounds of a critique of the Uniformitarian Principle (section 1 and 2) but also with respect to premise 3 which states that biological adaptation needs a fixed target.

5. A thought experiment on early language change

The following thought exercise is intended to show that it is not only possible but also quite likely that languages (or proto-languages) have changed more slowly in the past than they do today:

> Suppose, you are playing a game with a friend and you are given only one red die. The only thing you can do is throw the red die – once or maybe repeatedly. Only if you are given an additional die, let us say a green one, is there the possibility to change the order of the two dice. Now, more "complex" games are possible, e.g. throwing the red die three times, the green die three times etc. Given yet another colored die, the options of the game multiply. Crucially, the game can only be changed if there are enough elements in the game to be changed.

Something similar might have been the case in the early stages of language evolution – if one wants to avoid a saltational theory of language evolution it seems to be necessary to assume "simpler" stages of languages. This is something done by a large number of scholars who posit the existence of some

form of intermediate proto-language before the advent of modern human languages.

With respect to these proto-languages we might ask questions such as: Can word order be changed if speakers only use single words? Can tone be changed in a meaningful way if the speakers of a proto-language have not yet started to employ tones to distinguish meanings? Can two categories be merged if there is only one category in the language? The answer to all these questions is obviously 'no'. Therefore, it is likely that language change was not only slow but severely limited. Because languages at a certain stage in the language-brain co-evolution were likely to have been less complex, they had fewer dimensions on which cultural change could have acted.

The crucial difference between this thought experiment and the rapid emergence of new languages we observe in creolization processes is that today 'the game' is not biologically constrained and therefore the inventory of categories and patterns can expand at astonishing rates in language genesis. However, the thought experiment pertains to biological constraints. Let us take working memory capacity as an example. If there were selective pressure on increasing working memory capacity in the early stages of language evolution, adaptations to this pressure would lead to longer sentences. These are more likely to exhibit more complexity and the ability to change this complexity in increasingly different ways.

6. Conclusions

In this paper, I have argued that the Uniformitarian Principle does not hold across the board and should be used with caution since rates of change differ. I have also put forth the possibility that linguistic change and biological evolution are on a similar and sometimes overlapping timescale. Other researchers have reached similar conclusions on different grounds, e.g. Nettle (2007: 10756) argues for a greater role of gene-culture co-evolution than previously suspected. In the comments to Christiansen & Chater's paper, over five commentators argue for a bigger role of co-evolution in the origins of language. Taken together, these considerations show that the extent of co-evolution as opposed to one-sided adaptation of language 'to fit the human brain' (Christiansen & Chater 2008: 489) has probably been underestimated. The picture that emerges is an evolution of language/culture and biology in tandem. In the initial stages, proto-languages did not change as much as modern languages but with some general biological adaptations to language (e.g. in the domain of working memory, cooperation etc.), there was more and more room for languages to change and at the same time, to increase the rate of change.

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