THE ROLE OF MEMES IN CULTURAL EVOLUTION: MEMES IF NECESSARY, BUT NOT NECESSARILY MEMES

Abstract

The concept of cultural evolution is central to any discussion of "memes". It was because of the possible existence of Darwinian evolutionary processes beyond the gene-based biological that Dawkins introduced the concept in the first place as a possible substrate. The meme concept was generally not very well received in academic circles, albeit the reception among those interested in Darwinian-style theories of cultural evolution was more mixed. Beyond the sociology of its invention and reception, objections to the meme concept that there are discrete units of symbolically-encoded biological information which evolve, - genes, but not of cultural information - memes, are not persuasive as will be discussed. Both genetically and linguistically encoded information include units of structure which are discrete and of function which are symbolic, but because recombination can and does take place structurally within function units, in neither case do the two necessarily coincide. Hence the relationship between structure and function can be one to many and many to one (which is not to deny the capacity for evolution). Despite the complexity, like the gene concept historically, the meme concept can be shown to be capable of doing a useful job of scientific work. Although a great variety of other terms are used in a variety of evolutionary social science disciplines, the meme term may be particularly useful in interdisciplinary discourse. With respect to cultural inheritance, memetic talk may be most appropriate when social learning is by linguistic instruction and least appropriate when it is by individual learning mechanisms, but the situation is unclear when social learning is by observation or true imitation.

THE ROLE OF MEMES IN CULTURAL EVOLUTION: MEMES IF NECESSARY, BUT NOT NECESSARILY MEMES

The concept of cultural evolution is central to any discussion of "memes". It was because of the possible existence of evolutionary processes beyond the gene-based biological that Dawkins (1976:191-201, 322-31) introduced the concept in the first place as a possible substrate. Strangely enough he, of all people, did not initially clearly distinguish the gene and genome-like from the phene and phenome-like aspects of cultural evolution, a confusion which he corrected thereafter (e.g. 2003:119-127, albeit even that discussion somewhat confounded learning by observation and by verbal instruction). This paper on the role of memes in cultural evolution is divided into eight sections on the reception of memetics, the evolutionary gene, the related puzzle of sex and recombination, the role of language in cultural evolution, the scientific usefulness of the meme concept, alternative terms in evolutionary social sciences, memes and social learning mechanisms and a conclusion.

The reception of memetics

The meme concept was generally not very well received in academic circles. Books on memetics were interdisciplinary (which can itself be a problem); they often ignored many of the conventions of academic discourse; they were sometimes written by non-professionals for a popular audience; and they were commonly viewed by social scientists, when they paid any attention at all, as yet another (post-sociobiology) incursion by biologists into their subject matter. In addition, the fratricidal war between adherents of the gene-like biologically adaptive view (which can most obviously be associated with vertical transmission) and adherents of the virus-like biologically maladaptive view (which can most obviously be associated with

horizontal transmission) did not help when it should have been obvious that both are possible. The overall result was predictable. Of the editor of the *Journal of Memetics* in its heyday and the authors of all of the books on the topic, none currently hold an academic position. They include an IT professional, a business person, a professional poker player, one dead of an accidental drug overdose and a science journalist. On the other hand, the reception among those interested in Darwinian-style theories of cultural evolution was more mixed. For example Aunger managed to get a group of academics together including some well known ones including David Hull, Daniel Dennett, Henry Plotkin, Robert Boyd etc. for the conference that led to the anthology on "Darwinizing Culture" (Aunger, ed. 2000). That interest continues (e.g. see articles by Gil-White, Greenberg, and Chater in Hurley and Chater EDS. Vol. II, 2005). Moreover, a lot of those doing empirical and/or theoretical work on Darwinian-style cultural evolution in various social science disciplines often at least casually refer to memes. They do so because it helps to distinguish what they are doing from sociobiology/human behaviour ecology/evolutionary psychology as well as from the developmental stage theories of history traditional in the social sciences. A recent example that comes to mind are several of the essays in the anthology on *Mapping our Ancestors: Phylogenetic Approaches in Anthropology and Prehistory* (Lipo et. al. Eds. 2006). As a colleague put it to me, "the concept is out there" and it gets, and undoubtedly will continue to get, picked up and used in interesting and surprising ways. For example Keith Stanovich, an accomplished cognitive psychologist, argued in *The Robot's Rebellion: Finding Meaning in the Age of Darwin* (2004) that in pursuit of humanistic and democratic values, we (the robots of the title) need to bootstrap our way to rebellion against both our genes and our memes.

Given that in addition to Dawkins himself, some of the greatest evolutionary biologists of

our time including George Williams (1992:15-16, 18-19), John Maynard Smith (Maynard Smith and Warren 1982; Maynard Smith and Szathmary 1995:309) and Paul Ehrlich (2002) have made clear their awareness of the significance of a Darwinian cultural evolutionary process, and some, including Luigi Cavalli-Sforza and Marcus Feldman (1981 and subsequently for Feldman) have even made it a major part of their work, one might have expected biologists to display more enthusiasm. There currently are some biologists working on cultural evolution (including Kevin Laland and Alex Mesoudi). I believe however there is a reason why such work is not more widespread among biologists. The meme concept was introduced just at a time when there were rising "discontents" (Ruse 2006) within the biological community with neo-Darwinism (as it was known in Britain), or the synthetic theory of evolution (as it was known in America), i.e. with population genetics or the genetical theory of evolution. Those discontents included an implicitly naive view of the origin of life; an extreme micro and gradualist emphasis; an overemphasis on conflict as opposed to cooperation; a relative neglect of development and ecology; and overly restrictive theories of speciation and macroevolution. Moreover, it was introduced by the very person around whose work many of those discontents crystallized. Nevertheless, I think it is fair to suggest that by its linkage in peoples' minds, the wide diffusion of the meme concept gave Darwinian-style cultural evolution a lift, helping move the latter some distance out of the small, scattered academic niches in which it dwelt at the time.

The evolutionary gene

Beyond the sociology of its reception, objections to the meme concept that there are discrete units of symbolically-encoded biological information which evolve - genes, but not of cultural information - memes, are not persuasive. I am going to devote a fair amount of space here to talking about genes. I think that may be useful because memes are intended to be

analogous to genes, and the gene concept itself is commonly taken for granted in the memetics literature in a way that is problematic. If I can be so self-indulgent as to quote myself:

> "Genetic units of structure, function, replication, mutation and recombination do not coincide with one another. Units of structure are base pairs, nucleosomes, 30-nm fibres, loops, and chromosomes. Units of function include codons, open reading frames (ORFs, between initiator and terminator codons), cistrons (functional units defined operationally by cis-trans complementation tests, once assumed to be coincident with the molecular gene concept of a sequence coding for the polypeptide sequence of a single strand of a protein molecule), as well as many, many potential others e.g. with introns counted in or out, adjacent and even distantly acting regulatory sequences in or out, sequences coding for other strands of the same protein in or out, sequences coding for other enzymes functioning in the same pathway in or out, and ultimately even whole hierarchies and networks serving some particular ecological, sexual or social function. Units of replication are replicons and chromosomes. Units of mutation can be sequences of any length from a base pair to the entire genome and units of recombination can be sequences of any length in crossing over and are chromosomes in independent assortment. This lack of correspondence and consequent multiple 'gene' concepts has been the source of endless angst in the history of biology" (modified from Blute, 2005).

Not only have concepts of what exactly "a gene" is changed historically (for a brief history see Rheinberger & Muller-Willie 2004, for more in depth discussions see the essays in Beurton, Falk and Rheinberger Eds. 2000), they also vary currently among biologists as some delightful survey research has shown (Stotz, Griffiths, & Knight 2004). Some biologists even blog about it (Moran 2007)! This variation and change is of course exactly what a cultural evolutionist would expect, including in science (Hull 1988).

One can sometimes get the impression from recent literature that this was a new problem with the coming of the molecular biological discovery of "genes in pieces" and all that but that is not the case. As early as 1957, Benzer was advocating, on the basis of results from his elegant experiments on mapping within classical Mendelian genes and interpreting them in terms of the new DNA theory and later of the Watson and Crick model, that the term gene be replaced by cistron, muton, replicon, and recon for units of function, mutation, replication and recombination respectively (Holmes 2000). And from then, at least through the 1960's and early 1970's, the

problem was a topic of discussion even in textbooks (for example in the several editions of H.L.K. Whitehouse's *Towards an Understanding of the Mechanism of Heredity*) where I first read about them in the early 1970's.

Although it was not discussed in *Adaptation and Natural Selection*, this was the background against which Williams (1966) classic book was written. Which, if any, of Benzer's genes is it, that evolutionists in general, and population geneticists in particular, are talking about? It was apparent to Williams that it was none of them, that evolutionists needed their own gene and hence his definitions: "that which segregates and recombines with appreciable frequency" (p. 24) and "in evolutionary theory" "any hereditary information for which there is a favorable or unfavorable selection bias equal to several or many times its rate of endogenous change" (p. 25). Because the point of Williams' definition was that the evolutionary gene needed to be short enough to tend to remain intact through recombination as well as be long enough to affect function and hence be subject to selection, his gene came to be known as that which is "small enough to be different, and large enough to make a difference" (origin unknown to me). These are impossible criteria to combine. If being a gene is both a negative and a positive function of sequence length, which on the simplest assumption combine additively for example, then no sequence - short, intermediate or long would be any more gene-like than any other. Later in 1992, in distinguishing between the "domains" of information and matter ("codical" and "material" domains respectively), emphasizing that a gene is "a package of information, not an object", he reiterated the theme that to evolve by natural selection, a "given package of information (codex) must proliferate faster than it changes" (p. 11). He also noted that the same thing is true of memes (p. 13).

In 1976, between these two books of Williams, Dawkins introduced the term "replicator"

in his classic, *The Selfish Gene*. Not only did it carry the unfortunate connotation that genes replicate themselves instead of being replicated by enzymes, imply that the origin of life problem was pretty much one of 'once upon a time there came a replicator', and lent itself to misunderstanding by uninformed readers that the primordial replicator might possibly have been DNA, but it also tended to suggest the structural (and hence the short) rather than the functional (and hence the long) component of Williams definition. Later in *The Extended Phenotype* subtitled *The Gene as the Unit of Selection* (1982) he got more specific by specifying the criteria of copying fidelity, longevity, and fecundity. Note how the copying fidelity equates with the 'short enough' component of Williams definition and the longevity and fecundity (i.e. viability and reproductive success, the two large components of fitness) equate with the 'long enough' component of Williams definition. (To further confuse the waters however he also called it the "optimon" which suggests the latter i.e. that which functions, whereas replicator tended to suggest the former i.e. that which maintains its structure!) It probably would have been better if both Williams and Dawkins had gone to "evcon" which, like Mayr's, "selectron", rhymes with cistron etc. but unlike it, does not unduly emphasize function over maintaining structure (see discussion in Dawkins 1982: 81).

Whatever term is chosen and whatever description of the criteria is used, the important point is that the evolutionary gene combines a unit of recombination (which is the unit of genetic transmission in sexual species) with a unit of function. However since these do not in fact always or perhaps even often coincide - the evolutionary gene or replicator is as much a fiction, a theoretical construct rather than a hypothetical entity, as is an ideal gas for example. Williams (1966) understood this. He often spoke of "hereditary information" instead of genes, sometimes put "the gene" in quotations marks, called it the "abstract" gene of population genetics (p.24),

and noted that such a gene "would produce or maintain adaptation as a matter of definition" (p.25). Such fictions are useful one must hasten to add. One can write equations and prove theorems about them just like one can about right angled triangles say, which is what theoretical population geneticists do. To the extent that things in the real world approximate to the axioms employed (and they *always* only approximate), then what can be proven deductively true about the ideal entity will also tend to be true about the objects in the material as opposed to the conceptual world. In the real, as opposed to the fictional world, because recombination commonly takes place among structural rather than necessarily functional entities, the relationship between structure and function is not always one-to-one but can be one-to-many or many-to-one. This is the case not only in the traditional sense that one Mendelian gene can affect many traits and many Mendelian genes can affect the same trait, but also on a finer scale so that information from the same smaller genomic sequence can end up incorporated into more than one polypeptide chain and one polypeptide chain can be woven together from the information in scattered genomic sequences. Such cutting and pasting can and does take place in a variety of ways at any stage from transcription to post-translation. However, none of this should be taken to deny the fact that any particular sequence of whatever length has some mean effect on the fitness of individuals in a population and hence is potentially subject to natural selection.

The puzzle of sex and recombination

The really interesting question is not just how to cope verbally with fact that the kinds of units required for relatively accurate transmission on the one hand and selectability on the other hand do not always coincide, but *why they don't*. Why have sex and recombination which break up favourable "gene combinations" (as it is said) in every generation evolved and been maintained? That, after the origin of life, remains the mystery of mysteries. For example, it is

possible that it will turn out that on the level of chromosomes, they *do* coincide. Chromosomes may turn out to be also units of function, the only list of the five above (structure, function, replication, mutation and recombination) from which they are presently absent. If each controlled some major component of life histories with some specialization by gender, they would probably assort at random simply to reduce risk. For example, if because of sex-linked or limited expression, males grow bigger and females live longer, as tends to be the case among mammals, it would probably be advantageous for males to include females as well as males among their offspring and vice-versa as a means of reducing risk. Sex is good portfolio management. On that view chromosomes would be "near decomposable modules of a complex system" (Callebaut and Rasskin-Gutman EDS. Foreword by Simon 2005), in this case of a genetical system.

Crossing over within chromosomes on the other hand may be as much about conflict (in an overall cooperative context) or about innovation as anything else. Some years ago Hickey and Rose (1988) hypothesized that sex had its origin in parasitic DNA adapted for horizontal transmission. Non-Mendelian ratios as a result of gene conversion are not uncommon although most easily detected in yeast and fungi where the products of a single meiosis can be observed. Conventional reciprocal crossing over might well then be viewed as a balanced or dual form of gene conversion, mutual exploitation if you like. On that view, it would not be surprising that (ecologically) favourable gene combinations are broken up; crossing over, unlike random assortment, may not be adaptive from the perspective not only of the diploid genotype, but also from that of sequences on either side of those initiating homologous crossover events. Alternatively, reciprocal crossing over which takes place without regard to units of function may be viewed as a mechanism of innovation. From a functional point of view, such a recombinant is actually a mutant. On the other hand, given that we do not know what *most* of the DNA in

eukaryotic organisms does, caution is needed in drawing such radical conclusions - we are only in the very earliest phase of coming to understand the grammar of genomes. Whatever the merits may or may not be of various views, the point is that the evolutionary version at least of the "lost gene concept" from the title of Griffiths' (2002) review of Beurton, Falk and Rheinberger (2000) is lost in the territory of sex and recombination and his "reward to finder" will go to those who search there.

In the meantime, there seems to be little choice other than to tolerate the variety of gene concepts used in particular contexts in particular research traditions in biology which is what many philosophers and biologists who have considered the question have concluded and what the majority of biologists in fact do. As an example of how the saga continues, the website of the HapMap project has taken to calling SNPs "alleles" (i.e. the historic term for different versions of a gene). So a single nucleotide is now a gene! A second alternative would be to abandon the term gene completely and use the various historically suggested "on" - recon, cistron etc. substitutes. Not only would concepts of function need to be multiplied further given current molecular knowledge, but the approach seems sociologically quite unlikely to be successful, given that the transition did not take place in their heyday. As all evolutionists know, there is an inertia to history. A third possibility is to do what Burt and Trivers (2006) largely do in their monograph on intra-individual conflict, which is to talk about "genetic elements" or sequences, or even better, genomic elements or sequences, all of which conservatively retain the historic "g" word or its root while signalling more cognizance of the complexities involved.

Having disabused you, if you were not already, of the notion that the same "gene" is both a unit of both recombination i.e. of transmission in sexual species and a unit of function - one perhaps coincident with the molecular biological concept of that which codes for a single

polypeptide strand - where does all of this leave memes? In order to approach that question, it will be useful to consider the role of language in cultural evolution.

The role of language in cultural evolution

Most cultural transmission in the human species takes place using language in whatever medium it is embodied in - gesture, sound, print, electronic etc. Presumably it is because we can *tell* our children (and others) what we know and what to do, rather than just *show* them that partially accounts for the great success of our species. Eight points about genetic and linguistic systems of transmission are basic here.

i) Both genetic and linguistic forms of heredity are digital at their base (base-pairs and phonemes respectively) which facilitates stability in transmission (Dawkins 1995). So the problem is not that genes are discrete and culture, at least in linguistic form, is not.

ii) In both genomes and language there are units of function as well as units of structure (e.g. codons and morphemes respectively) and in both there are a number of more inclusive units of each (which I will not try to specify further to avoid getting trapped among warring linguists - linguistics and semiotics generally seem to be the only disciplines more contentious than sociology!).

iii) Both are said to be symbolic because of the arbitrary or conventional (i.e. historically evolved) nature of the link between symbol and what it stands for or represents (codons for amino acids biologically; morphemes and lexical items for their reference linguistically). Genetically-encoded information is legitimately said to be symbolic in that there is no physio-chemically necessary connection between a genetic codon (a triplet of base pairs in DNA) and what it stands for or represents (an amino acid in a protein molecule). According to current knowledge the connection is as arbitrary, is as much a product of history as is the connection

between red and stop rather than go, or between the word "father" and a male parent rather than a female one. It could as easily have been the opposite (Crick, 1968). This is possible biochemically because "adaptor" molecules are what associate a genetic codon (translated into messenger RNA) on one side and the amino acid component of a protein it stands for, represents, or encodes for on the other side. These adaptor molecules (tRNA's recognize the message with their anti-codon and aminoacyl-tRNA synthetases recognize both the tRNA and the protein component and link them) themselves have evolved - they are a product of history. To be sure the meaning of "no necessary connection" in the two cases is substantively different. Biologists say there is "no necessary connection" meaning no physio-chemical necessity. Linguists say there is "no necessary connection" meaning in addition that there is no biological or psychological necessity. Nevertheless the point is theoretically ultimately the same. The association between symbol and what it symbolizes is a fact of history rather than a necessity.

'Semiotic talk' in biology has been subject to criticism in the last decade (stemming initially from Sarkar 1996a, b), criticism which I believe is generally misplaced. Despite the fact that the *current* functioning of the components of cells like nucleic acids and proteins could in theory be given a complete description in terms of the chemistry of molecular recognition, enzymatic action and so on, such a reductionist description would be utterly incapable of providing a broader understanding of the historical evolutionary context that is the reason for their existence. Nuclei may best be viewed as the brains of cells which perceive, calculate and act (Blute 2005). Their genomes represent the cell's encoded memory of events in the past history of its lineage (including mutation, migration, drift, selection etc.) and, by the same token, their expectations of and hence basis for action in the future. Moreover, it is sociologically impossible to imagine a wholesale revision of the language of information, the code,

synonymous codons, transcription, translation, proof reading, editing and so on in molecular biology taking place anytime soon. Indeed, 'semiotic talk' is currently expanding rather than contracting. A couple of fairly recent introductions in genomics are "annotating" sequences (a way of lumping all considerations of function together) and the search for sequence "motifs", variations on which are characteristic of some particular phenomenon.

iv) In neither case do units of structure and function necessarily coincide; in particular the smallest unit of structure (base pair, phoneme) is smaller than the smallest unit of function (codon, morpheme).

v) In both, the building of larger units of function from permutations of smaller units of structure (e.g. of codons from base pairs, morphemes from phonemes) is what makes possible "unlimited inheritance" (Maynard Smith and Szathmary 1995) and thereby facilitates adaptation by means of the cumulative evolution of complex, diverse and unique entities in both cases. In both however, there remains much to be learned about the relationship between structure and function because in both many units serve purely internal organizing and controlling functions (e.g. cis and trans acting regulatory sequences as well as probably a lot of the untranslated rna in cells, many morphemes and words in language which serve purely grammatical functions. Note that the term "functional" is used in the opposite sense in the two disciplines - e.g. for the purely grammatical in linguistics.)

vi) Eventually in both one arrives at that which is capable of 'standing alone' (a genome, and traditionally an utterance or a sentence, although many today would prefer a narrative or text). This should not of course be taken to deny their "embodiment" in either case. Then of course there are populations or species of such with variation among individuals. We all say something a little, and sometimes a lot differently, even in similar situations, and we all have our

own versions of a story. (If we were talking about the evolution of *languages* rather than other aspects of culture *expressed* in language such as hip hop, scientific or Serbian culture for example - then these populations and species would be of the idiolects of individuals. A language is a species with members able to exchange communications linguistically within its boundaries but not beyond them analogous to a biological species with members able to exchange genes within but not beyond its boundaries.)

vii) The famed recursiveness of language (clauses within clauses etc.) may or may not in the long run turn out to be unique to human language among animal communication systems. However, it is probably not unique in another sense in that it may represent one version of the major means by which something new is generated in evolutionary processes including the genetic - by over-duplication and divergence, inserted in this case internally rather than adjacently.

viii) Grammaticization (in the narrow sense by which sense and meaning are emphasized or expanded by additions but which then tend to become more economically expressed by the use of purely grammatical elements both morphologically and syntactically) is a process apparent in both realms. It is most obvious genetically in the large increase in the proportion of regulatory "non-functional" DNA in the transition from prokaryotes to eukaryotes. What remains unclear in language is how much of it took place in the biological evolution of the human capacity for language (thus confirming the structural linguists' dream of a universal grammar); how much in the cultural evolution of languages plural (thus confirming the historical and anthropological linguists' view of the cultural evolution of grammar); and even how much takes place in the acquisition of language by individuals (thus confirming the psychologists' and social-psychologists' view of grammatical acquisition in development - no child begins to speak

with clauses).

When culture is transmitted lingustically, there is no systematic recombination process every generation - which is not to say that recombination does not happen. Much of the famous "productivity" of language occurs as a result of such 'reslotting'. We can say the boy ran "up the hill" or "across the road" or "over to her" etc. As with genomes, recombination in language can take place structurally without regard to functional units which can destroy the result semantically including the "sense" of a component and the "meaning" of a whole. The potentially pathological effect is seen at its most extreme in the "word-salad" of classic schizophrenic language in which syntax can remain eerily normal while meaning is destroyed.

> "If we need soap when you can jump into a pool of water, and then when you go to buy your gasoline, my folks always thought they should get pop, but the best thing is to get motor oil" (quoted in Covington et. al. 2005).

Similar phenomena can take place in units smaller than sentences so that schizophrenics commonly coin neologisms which are morphologically correct in that they could be a word in the language - except that they are not, as well as in larger units - so that an entire narrative can be "florid" as it is described, essentially not conveying intelligible meaning. On the other hand, as in genomes, recombination can also be creative. Some neologisms and even fantastical versions of a story for example *are* picked up and widely disseminated.

Van Driem (2001) in his symbiotic theory of language has argued that a linguistically informed understanding leads to the conclusion that, "meaning" i.e. semantics, is or should be central to the meme concept and I am inclined to agree. The concepts of function and adaptation have always been central to the theory of evolution by natural selection and they roughly correspond to the concepts of the "sense" of a component and the "meaning" of a whole

respectively in semantics. What they are properties of also correspond roughly to the concepts of a meme and a memeplex respectively in memetics (see the discussion in Blackmore 1999:18 ff). If a meme does not make "sense" (have a useful function) or a memeplex is not "meaningful" (not adaptive in the setting in which it is found), they are unlikely to be transmitted further (except in the former case as "uh" a parasite of the rest of the whole). Assuming a gene-meme analogy, falling back on units of function and adaptation in memetics may seem to contradict what was said above about genes but it really does not. To recap, genetic recombination may take place for some or a mixture of all of the following reasons. First, from a larger perspective it may be a pathological side effect of social conflict. Memes too do not always work well together in memeplexes - it is not only in talking to schizophrenics that we have all struggled to understand what someone else "means". Secondly, recombination can be a mechanism of innovation. With memes too, sometimes when we struggle to understand what someone else means, that may because they are saying something new which may turn out turn out to be well worth hearing. Thirdly, more recombination than we are currently aware of may align with units of function - not only between chromosomes but also within them. There are many departures from randomness in crossing over such as inversions and hot spots for example and more of it may become intelligible as we come to understand the hierarchical structure of genomes as well as we understand that of sentences which makes possible the productivity of language.

All of this says to me that to the extent that human culture exists in linguistic form which it largely does, the "meme" concept is no more (but admittedly no less) problematic than is the gene concept. Hence it cannot be banished on a priori grounds but perhaps like genomic sequences for genes say, a better substitute should be sought. I do not know what would be best - language string perhaps - or maybe just information for both as many have chosen would be

most useful in the final analysis. In any case, as with some particular genomic sequence, it remains the case that any particular language string of whatever length has some mean probability of being transmitted culturally, and hence is potentially subject to selection.

The scientific usefulness of the meme concept

Not surprisingly, as with the gene concept historically, despite the problems, "memes" can be shown to do a useful job of scientific work. To cite just one good example, inspired by the meme concept, Pocklington and Best (1997) used a text retrieval algorithm (latent semantic indexing) to identify sets of rare words that co-occur (sets which they called "term-subspace traits") in posts to some news groups on the internet. Since many posts originate in response to previous posts, they are threaded, i.e. the authors possessed genealogical data. They were able to show statistically that in some cases the reproductive success of a post, i.e. its success in generating in-reply-to posts, was a function of the degree to which certain of these traits were expressed within it. There was some lack of clarity in terminology (they sometimes referred to a term-subspace as a replicator, other times as a trait, and still other times as an indicator only of the underlying "cognitive motif" which is the true "conceptual replicator" although later they seemed to settle on the set of words that co-occur - Best and Pocklington 1999). Despite that, the study clearly was a proof-of -principle illustration of cultural microevolution in texts.

But also note two things. A set of words that co-occur is not strictly compatible with the evolutionary gene or replicator concept because the words are not necessarily adjacent to each other or "linked" in genetical terms. For example in one case illustrated the words "James", "Smith" and "Nazi" were not necessarily found side-by-side. The relationship between structure and adaptive function then was many to one. (If you are wondering how that is possible, an evolutionist would explain that such co-occurrence without linkage is possible because in

addition to their ecological effects, separated sequences can have social effects on each other i.e. have positively or negatively non-additive effects on fitness due to their co-occurrence. Moreover, with positively non-additive fitness effects, an evolutionary geneticists would tend to expect them to evolve towards becoming linked to make it less likely that they become separated). Secondly, in some cases the adaptive effect of the terms on the post could have been the result of someone saying "James Smith is a Nazi" but in other cases it could have been the result of someone saying "How dare you call James Smith a Nazi" (an issue which the authors subsequently addressed, Best and Pocklington 1999). The relationship then was-many-to-one. In other work, by grouping posts similar in their term-subspace contents into quasi-species, Best (1997) was also able to show that similar posts tend to be related by descent (come from the same thread) and that competition among quasi-species is more intense the closer their ecological niche.

Alternative terms in evolutionary social sciences

I used the Pocklington and Best work to make the point that despite the same structure-function disjunction problem as in genomes, the concept of a meme, like that of a gene, can and has historically been used to do useful scientific work. It is not the only one to have done so however. A lot of terms other than memes have been historically, and are currently in use in different social scientific disciplines for the 'iss and oughts' normally expressed linguistically and which evolve culturally. Mesoudi et. al. (2004, 2006), paraphrasing Boyd and Richerson (1985) and Richerson and Boyd (2005) use information - "information such as knowledge, beliefs, and values that is inherited through social learning and expressed in behavior and artifacts" or "information capable of affecting individuals' behaviour that they acquire from other members of their species through teaching, imitation, and other forms of social transmission."

Sociologists tend to refer to “norms and values”, linguists to “rules”, institutional economists and organization theorists to “habits”, “routines”, and “competencies”. Anthropologists once liked to talk about “folkways and mores” but today more often say “traditions” (albeit some students of animal behavior like to call animal cultures “traditions” to distinguish them from human culture). Archaeological speak is quite varied - “techniques”, “design elements”, “traits” and “traditions” for example are fairly common. In science studies they speak of concepts, theories and methods although sometimes more inclusive entities such as “paradigms” and “research programmes” are investigated.

It is not necessary, nor is it likely, that those doing cultural evolutionary research in such a wide variety of social science disciplines should or will abandon the conventional terminology used descriptively for their particular sphere of culture in favour of memes and memeplexes. Whatever terminology is used, it is important that the sense not only of knowledge or expectations but also of instructions be included. Both biology and culture include not only knowledge or expectations about the world but also instructions about how to act in it, how to deal with it. As noted previously however, talk of memes has been commonly found useful for communicative purposes in this wild west of cultural evolution when the discourse is interdisciplinary.

Memes and social learning mechanisms

Most social communication in animals, and perhaps in people as well, is not about social learning in the sense relevant to culture i.e. about Boyd and Richerson’s (1985) “second inheritance system” that creates similarity between individuals. More often it is about what is “accomplished” rather than what is “conveyed” as ethologists and behavioural ecologists put it (Owings and Morton 1998). When it is about what is “conveyed” however, it is not obvious that

it is appropriate to talk about memes irrespective of the social learning mechanism involved. With appropriate caveats about units as discussed above, the meme concept can be useful when the mechanism involved is linguistic because information is obviously being transmitted. But what about other mechanisms? Psychologists have proposed a variety of mechanisms that could be involved in social learning but we will consider only two other broad categories (for recent reviews see Zentall 2006, and the articles in Hurley and Chater EDS. V. I 2005).

Before doing so it will be useful to note that we assume here that all learning is cognitive - not in any sense related to conscious, but in the sense that it creates information (knowledge/expectations and instructions) in the brains of individuals. Demonstrations of this go back to experiments in place learning performed by the cognitive behaviourist Edward Chance Tolman in the 1940's (e.g. Tolman, Ritchie and Kalish 1946). For example, in a four arm maze, if you first teach rats starting from the south to get food in the west box, then test them starting from the north box and they still get the food, then they obviously have not learned only a behaviour (i.e. turning left which would have lead them to go east when coming from the north), but instead they have learned to know, or more accurately to expect, where the food will be. This can be most parsimoniously explained with the concept of a programme - what was increased in frequency by the reward in learning was not a behaviour, turning left, but the execution of a programme which minimally contained the instructions “If coming from the south, go left; if coming from the north go right” (“south” and “north” here being simply markers for any discriminable features of the environment such as a scratch on the floor or a light overhead). The full content of the programme did not become obvious however until the testing phase. (Of course no programme includes all conceivable ways of achieving a result which would imply a naive form of pre-scientific teleology. For example, if we cemented up the west arm for testing,

the food would not be acquired. In that sense there is no such thing as learning to achieve a goal without qualification.) However, most behaviour in animals, even those with quite simple nervous systems, probably involves the execution of complex programmes including routines, sub-routines and so on. So we assume that in social learning, the situation is similar, that social learning is cognitive.

Now consider a case of social learning taking place by individual learning mechanisms e.g. by instrumental or operant conditioning. An episode of social learning between ego and alter with the direction ego to alter may actually be rather complicated. It may be in the (reinforcement) interest of ego to shape alter's behaviour to be similar to its own (in which case the interaction could be neutral or predatory with respect to alter), or it may be in the (reinforcement) interest of alter to have its behaviour shaped to be similar to ego's (in which case the interaction could be neutral or parasitic with respect to ego), or both (i.e. be in their mutual interests). For example, the former was the implicit assumption in the first theory of social learning by individual learning mechanisms - the theory of matched-dependent learning (Miller and Dollard 1941, 1962) in which ego reinforces alter's behaviour for matching its own. On the other hand, the second is the assumption in Boyd and Richerson's theory of the evolution of cultural transmission according to which learning from others is favoured if learning individually is error prone or expensive, and environments are neither too variable (which would favour individual learning) nor too stable (which would favour genetic transmission) (Boyd and Richerson 1985, Richerson and Boyd 2005: Chpt. 4) . Notice that in the first kind of case, ego must learn individually how to emit "signals" (cues which induce the expression of some particular behaviour in alter, warnings which suppress it, and/or rewards and punishments which select among alter's behaviours), in order to *shape* (as the psychologists call it) alter's knowledge

and behaviour to be similar to its own. Because ego knows how and is able to do something does not mean that it knows how to shape another to know and do similarly. In the second kind of case on the other hand, alter must learn individually how to have its behaviour shaped by ego - i.e. to receive and correctly interpret "signals" (cues, warnings, rewards and punishments) emitted by ego in order to have its behaviour rendered similar to ego's. In both cases, "signals" are in quotation marks because they are signals in the ordinary language sense only to one, not both of the parties. In the third kind of case in which behaving similarly is in their mutual interests, they are signals to both and both are learning.

Given the assumption that all learning, including the social, is cognitive, in all three cases information has been created in one or more brains. The important point however is that in the first case information has been created in the brain of ego only; in the second in the brain of alter only; and in the third, information has been created in both, but it is *completely different information*. There would be no reason to believe that alter who has been shaped socially by such a mechanism would thereby be capable of shaping another in turn. It would have to learn individually to do so. In essence, these are social-psychological and not cultural processes. There is no meaningful sense in which information has been transferred. Memetic language to describe them would therefore be inappropriate.

While social learning by linguistic instruction clearly transmits information and social learning by individual learning mechanisms clearly does not, the case of social learning by observation (in any sensory modality), 'learning to do by seeing it done', variously called observational learning, imitation or true imitation, the situation is unclear. The possibility or even the probability of imitation arises particularly when the learning is latent (the learner just observes, not performs in the learning situation) and when a long time lag exist between

observation and performance. According to Zentall's review (2006), the evidence for imitation is rather good for birds and primates. However most ethologists and behavioural ecologists would at least extend the primates to mammals in general (including Cetaceans for example, Rendell and Whitehead 2001) and even to fish and insects when the behaviour involved is female mate choice (for an overview see Dugatkin 2000). The copying of mate choice among females is a long established feature of lek mating systems for example. It whatever group, it would seem that the only obvious mechanism to explain imitation must include an analogue of reverse translation. One would have to "reverse translate" the actions of another into cognitive descriptions of the behaviour, and then use the latter to guide one's own actions. In humans of course, this reverse translation would normally be into language, whether silent or overt. In animals what form these descriptions would take is unclear (as is the nature of cognition in animal learning in general for that matter). However, in either case it is reasonable to suggest, as many have, that the existence of mirror neurons (discovered initially by Gallese et. al. 1996; Rizzolatti et. al. 1996) - neurons which "mirror" the actions of another by being active both when an action is observed and when it is performed may be relevant to understanding this form of cognition. In either the human or the animal case, the issue of whether or not information has been transferred and hence whether memetic language would be appropriate however, comes down to the question of whether the resulting information in the two individuals' heads is "the same". I do not know of any way of deciding that although ultimately neurophysiology may provide the answer.

It is worth noting that the teaching of physical skills in humans (say a child to tie a shoelace) is often accomplished by combining all three of these mechanisms - we demonstrate the behaviour, shape their behaviour (perhaps guiding their fingers and offering rewards for a

step accomplished correctly declaring “that’s it”), all the while emitting verbal instructions such as “now bring the top one down, back, then up again and pull on both ends”.

Conclusion

The subtitle of this article might better have been put as “memes if useful, but not necessarily memes” (but it does not sound as good!) . Objections to the meme concept that there are discrete units of symbolically-encoded biological information which evolve, - genes, but not of cultural information - memes, are not persuasive as has been discussed because the same problem with respect to units exists in both realms. Despite this complexity, like the gene concept historically, the meme concept can be shown to have done useful jobs of scientific work. Although it is unlikely that the descriptive terminology utilized in a variety of social sciences including their evolutionary versions will be abandoned in favour of memes, memetic terminology may be particularly useful in interdisciplinary communication. Because it implies the transmission of information, memetic talk may be most appropriate when social learning is by linguistic means, least appropriate when it is by individual learning mechanisms, but the situation is unclear when social learning is by observation i.e. imitation, where a reverse translation-like mechanism would seem to be required.

Finally, I note that memetics in particular, and cultural evolution in general, has done little to address some of the most interesting problems in the general theory of selection processes today - such as those involving the relationship between evolution, development, ecology and heredity. That needs to change.

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