The Mystery of the Routine

The Darwinian Destiny of *An Evolutionary Theory of Economic Change*

Geoffrey M. Hodgson*

The three core Darwinian principles of variety, inheritance and selection are found in Nelson and Winter's Evolutionary Theory of Economic Change *(1982). Is the application of these core Darwinian principles purely analogical, or does it also relate to ontological communalities between social and biological evolution? Why do Nelson and Winter describe their theory as "Lamarckian" despite this strong Darwinian content? This "Lamarckian" inclination is related to their imperfect and inconsistent definitions of their core concept of "routine". It is argued here that a routine must be treated as a genotype rather than a (behavioural) phenotype. Following Winter (1987), it is also argued that the use of Darwinian principles in economics relates to general features that are common to both social and biological systems. This permits consideration of the routine as a replicator in a broad Darwinian analysis. A definition of replication is taken from the recent literature on cultural evolution and applied to the key concepts of (individual) habit and (organisational) routine. An ontologically-grounded Darwinian and evolutionary economics leads us to a more detailed discussion of the mechanisms of replication, as well as the sources of variety and the processes of selection.*

LE MYSTÈRE DE LA ROUTINE OU LE DESTIN « DARWINISTE » DE *AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE*

Les trois principes centraux de l'approche darwiniste sont présents dans l'ouvrage de Nelson et Winter (1982) : la sélection, la variété et l'héritage. Ce article s'interroge sur leur statut : la mise en œuvre de ces concepts reste-t-elle purement analogique ? Suppose-t-elle au contraire une articulation forte entre évolution sociale et mutation biologique ? Comment expliquer qu'en dépit de leurs références darwinistes, Nelson et Winter décrivent leur théorie comme « lamarckiste » ?

Cette approche « lamarckiste » est mise en relation avec les faiblesses que présentent les définitions du concept central de routine chez ces auteurs : l'argument développé ici est que l'analyse d'une routine doit mettre l'accent sur les génotypes plutôt que sur les comportements et les phénotypes. Conformément à l'approche développée par Winter (1987), on défend l'idée que l'utilisation des concepts darwinistes en économie

* The Business School, University of Hertfordshire, Mangrove Road, Hertford, Hertfordshire SG13 8QF, UK

http://www.herts.ac.uk/business/esst/Staff/g-hodgson/hodgson.html

http://www.geoffrey-hodgson.ws

Address for correspondence: Malting House, 1 Burton End, West Wickham, Cambridgeshire CB1 6SD, UK g.m.hodgson@herts.ac.uk

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s'appuie sur des principes généraux communs aux systèmes biologiques et sociaux. Cela permet de considérer la routine comme un « réplicateur » au sens de la littérature récente consacrée à l'évolution culturelle. Cette approche ontologique, inspirée des principes darwinistes, conduit alors à discuter les mécanismes de réplication en tant que source de variété et comme processus de sélection.

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Richard Nelson and Sidney Winter's *Evolutionary Theory of Economic Change* (1982) is a rare and historic achievement. One of the reasons for its importance is its deployment of the three core Darwinian principles of variety, inheritance and selection. However, Nelson and Winter were reluctant to admit to more than the use of a biological analogy. They also described their theory as "Lamarckian", where its implicit Darwinian content might also warrant a "Darwinian" description.

It is suggested here that these apparently superficial features of their work might be more deeply problematic than they appear at first sight. It is argued that the justification for the use of core Darwinian principles in economics must be existence of entities and processes that actually share in common some general features with entities and processes in other complex evolving systems. Although the details of biological and economic evolution differ substantially, and the one is not reducible analytically to the other, more than mere analogy is involved in the application of Darwinism to economics (Hodgson, 2002).

Realising this, we are required to look more closely, in the economic domain, at key Darwinian entities and processes, in particular the replicator and its replication. Replicators are information-carrying entities that can be copied in some way in an evolving system. This leads us to the key Nelson-Winter concept of "routines as genes". However, if a routine is a gene-like entity, in the sense that it is a generative coding with the potential to lead to specific outcomes, then it cannot simultaneously be defined as "behavior". From both a Darwinian and a philosophical perspective the Nelson-Winter definition of routines as behaviour is criticised.

Here an alternative definition is constructed, first by looking at the key concept of habit. This is compared with the notion of a "meme" (Dawkins, 1976). Some difficulties with the latter concept are identified, and it is proposed that the concept of habit is superior. Possible processes of replication of habits are discussed. It is argued that the concept of routine is analogous to an "organisational habit"; that is, routines relate roughly to organisations as habits relate to individuals. Like habits, routines are propensities rather than behaviours. Routines are grounded (and may remain latent) in the organisational complex, which involves both the organisational structures and the habits of individual members of the organisation. Their operation is triggered by cues in the organisational environment.

THE DARWINIAN CORE OF NELSON AND WINTER'S THEORY

It is common knowledge that three key theoretical elements in Charles Darwin's theory of evolution are the existence and replenishment of variety, the inheritance of information, and the selection of some of the relatively fitter units

(Campbell, 1965; Lewontin, 1978; Mayr, 1992). Notably, these three ideas were emphasised by Darwin himself. They are all found in the long, final paragraph of the *Origin of Species* (Darwin, 1859, pp. 489-90).

The very same three ideas are central to the innovative work of Nelson and Winter (1982). In their introductory chapter, Nelson and Winter (1982, p. 9) emphasise that their prominent and thematic use of the term "evolutionary" is "above all a signal that we have borrowed ideas from biology, thus exercising an option to which economists are entitled in perpetuity by virtue of the stimulus our predecessor Malthus provided to Darwin's thinking." They identify routines in the firm as the repository of information, and compare them to genes in biology.[1] Like the gene, routines enable information to endure and be inherited through time, and are key elements in the determination of the fitness of a firm and its capacity to survive in the process of competitive selection:

> "Our general term for all regular and predictable behavioral patterns is 'routine.'… In our evolutionary theory, these routines play the role that genes play in biological evolutionary theory. They are a persistent feature of the organism and determine its possible behavior (though *actual* behavior is determined also by the environment); they are heritable in the sense that tomorrow's organisms generated from today's (for example, by building a new plant) have many of the same characteristics, and they are selectable in the sense that organisms with certain routines may do better than others, and, if so, their relative importance in the population (industry) is augmented over time". (Nelson and Winter, 1982, p. 14.)

Darwin's ideas of inheritance and selection are clearly present in the above quotation. Furthermore, by borrowing the concept of the gene, Nelson and Winter allude explicitly to later "synthetic" versions of Darwinian theory, where Mendelian genetics were combined with Darwinian evolutionary ideas.[2] Nelson and Winter (1982, p. 17) go on to apply the concept of selection to the competitive struggle between firms:

> "Thus, profitable firms will grow and unprofitable ones will contract, and the operating characteristics of the more profitable firms therefore will account for a growing share of the industry's activity. The selection mechanism here clearly is analogous to the natural selection of genotypes with differential net reproduction rates in biological evolutionary theory".

While Nelson and Winter point to selection mechanisms in their models, their selection mechanisms do not always involve birth and death. Instead they typically involve some routines and firms prospering relative to others. In contrast, the selection of organisms in nature involves birth and death, as well as differences in prominence or prosperity. Nelson and Winter's idea of selection is consistent with the broadly and formally defined concept in the work of recent scholars. Selection involves an anterior set of entities being transformed into a posterior set,

1. Earlier Winter (1971, pp. 245-7) had written that "decision rules themselves are the economic counterpart of genetic inheritance… The assumption that firms have decision rules, and retain or replace them according to the satisficing principle, provides both genetic stability and an endogenous mutation mechanism."

2. Of course, Darwin himself did not know of Mendel's work and did not refer to "genes". The term appeared in 1909, shortly after the "mutation theory" of De Vries in 1901. The synthesis between Darwinism and Mendelian genetics occurred in the 1930s and 1940s.

where all members of the posterior set are sufficiently similar to some members of the anterior set, and where the resulting frequencies of entities are systematically related to their properties (Price, 1995; Frank, 1998; Knudsen, 2002b, 2002c).

Finally, Nelson and Winter consider the ongoing sources of variation in socio-economic evolution. For Nelson and Winter (1982, p. 180) the principal source is the firm's routine-guided search for more efficient practices in the face of adversity:

> "These routine-guided, routine-changing processes are modeled in "searches"… Our concept of search obviously is the counterpart of mutation in biological evolutionary theory. And our treatment of search as partly determined by routines of the firm parallels the treatment in biological theory of mutation as being determined in part by the genetic makeup of the organism".

Nelson and Winter thus suggest that there is something equivalent to mutation in the economy. Of course, there are important differences between natural and socio-economic evolution. Nevertheless, there are ongoing potential sources of variation in the socio-economic domain. Again Nelson and Winter allude to core similarities between the natural and the socio-economic spheres.

These quotations make it clear that Nelson and Winter's *Evolutionary Theory of Economic Change* involves not only a thoroughgoing adoption of the three key principles in Darwin's evolutionary theory but also elements of the postwar synthesis of Darwinian theory with Mendelian genetics. But this not a version of biological reductionism, in which attempts are made to derive key economic principles or phenomena from entities or principles that derive exclusively from the biological domain.[1]

On the contrary, while establishing *analogies* with entities and processes at the biotic level (such as genes and mutations), Nelson and Winter consider special units and processes that are unique to the level of economy and society. In particular, they identify the routine as the repository of generative and hereditable information (analogous to the gene), the processes that lead to new hereditable information (analogous to mutation), the firm as the vehicle that both carries and is partly moulded by its routines (analogous to the organism), and profitability as the principal indicator of the firm's potential to survive (analogous to biological fitness). In short, in developing an evolutionary theory in economics, Nelson and Winter posit repositories of hereditable information and processes of variation and selection, all of which are unique to the socio-economic domain, while being analogous to some features in biology.

The relationships and connections between *An Evolutionary Theory of Economic Change* and Darwinian theory should now be obvious. Not only are the three key Darwinian ideas central to this theoretical construction, but also within it are ideas that are equivalent to the concepts of gene, mutation and fitness, all of which are central to modern, Darwinian, evolutionary biology.

The importance and rarity of this achievement should be stressed. Although some previous authors (including Armen Alchian and Milton Friedman) applied some of Darwin's ideas to economics, the achievement of Nelson and Winter is unprecedented in its scope. As I have argued elsewhere (Hodgson, 1993), its prin-

1. Attempts at such biological reductionism in economics include G. Becker (1976), Hirshleifer (1977, 1982) and Robson (2001a, 2001b).

cipal precursor is the evolutionary economics of Thorstein Veblen, who also applied the Darwinian principles of variety, inheritance and selection to economic phenomena. Despite evolutionary credentials that are genuine in some broad sense, the same cannot be said for others, including Karl Marx and Joseph Schumpeter. They did not apply the key Darwinian principles to their economics.[1]

Two crucial questions emerge at this stage:

1. To what extent do Nelson and Winter make use of *analogies* taken from biology, or, in contrast, to what extent is their theory a *direct application* of Darwinian ideas, based on the presumption that entities in the biological and socio-economic spheres may be *sufficiently similar in some important respects*? In other words, to what extent does their theory involve mere *analogies* taken from biology, and to what extent is it based more firmly on elements that are common to the *ontologies* of both biotic and socio-economic phenomena? The use of analogy implies similarity but not identity, whereas an assertion of common ontological features involves a supposition that evolutionary processes at different levels are in some respects identical. Answering this question is not only important for understanding the nature of the Nelson-Winter approach, but also it is vital for dealing with important recent debates in evolutionary economics and evolutionary theory, and for the future development of evolutionary economics. This question will be addressed in a later section of this essay.

2. Why do Nelson and Winter (1982, p. 11) describe their theory as "Lamarckian" and fail to describe it as "Darwinian"? In fact, the only reference to Darwin or Darwinism in the entire work is in their passage quoted above (p. 9). Although their use of Darwin's three principles is obvious to the informed reader, Nelson and Winter are remarkably coy in proclaiming any Darwinian pedigree for their theory. Instead, they insist upon its "Lamarckian" character, on the grounds that "it contemplates both the 'inheritance' of acquired characters and the timely appearance of variation under the stimulus of adversity" (p. 11). We shall deal with this second question of Darwinian omission first, and relate it to the modern literature on "memetics".[2]

The proclamation that socio-economic evolution is "Lamarckian" diverts attention from the first question raised above, and discourages any discussion of the extent to which socio-economic evolution is *actually* (and not merely by analogy) Darwinian in some meaningful and significant sense. Hence the two questions raised here are related.

DARWINISM, LAMARCKISM AND MEMETICS

Before 1982, authors such as Karl Popper (1972) and Herbert Simon (1981) described social evolution as Lamarckian. After 1982, Friedrich Hayek (1988), Geoffrey Hodgson (1988), J. Stanley Metcalfe (1993) and many others did the same. These claims rest on the supposition that the inheritance of acquired cha-

1. This proposition has been the source of some published disputes. The author will be pleased to supply detailed references on request.

2. This section and section 5 below draw in part from material in Hodgson (2001a).

racters occurs in social evolution. For the reasons below, I propose that this description is valid in a restricted sense only. Furthermore, even if socio-economic evolution is Lamarckian, the possibly that it may *additionally* be Darwinian as well is rarely considered. Lamarckism and Darwinism are often posed as alternatives, whereas in key respects Lamarckism requires Darwinism as a complement.

Indeed, Darwin himself was a Lamarckian in the sense of believing in the possible inheritance of acquired characters. Even in the first edition of the *Origin of Species*, Darwin (1859, pp. 82, 137, 209) endorsed this idea. He never denied a limited role for the inheritance of acquired characters. In his later life he gave it increasing rather than decreasing attention and approval. Hence Lamarckism (in this sense) and Darwin's doctrine are not necessarily mutually exclusive. We now know that the possibility of the inheritance of acquired characters is nonexistent (or highly limited) at the level of genetic evolution. But this does not alter the Lamarckian character of Darwin's own theory.

Nelson and Winter (p. 11) also identified Lamarckism with "the timely appearance of variation under the stimulus of adversity". Darwin (1859, pp. 11, 43, 167) also believed that some variations could "be attributed to the direct action of the conditions of life" and the "external conditions of life… seem to have induced some slight variations." Again, Darwin was a "Lamarckian" in the broad sense of believing that variation could be stimulated in some way by external conditions. However, Darwin candidly admitted his ignorance of the precise mechanisms of variation, his speculations in this area were highly tentative, and some of his detailed suppositions concerning the mechanisms of inheritance have been shown to be false.

For these reasons it is not useful to define Lamarckism and Darwinism as mutually exclusive. The position opposed to Lamarckism is not the Darwinism of Darwin, but something that might more appropriately be described as neo-Darwinism or Weismannism (after the biologist who, on theoretical and experimental grounds, denied the inheritance of acquired characters). Hence three different positions can be defined in terms of the following table.

Table 1. *Definitions of Darwinism, Lamarckism and Weismannism*

Term	Definition
Darwinism	A causal theory of evolution in complex or organic systems, involving the inheritance of genotypic instructions by individual units, a variation of genotypes, and a process of selection of the consequent phenotypes according to their fitness in their environment.
Lamarckism	A doctrine admitting the possibility of the (genotypic) inheritance of acquired (phenotypic) characters by individual organisms in evolutionary processes.
Weismannism (or neo-Darwinism)	A doctrine denying the possibility of the (genotypic) inheritance of acquired (phenotypic) characters by individual organisms in evolutionary processes.

There are internal gaps in the Lamarckian theory of the inheritance of acquired characters. These apply even in the social sphere. For Lamarckian theory to be adequate, we further require an explanation of (a) what inhibits or prevents injuries or other *disadvantageous acquired characters* from being inherited, and (b) why organisms seek to adapt to their environment. Lamarckism simply as-

sumes that only *advantageous* acquired characters will be inherited. In addition, some Lamarckians (contradicting Lamarck himself) presume a voluntarism of will, but the origin of this will itself remains unexplained. A causal explanation of why organisms strive for advantage or improvement is lacking.

These gaping holes in Lamarckian theory have to be filled by a Darwinian or other explanation (Dawkins, 1983, 1986; Cronin, 1991; Plotkin, 1994). Darwinian natural selection explains how advantageous characters are favoured. Organisms seek to adapt to their environment in terms of the production of variations of genotype, leading to different behaviours, some of which involve successful adaptations.[1] Upon these varieties, natural selection does its work. Insofar as organisms are purposeful, this too has evolved through natural selection. Darwinism thus points to an evolutionary explanation of the very origin of will of purpose itself. The bottom line is this: even if acquired characters can be inherited, Lamarckism requires Darwinism as an explanatory crutch. Hence Darwinism is a more general and powerful theory than Lamarckism. If social theory can be legitimately described as Lamarckism, in the sense of admitting the possibility of inheritance of acquired characters, then this Lamarckism must be nested within a Darwinian theory (Hodgson, 2001a; Knudsen, 2001). Accordingly, Lamarckism is not an alternative to Darwinism, even in the social sphere. Lamarckism depends on a Darwinian selection mechanism to complete its explanations. If we can talk of acquired characters being inherited in the social domain, then this does not undermine the greater explanatory importance of Darwin's theory (Veblen, 1919; Campbell, 1965).

Many proponents of Lamarckian inheritance in the socio-economic domain do not consider the process of socio-economic inheritance in sufficient detail. This makes their theory open to the criticisms of David Hull (1982), who argued that Lamarckism does not apply to the social domain. For him, the processes of social evolution cannot literally involve the key Lamarckian idea of the inheritance of acquired characters. For instance, in the case of learning, this "is not an instance of the inheritance of acquired characters" (Hull, 1982, p. 278). For him, it is more like infection or contagion. Unlike a disease, learning can be beneficial, but Hull (1982, p. 309) suggests that a similar mechanism of contagion takes place:

> "a mother can transmit syphilis to her unborn child. Such transmission is congenital, not hereditary, and for this reason is no more an example of the inheritance of acquired characteristics than is the transmission of fleas".

According to modern biology, there is no feasible way in which the ideas we acquire by learning can lead to the reprogramming of *our own* biological genes. (Although ideas can, for instance, affect our choice of sexual partner and thereby influence the genes of our offspring.) Accordingly, social evolution does not involve Lamarckian processes at the individual, *biological* level, and Hull is clearly right in this respect.

1. The genotype is the genetic coding of an organism. The phenotype is its actual character, including its propensities and behaviour. The phenotype is an outcome of the genotype and the organism's environment.

But the question of whether social evolution is Lamarckian in another sense remains. When Hull criticises the idea that social evolution is "metaphorically" (or culturally) Lamarckian, he takes it for granted that the unit of cultural evolution is the idea or "meme" (Dawkins, 1976). Hull neglects other sociocultural theories – including Nelson and Winter's – that have been described as "Lamarckian". This raises the so-called science of "memetics" and its attempts to apply Darwinian ideas to socio-cultural evolution. The issues raised here are of vital importance to any evolutionary theory in the socio-economic domain, and to the clarification of Nelson and Winter's own theory.

With the "memetic" version of socio-cultural evolution in mind, Hull (1982, p. 311) argues that the inheritance of acquired ideas or memes is not an instance of the inheritance of acquired characters, because "ideas are analogous to *genes*, not characteristics". He thus rejects the notion that something like Lamarckian transmission is involved. Furthermore, for Hull (1982), the idea itself does not acquire characteristics. Hence there is no parallel to the genotype-phenotype distinction: there is no idea-genotype that helps to determine a distinguishable idea-phenotype. Given these assumptions, there is indeed a problem with the Lamarckian analogy: "In order for sociocultural evolution to be Lamarckian in a metaphorical sense, conceptual genotypes must be distinguishable from conceptual phenotypes and the two must be related in appropriate ways" (Hull, 1982, p. 309). Hence, for Hull in his 1982 paper, social evolution is in no sense Lamarckian. "At the metaphorical level, however, a consistent story can be told for sociocultural evolution being Darwinian" (Hull, 1982, p. 311).[1]

Hull's (1982, 1984) discussions of Lamarckism in the social domain are based on a narrow notion of culture as ideas or memes. Working in the same framework, Susan Blackmore (1999, pp. 61-2) rightly argues that whether memetic evolution is Lamarckian or not depends on whether it is meme-as-behaviour or meme-as-instructions that is being copied. Copying-the-product brings the possibility of inheritance of acquired modifications to the outcome, whereas copying-the-instructions does not; any alterations in behaviour or outcome will not be passed on, because it is the instructions, not the outcomes, that are being replicated.

Blackmore then goes on to argue that the transmission of some memes involves the copying of behaviour by imitation while others involve the copying of instructions. However, Blackmore does not probe more deeply into the notion and mechanics of such terms as "copying" and "instruction". Indeed, the concept of the meme is itself ambiguous. The literature on memetics suffers from some confusion concerning the casual use of "information" or "ideas" as the analogue of the gene.[2]

1. Note, however, that two years later, Hull (1984, p. lx) modified his position, accepting that when we learn from experience "sociocultural evolution is in this sense Lamarckian".

2. The contemporary enthusiasm for "memes" and "memetics" far outstrips the achieved degree of clarity and consensus concerning such core categories. A meme has been variously described as a unit of cultural imitation (Dawkins, 1976), a unit of information residing in a brain (Dawkins, 1982), units of culturally transmitted instructions (Dennett, 1995), an influential and replicable unit of information in the mind (Brodie, 1996), actively contagious ideas (Lynch, 1996), or behavioural instructions stored in brains and passed on by imitation (Blackmore, 1999), or the state of a node in a neuronal network (Aunger, 2002).

The casual identification of memes with ideas has a crucial defect. The nature of ideas and the causal mechanisms by which ideas lead to behaviour are not spelt out. It is simply assumed that one leads to the other. As a result, as I have argued elsewhere (Hodgson, 2001a), memetics is insufficiently Darwinian: it does not identify the detailed, causal mechanisms involved.

The discussion within memetics has important implications for the concept of the routine. Above all it is necessary to be absolutely clear whether a routine is a gene-like entity (or genotype) or a characteristic (or phenotype). As Hull (1982) suggests, any meaningful description of socio-economic evolution as "Lamarckian" would depend on a distinction between genotype and phenotype. But as shown below, Nelson and Winter confusingly define routines as both genotypes and phenotypes. The upshot is that we have to reconsider their definition, and make the nature of the routine and its mechanisms of inheritance sufficiently transparent.

ARE ROUTINES DISPOSITIONS OR BEHAVIOURS?

Nelson and Winter simultaneously embrace Lamarckism and describe routines as genes. But to paraphrase Hull in the terms of Nelson and Winter: routines are analogous to *genes*, not characteristics. So what are the *characteristics* that Nelson and Winter see as acquired in their avowal of Lamarckism? The answer is not clear in their 1982 book. Sometimes routines are treated as dispositions or genotypes, sometimes they are treated as behaviours or phenotypes. Sometimes both definitions are confusingly conflated. Examine their definition of routines in terms of "regular and predictable behavioral patterns" (Nelson and Winter, 1982, p. 14). Here routines are defined in terms of manifest behaviour – a phenotypic characteristic – rather than any generative rules or structures that give rise to such characteristics or behaviour. This same emphasis on behaviour is evident in the following quotation:

> "It is that most of what is *regular and predictable* about business behavior is plausibly subsumed under the heading 'routine', especially if we understand that term to include the relatively constant dispositions and strategic heuristics that shape the approach of the firm to the nonroutine problems it faces". (Nelson and Winter, 1982, p. 15.)

Note, however, as well as seeing routines as behaviour, in the very same sentence routines are described as "dispositions… that shape the approach of the firm" to problems. Routines are also treated as "organizational memory", which refers more to capabilities than to behaviour. Of course, routines are not exactly like genes. But Nelson and Winter's description of "routines as genes" would be valid if it pointed to the fact that routines are like genes in the sense that they are both generative structures or potentialities. However, routines cannot be both generative structures and outcomes of such structures. This point is not about biological analogies but the clear meanings of words and their ontological references. Another passage repeats the same error:

> "We use 'routine' in a highly flexible way, much as a 'program'… is used in discussion of computer programming. It may refer to a repetitive pattern of activity in an entire

organisation, to an individual skill, or, as an adjective, to the smooth uneventful effectiveness of such an organisational or individual performance". (Nelson and Winter, 1982, p. 97.)

There is a difference between a computer program and the computer's output or behaviour. The computer program is genotypic, because it is the generative coding that, along with other inputs, determines the computer's (phenotypic) output or behaviour. Yet in the above quotation Nelson and Winter conflate (genotypic) factors such as the computer program or "an individual skill" with (phenotypic) factors such as a "repetitive pattern of activity" or "individual performance".[1]

Unless due care is taken, the distinction between genotype and phenotype can be corroded. This corrosion is evident in Nelson and Winter's definition of a routine. But it is not only issues from biology that are important here. Insights from the philosophy of science are also relevant. Modern philosophy of science is predominantly realist in its inclination. Central to most strands of modern realist philosophy is the distinction between the *potential* and the *actual*, between dispositions and outcomes, where in each case the former are more fundamental than the latter. This distinction is traceable back to Aristotle. Science is about the discovery of causal laws or principles. Causes are not events; they are generative mechanisms that can under specific conditions give rise to specific events. For example, a force impinging on an object does not always make that object move. The outcome also depends on friction, countervailing forces, and other factors. Causes relate to potentialities; they are not necessarily realised in outcomes. The genotype is a generative mechanism; it is part of the causal apparatus that determines (phenotypic) outcomes and behaviour. Hence there must be a distinction between an observed empirical regularity and any causal law that lies behind it.[2]

Genes and genotypes are wholly potentialities; they are not behaviours. In the socio-economic domain, the closest thing to genotypes are the generative rule-like structures inherent in ingrained individual habits and in organisational routines. Habits and routines are thus understood as conditional, rule-like potentialities or dispositions, rather than behaviour.

A complication arises because biologists also regard behavioural dispositions as part of the phenotype, along with actual behaviours. Hence we must be careful in applying the genotype-phenotype distinction to the socio-economic domain. In biology there are not two but three layers or categories: first, the genotype; second the behavioural dispositions; and third the actual behaviours. Put in this way, there is nothing in the socio-economic domain that strongly corresponds to a gene or genotype. As imperfect options, habits and routines are the closest thing to genotypes in the socio-economic sphere, but they are essentially behavioural dispositions. So the key distinction in the socio-economic sphere is between habits and routines as dispositions, on the one hand, and manifest behaviour, on the other hand.

1. Note that Nelson and Winter later regretted their association of routines with individuals and insisted that they were essentially organisational phenomena: "In our view, clarity would be served by reserving the term 'skills' to the individual level and 'routines' to the organizational level." (Dosi, Nelson and Winter, 2000, p. 5)

2. For realist accounts upholding a distinction between generative mechanisms or causal powers, on the one hand, and outcomes or events, on the other, see for example Bhaskar (1975), Harré and Madden (1975), Popper (1990).

In this light, the Nelson-Winter emphasis on the allegedly *predictable* character of routines is misplaced. Predictions relate to outcomes or events, not to causal laws, rules or generative structures. The moderately dependable feature of a routine, rule or computer program is not one of predictability but of durability. Routines (or rules or computer programs) are usually conditional on other inputs or events. As a result any predictability does not stem from the routine alone but from the predictability of these other inputs. For example, a firm may have a fixed mark-up pricing routine of adding 20 per cent to the unit costs of its products. But if costs were capricious and highly variable, then the resulting price would be equally unreliable. The relatively enduring and persistent quality of a routine is not its outcome but its generative rule-like structure.

The problematic conceptual status of routines in Nelson and Winter's theoretical paradigm has become a central difficulty for the theoretical tradition that takes inspiration from their work.[1] As Michael Cohen and Paul Bacdayan (1994, p. 556) remark, since Nelson and Winter have drew widespread attention to the concept of a routine, "very little advance" has been made in its further development. The important contribution of Cohen and Bacdayan was to help to ground the concept of routine further on theoretical and empirical insights, principally from psychology.

The complementary attempt here to clarify and refine the concept of a routine rests principally on the genotype-phenotype distinction taken from biology and clarified by modern realist philosophy of science. Its key distinction is between an actuality and a potentiality. Winter (1995, pp. 149-50) himself distinguishes between a "routine in operation at a particular site… a web of coordinating relationships connecting specific resources" and the "routine *per se* – the abstract activity pattern". But the one term "routine" cannot apply to both the "web of coordinating relationships" and the "activity pattern" that is the outcome of the coordinating structure and its environmental triggers; it cannot usefully denote both potentiality and actuality. It has to denote one or the other, but not both.

The choice taken here is to define a routine as a generative structure or potentiality of some kind. Having defined routines in terms of potentialities, as generative structures, the enormous task remains of considering their mechanisms of endurance and inheritance. Winter (1990, p. 270) himself emphasised the importance of this effort, noting that so far "little attention has been paid to the mechanism by which whatever-it-is-called is transmitted" and to its "replication mechanism". For Winter (1990, p. 294 n.) this amounts to a regrettable "vagueness on a key issue". As Winter (1990, pp. 270-5) insisted: "The question of what is 'inherited' and how the inheritance mechanisms works is, however, … central and… far from definitive resolution… To develop the routines as genes approach fully, the problem of inheritance mechanisms needs to be dealt with convincingly."

To their credit, both Nelson and Winter are now more inclined to describe the routine in gene-like terms. Nelson and Winter (2002, p. 30) write: "we treat *organizational routine* as the organizational analogue of individual skill." Nelson (2002) writes that "if you were to force me to choose, I would propose that my routine concept is more like a gene than like a physical trait or behavior". Winter

1. For discussions of some of these difficulties see Cohen *et al*. (1996), M. Becker (2001) and Lazaric (2000).

(2002) concurs that "the fundamental theoretical status of a routine is (corresponds to?) that of a genotype".

Accordingly, rather than behaviour, a routine is a generative structure of conditional, rule-like mechanisms. As Barbara Levitt and James March (1988, p. 320) put it: "The generic term 'routines' includes the forms, rules, procedures, conventions, strategies, and technologies around which organizations are constructed and through which they operate." Another useful definition of a routine as a potentiality or capability, rather than behaviour, is found in the discussion in Michael Cohen *et al.* (1996, p. 683) "A routine is an executable *capability* for repeated performance in some *context* that [has] been *learned* by an organization in response to *selective pressures*."

Some small steps in the desired direction of clarifying the mechanisms of inheritance and operation of routines are attempted a later section of the present article. In the meantime it is necessary to legitimate the appropriate analytical strategy for dealing with the routine. This intermediate step is the subject of the next section.

DARWINISM: FROM ANALOGY TO ONTOLOGY

We now address the first question concerning Nelson and Winter's approach, as raised above: to what extent does it rely on *analogies* taken from biology, and in contrast to what extent does their theory depend on a *direct application* of core Darwinian ideas that apply to both socio-economic and natural evolution?[1]

Nelson and Winter refer to their own use of "analogies" taken from modern biology. Also they rightly and repeatedly warn that key mechanisms at the biological level are different from those found in socio-economic systems. Clearly, analogies have to be handled with care because at the level of detailed mechanisms, features that are found in one sphere can be different in key respects from those found in another. For instance, routines are like genes in that they store information. But their longevity and their mechanisms of replication are very different from those of genes. They make imperfect copies of themselves, compared with the high fidelity of the reproduction of segments of DNA. Socio-economic selection is not principally from generation to generation but also within the life of socio-economic units. Furthermore, the environment of socio-economic selection is often changing rapidly, compared with the long and often more stable epochs in which most selection in nature takes place. The use of the gene analogy does not give us licence to treat a routine in all or most respects like a gene.

But what is largely underdeveloped is the insight that, underneath the very real differences of character and mechanism, biological evolution and economic evolution might have types of process or structure in common, *when considered at a sufficiently general level of abstraction.* At this level, we are not addressing mere analogy. We are considering a degree of identity in reality. The question is whether the appropriate social and natural ontologies share sufficient features in common at some fundamental level. If so, we have to extract and examine these

1. The ideas in this and the succeeding section are presented at greater length in Hodgson (2002).

features. These identical types of process or structure will be far from enough to explain everything. But nevertheless they will point to common concepts or mechanisms, such as those at the core of Darwinism. They will not themselves provide us with a complete theory of evolution relevant to the socio-economic domain, but with an essential, general scaffolding within which other necessary and specific features must be assembled.[1]

Consider Nelson's and Winter's deployment of the general Darwinian concepts of variety, inheritance and selection. At least in these abstract terms, these are not mere analogies. Variety in the economic sphere is real. Of course, there are differences between the economic and biotic realms concerning the composition and generation of this variety. But one thing that distinguishes the Nelson-Winter theory from much mainstream economics is its ontological commitment to a world of varied institutions.[2]

Consider inheritance. When routines pass on their characteristics through time, or to embryonic routines in other organisations, such characteristics are actually inherited. The analogy of the routine with the gene is acknowledged as highly imperfect, but nevertheless routines and genes are identical in the limited but important respect that they both have the capacities to store through time and pass on some kind of generative information to other entities. At least at that abstract level, inheritance is part of both underlying ontologies.

Likewise, selection is real, in both the natural and the economic domain. Some firms have the greater potential to survive than others. It is the same with natural organisms. In looking to biology, Nelson and Winter did not merely make useful *analogies*. They also pointed to *ontological commonalities*. Winter (1987, p. 617) himself has made this explicit:

> "In sum, natural selection and evolution should not be viewed as concepts developed for the specific purposes of biology and possibly appropriable for the specific purposes of economics, but rather as elements of the framework of a new conceptual structure that biology, economics and other social sciences can comfortably share".

In their commitment to these fundamental precepts and commonalities, Nelson and Winter have reached the point of no return. Twenty years ago they extracted this ontological core, but they failed to describe it properly by its Darwinian name. Some reticence is understandable, given the abuse of biology in the social sciences in the past. But such caginess and "Lamarckian" mis-labelling have helped to impair the further exploration of the strategy to which they were implicitly committed.

Developments in theoretical biology, evolutionary anthropology and elsewhere in the last twenty years make the next step unavoidable. This is to engage with the literature on "Universal Darwinism" in general and its particular extension to "memetics" in particular. This involves a critical discussion of works by Richard Dawkins (1983, 1986), Henry Plotkin (1994), Daniel Dennett (1995) and others. I hope to demonstrate that this engagement can be critical, useful and constructive. In particular, it can even help us to clarify the Nelson-Winter concept of a routine.

1. See the extended discussion of the relationship between general and specific theorising in Hodgson (2001b).

2. See also, for example, Nelson (1991, 1995).

UNIVERSAL DARWINISM

The idea of Universal Darwinism is not new. A number of early thinkers, including Walter Bagehot (1872), William James (1880), David Ritchie (1896), Charles Sanders Peirce ([1898] 1992), Thorstein Veblen (1899, 1919), and James Mark Baldwin (1909) argued that the Darwinian principles of natural selection apply not simply to biology but also to mental, epistemological, moral, social or even cosmic evolution. They believed that Darwinism had a wider application than to biology alone. Later Donald Campbell (1965) argued that Darwinism contained a general theory of the evolution of all complex systems. Campbell (1965, p. 24) made the point that the appropriate analogy for social evolution is not biotic evolution, but the more general processes of evolution of complex systems "for which organic evolution is but one instance". Subsequently, Richard Lewontin (1970) also suggested that the domain of application of Darwinian theory could be broadened from biology.[1]

Dawkins (1983) later coined the term "Universal Darwinism". Dawkins argues that if life existed elsewhere in the universe, it would follow the Darwinian rules of variation, inheritance and selection. Even if there were a very different system of replication, including one that allowed the "Lamarckian" inheritance of acquired characters, a coherent account of the evolutionary process would still require the key elements of the Darwinian theory. As long as there is a population with imperfect inheritance of their characteristics, and not all of them have the potential to survive, then Darwinian evolution will occur. Significantly, Gary Cziko (1995) describes the acknowledgement of such a "universal selection theory" as "the Second Darwinian Revolution".

As such, Darwinian evolution is not tied to the specifics of genes or DNA. On Earth, DNA has the capacity to replicate. But other mechanisms of replication or inheritance may exist, on this planet and elsewhere. One possible and relevant example is the propensity of human beings to communicate, conform and imitate, making the replication or inheritance of habits and ideas a key feature of human socio-economic systems.

"Universal Darwinism" is not a version of biological reductionism or "biological imperialism" where an attempt is made to explain everything in biological terms. The existence of Darwinian mechanisms also does not mean that the process involved is always that of *genetic* variation and selection. On the contrary, Universal Darwinism upholds that there is a core set of general Darwinian principles that, *along with essential and auxiliary explanations specific to each scientific domain*, may apply to a range of phenomena. Universal Darwinism encompasses a wide range of possible mechanisms. But they would share the common features of variation, inheritance and selection.

1. Commons (1934) and others have objected to the application of Darwinian principles to socio-economic evolution on the grounds that what is relevant in this domain is not "natural selection" but "artificial selection". Elsewhere I reject this objection, partly on the grounds that artificial selection is a special case of, rather than an alternative to, natural selection. Artificial selection is natural selection where intention and choice are important in the selection process. The evolution of intention and choice has also to be explained (Hodgson, 2002, 2003, forthcoming). See also Dennett (1995, pp. 316-17).

As a result, Universal Darwinism is not a monolithic doctrine in the manner of the "economic imperialism" of economists such as Gary Becker (1976) or Jack Hirshleifer (1982). Such "imperialisms" involve the claim that a wide range of phenomena can be explained *completely and exclusively* in terms of a single set of principles. By leaving an opening for domain-specific, auxiliary explanations, Universal Darwinism does not necessarily involve such a claim.

Darwin (1859, pp. 422-3; 1871, vol. 1, pp. 59-61) himself suggested that "the struggle for life" might be going on among such entities as the words and grammatical forms of human language, as well as among organic life. Another example of the extension of the principle of "natural selection" is the proposal of William James (1880) that ideas themselves are passed on and produce random variations, upon which social and natural circumstances select the survivors. Such a notion is now familiar to us in the form of the "evolutionary epistemology" of Karl Popper (1972), Donald Campbell (1974) and others. The ideas of "neural Darwinism" pioneered by Gerald Edelman (1987) also fit within the framework of "Universal Darwinism". Furthermore, as Plotkin (1994, chap. 3) points out, in the immune system there is selection process working on a regenerating variety of replicating units, be they lymphocytes (in the evolution of the immune system) or neural connections (with neural Darwinism). Computer viruses also replicate and evolve (Aunger, 2002). These are cases not merely of analogy, but of the existence of processes that are *actually* evolving in accord with basic Darwinian principles of variation, inheritance and selection.

Despite his reputation as a genetic reductionist, the work of Dawkins, as if against himself, opens the door to multiple-level selection theory. Even in his famous book *The Selfish Gene*, Dawkins (1976) proposed a second level of selection operating at the human level: the "meme". Accordingly, in two important essays, Hull (1980, 1981) "argued that in spite of himself Dawkins had made an important contribution to a hierarchically expanded Darwinism" (Depew and Weber, 1995, p. 384).

Likewise, in his approving discussion of Universal Darwinism, Plotkin (1994, p. 101) himself proposes "a hierarchically structured evolutionary theory" in which there are different units of selection at each level. Plotkin's (1994, p. 176) rejects the notion that evolution at a higher level can be explained entirely in terms of evolutionary processes at a lower level. For example, two individuals with identical genes can evolve very different neural networks. Even slight differences of environmental stimuli can lead to substantially different neural configurations. Brain development is a path dependent process, affected by each unique personal history. Darwinian mechanisms operate at the neural level but their units of selection are not genes (Edelman, 1987).

Consequently, the question of the adequacy or otherwise of "biological analogies" is not the fundamental question, as all social systems are subject to essential evolutionary principles by virtue of the existence of variety, inheritance and selection. In particular, by recognition of the ontological priority and replenishment of variety in both natural and social systems, Darwinian "population thinking" is also relevant for social scientists (Mayr, 1982; Metcalfe, 1998). Accordingly, even if the detailed mechanisms of change at the social level are quite different from those described in biology, *socio-economic evolution is still Darwinian in several important senses.*

However, while all open, complex, evolving systems may be subject to a core set of Darwinian principles, the notion of Universal Darwinism itself provides no alternative to a detailed explanation of the particular emergent properties and processes at the social level. Acceptance of Universal Darwinism does not provide all the necessary causal mechanisms and explanations for the social scientist, nor obviate the elaborate additional work of specific investigation and detailed causal explanation in the social sphere (Hodgson, 2001b).

Neither Universal Darwinism nor the theory of natural selection can give us a full, detailed explanation of evolutionary processes or outcomes. At the centre of Darwinism there is a rigorous theory, but it explains little on its own and it is thus placed in the context of a mass of empirical material (Hull, 1973, pp. 3-36). Darwinian principles cannot themselves provide a detailed explanation of why humans stand upright, or why a bird's plumage is a particular colour. Instead, Darwinian principles provide a general explanatory framework into which particular explanations have to be placed. For example, in some cases an unobtrusive appearance may be explained for reasons of camouflage; while in some birds, bright and colourful plumage is there to attract a mate. Darwinian biology invokes explanations in which the theory of natural selection is part of the over-arching and organising theoretical method and framework.

Far from being irrelevant to economics, multi-level evolutionary explanations are also necessary for the social sciences (Hodgson, 2001b, forthcoming). It is possible that some of the reaction against "biological analogies" is grounded on a mistaken view that theories operate on one level only. The concern is that the invocation of such analogies necessarily means a slavish copying of every detail of biological evolution. On the contrary, Darwinian evolution shares common ground with economics at a much higher level of abstraction, as a result of the fact that both biology and the social sciences address evolving systems. Accordingly, part of the relevance of Darwinism for economics is at a less detailed and more abstract level, concerning the general relevance of variation, inheritance and selection.

To recapitulate, Darwinism includes not only specific theories that explain particular biological mechanisms, but also a general theory that applies to all open, complex and evolving systems where there is inheritance, variation and selection, with possible differences in the detailed mechanisms involved. Accordingly, Darwinism has some unavoidable importance, at the general theoretical as well as the specific analogical and metaphorical levels (Hodgson, 2001c, forthcoming).

Accordingly, blanket dismissal of all "biological analogies" without recognition of the differences between the different aspects and levels of Darwin's thought is misleading. We have to be careful with biological analogies because of the detailed differences between the types of evolutionary mechanism applying to the socio-economic and to the natural domains. But society and nature also have things in common. The power of Darwinism is that it applies to all evolving and complex systems with variety, inheritance and selection. Accordingly, some general aspects of Darwinian theory would seem to apply to society as well as nature. As noted above, Winter (1987, p. 617) appears to accept this idea.

WHAT IS REPLICATION AND WHAT ARE THE REPLICATORS?

Having laid out the conditional possibility of Universal Darwinism, we now have to consider the meaning of inheritance or replication.[1] Universal Darwinism applies only to systems exhibiting such characteristics; hence in refining these terms we both clarify Universal Darwinism and probe its limits. Clearly, if Darwinian ideas are applied to the social as well as to the natural world then concepts such as replication or inheritance have to be carefully defined in both spheres. The detailed processes of replication are different. If one term is to be applied in both areas then it must be defined fairly broadly, but not too broadly or imprecisely to risk a loss of meaning.

Hull (1990, p. 408) defines a replicator as "an entity that passes its structure largely intact in successive replications." The idea of replication has become pervasive, including in memetics. However, as noted above, meme enthusiasts cannot agree on what a meme is. If a meme is a replicator then what structure is passed on? This analytical problem leads sceptics such Dan Sperber to probe the meaning of replication and to suggest that it involved elements of causation, similarity, information transfer and duplication. He then argues that many cases of so-called memetic replication are not true replication and that the "grand project of memetics… is misguided" (Sperber, 2000, p. 173).[2]

Peter Godfrey-Smith (2000) offers another useful refinement of the replicator concept. (He is also sceptical of versions of cultural evolution based on the meme). For Godfrey-Smith (2000, p. 413): "The… job of explaining *the heritability of variation,* in the sense relevant to evolution by natural selection… is the proper one for the replicator concept." Godfrey-Smith then (2000, pp. 414-15) constructs the following definitions:

> "Y is a *replicate* of X if and only if: (i) X and Y are similar (in some relevant respects), and (ii) X was causally involved in the production of Y in a way responsible for the similarity of Y to X. Replication is any process by which a replicate is produced".

It is notable that Godfrey-Smith's definition requires similarity "in some relevant respects", but does not specify what is "relevant". In an innovative volume, Robert Aunger (2002) refines Sperber's (2000) definition of replication. He argues that in general, replication is a relationship between a copy and some source exhibiting the following characteristics:

• *Causation:* the source must be causally involved in the production of the copy

• *Similarity:* the copy must be like its source in relevant respects

• *Information transfer:* the process that generates the copy must obtain the information that makes the copy similar to its source from that same source; and

• *Duplication:* during the process, one entity gives rise to two (or more).

1. Anger (2002) treats replication as a special case of inheritance that involves copies that *coexist* for a while. We need not dwell on this distinction here.

2. Note also the statement by Godfrey-Smith (2000, p. 405) that the Dawkins-Hull concept of replication "has two main elements, a *resemblance* between copy and copied, and some suitable *causal* relation linking the copy to the copied." In adopting the essentials of this concept, we need not follow Dawkins and also attribute to the replicator any powers of agency or selfishness.

For Aunger, the first condition (causation) implies no more than that the original replicator must participate in the process that results in the appearance of its copy. The fourth criterion (duplication) – added by Aunger to Sperber's definition – is a feature of replication that is not necessarily found in other forms of inheritance. In other words, according to Aunger, replication is special a type of inheritance where duplication is involved. Note also that Aunger's definition requires similarity "in relevant respects", but again does not specifying what is "relevant".

On the basis of these four criteria, Aunger argues at length that the salvation of the memetics project lies in his notion of "the electric meme", referring to neurons and electrochemical connections in the brain. Aunger regards a meme as essentially the state of a node in a neuronal network capable of generating a copy of itself in either the same or a different neuronal network, without being destroyed in the process. Acts of communication between people lead to neural nodes replicating their state from one brain to another.

Part of the problem with the original meme concept is that it referred to ideas, not to material entities or structures, without enough consideration of the material substrate of the "information" in the meme or of the physical mechanisms of replication. Aunger's dramatic reworking of the meme concept overcomes these limitations. However, he ends up with something that may be highly unpalatable to meme enthusiasts. The original notion of memes as replicating, gene-like ideas is essentially abandoned.

If an idea is communicated from one person to another, then there is no guarantee that the sub-structures of neural states relating to the communicated idea, in the brains of the receiver and the sender will be similar. The idea may take hold in the brain of the receiver on the basis of an entirely different sub-structure of neural states. The idea is communicated, but there is no necessary or likely replication of neural structures. By driving the meme concept into the neuron, Aunger moves away from the communication and cultural transmission of identifiable ideas, which memetics originally attempted to address. Instead he focuses on the replication of neural states. Aunger rightly insists that replication involves similarity and locates it in the neural domain. Any necessary similarity at the level of ideas is abandoned. Aunger's sophisticated but disturbingly radical refinement of memetics may well procreate viruses of doubt that eventually undermine the whole memetics project.

Being deeply uneasy about the very idea of a meme, I propose here a different approach. Instead of memes, I propose two alternative and mutually related concepts: habits and routines. We can learn from the debates and difficulties within memetics and give these alternative ideas greater meaning and refinement.

Habits are formed through repetition of action or thought. They are influenced by prior activity and have durable, self-sustaining qualities. Habits are the basis of both reflective and nonreflective behaviour. But habit does not mean behaviour; it is not itself a recurrent or repeated act. On the contrary, the meaning of habit adopted by Veblen, the pragmatist philosophers and instinct psychologists was of an acquired propensity or disposition, which may or may not be actually expressed in current behaviour. If we acquire a habit we do not necessarily use it all the time. It is a *propensity* to behave in a particular way in a particular class of situations. "The essence of habit is an acquired predisposition to *ways* or modes of response" (Dewey, 1922, p. 42). Crucially, we may have habits that lie

unused for a long time. Habits are submerged repertoires of potential behaviour; they can be triggered by an appropriate stimulus or context. Veblen and the pragmatist philosophers saw habit as something that may exist even if it is not manifest in behaviour. For the human agent, habits are themselves means of higher deliberation and conscious resolve.[1]

How are habits replicated? Unlike the replication of DNA or computer viruses, habits do not directly make copies of themselves. Instead they replicate indirectly, by means of their behavioural expressions. They can impel behaviour that is consciously or unconsciously followed by others, as a result of incentive or imitation. It is possible, but not always necessary, that codifiable rules or instructions are also involved. Eventually, the copied behaviour becomes rooted in the habits of the follower, thus transmitting from individual to individual an imperfect copy of each habit by an indirect route.

The replication of habits satisfies Godfrey-Smith's (2000) definition and all four of Aunger's (2002) criteria for replication. The habit in one person *causes* behaviour that is copied and leads to similar habits being acquired. The acquired habit is *similar* to the first with respect to the behaviour it might promote under specific conditions. Some kind of tacit or other *information* is transferred in the process. And because copying of behaviour is involved, *duplication* is also present.

Note, however, that unlike the gene and Aunger's neuron state or "electric meme", the similarity applies to the manifest behaviour that derives from the habit. There is no necessary similarity in the neural configurations or psychological states of the individuals involved, upon which the two similar habitual behaviours may emerge. Neural similarity may or may not exist. But behavioural similarity must exist, for it to be meaningfully described as a similar habit. In other words, essential similarity exists at the phenotypic and behavioural rather than the genotypic level. In a sense, phenotypic similarity is generally more important for any replicator because selection acts on phenotypes rather than genotypes. Substantial phenotypic similarity through replication is necessary for natural selection to work in a consistent way.

For this reason, focusing on similarity at the neural level could be misleading. Gene replicators can be successful only insofar as their genotypes give rise to successful phenotypes. In the case of genes, some degree of phenotypic similarity is achieved as a result of similarity at the genotypic level. In contrast, habits obtain phenotypic similarity by virtue of their indirect mode of replication, which works through communication at the phenotypic level alone.

Similar and important differences between the replication of genes and of habits also apply, as argued below, when we compare the replication of genes with routines. The crucial point is that in the case of the habit and the routine, the replicative criterion of similarity applies not to the genotype but to the phenotypical aspect of behaviour. In contrast, with genes, replicative similarity applies to the genetic coding, which can give rise to a significant degree of similarity at the phenotypic level as well.

1. Dewey (1922) emphasised repeatedly that habit is an acquired disposition or propensity. The conception of a habit as a propensity is also found in works such as Camic (1986), James (1890), Margolis (1994), Murphy (1994) and others.

In socio-economic evolution, this raises the question whether we should move the concept of the replicator from the habitual disposition to the expressed behaviour? In response, I would argue that while the behaviour is causally implicated in the replication of habits (and routines) both the behaviour and how it is perceived have also to be causally explained. To do this, we must look at the generative and psychological structures that cause behaviour. We must also consider the processes of cognition of the behaviour of others. Generative structures of some kind are required not only to cause the behaviour, but also to cause the copying and the interpretation of the behaviour. Behaviours cannot exist and are not copied without these generative structures. For these reasons it is desirable to identify the replicator with underlying generative structures and habitual dispositions.

Habits are acquired and imprinted instruction systems in an individual, made up of elements that direct its behaviour or growth. A Lamarckian possibility emerges here because the replication of habits proceeds by the replication of behaviour, rather than of the particular "software" of the habits themselves. Because the replication of habits works partly through the phenotypic and behavioural level, any additional behavioural characteristics that do not relate to the original habit might also be transmitted to the receiver. Hence with habits, acquired characters can be inherited. The reason is simple: habit replication itself works through characteristics, not through the direct replication of the generative structures.

However, while a Lamarckian *possibility* exists in social and cultural evolution, too much interference into "genotypic" habits by phenotypic behaviours would disrupt any beneficial selection process. Efficacious selection cannot occur if there is too much incidental "noise" created by the interference of phenotypes (Maynard Smith and Szathmáry, 1999; Knudsen, 2002a). Consequently, we should look in for mechanisms that maintain some fidelity in the "genotypic" replication of dispositions and rules in social evolution. If there is too much mixing or interference with replicators, then meaningful replication will not take place. This may be the case with at least some "memes". If replication is not meaningful, then "Universal Darwinism" does not apply.

However, there is remarkable evidence from cultural anthropology (Todd, 1985) and cultural history (Fischer, 1989) – redolent of earlier work by William Graham Sumner (1906) – that points to the remarkable persistence and replication of (often tacit) social codes and norms of behaviour. Furthermore, Michael Hannan and John Freeman (1989, pp. 22-3) argue that Lamarckian processes are unimportant in the population ecology of social organisations. According to them, selection takes places around deeply embedded and durable rules. Whether meaningful replication exists in socio-economic evolution is an empirical question, and invites further empirical and theoretical research.

We may briefly consider two possible types of mechanism by which habit may be replicated. The first is by incentive or constraint. These can provide reasons to acquire specific customs, follow particular traffic conventions and use specific linguistic terms. In these cases, because others are acting in a particular way we can have powerful incentives to behave accordingly. In doing so, we too build up habits associated with these behaviours. The behaviours are reproduced and also the habits giving rise to them are replicated.

Another possible mechanism is imitation. Imitation need not be fully conscious, and it will also involve some "tacit learning" (Polanyi, 1967; Reber,

1993; Knudsen, 2002a). Perhaps imitation can occur even without strong incentives, on the grounds that the propensity to imitate is instinctive, and this instinct has itself evolved for efficacious reasons among social creatures (James, 1890; Veblen, 1899; Campbell, 1975; Boyd and Richerson, 1985; Simon, 1990; Tomasello, 2000). However, an imitation instinct would require an existing set of common behaviours in the group, otherwise an emerging propensity to imitate might not have a selection advantage. For instinctive imitation to take off, common behaviours may have to emerge for other reasons. Furthermore, if imitation is more than mimicry, then the rules and understandings associated with it also have to be transmitted. Imitation is more problematic than it appears (Aunger, 2002). Nevertheless, there are provisional grounds to consider a partially instinctive propensity to imitate as a strong element in the complex social glue, and hence a force behind the replication of habits.

Like any replicator, habits do not stand alone. Genes require organisms to carry them, and these organisms are dependent on their environment. Genes exist on a biochemical substrate. Likewise, habits cannot exist apart from the human organisms in which they reside. They exist on a psycho-neural substrate; it is the individual human nervous system that they are formed and stored. They depend upon stimuli from the social environment. They are not unique in this respect. But habits differ from genes in their mechanism of replication, and habits do not have the potential durability and copying fidelity of the gene. In social evolution there are additional mechanisms to supplement habit replication, which often weed out or alter aberrant habits. Mechanisms of social conformity are particularly important (Henrich and Boyd, 2001). If people have incentives to conform and disincentives to rebel, then these mechanisms can partially overcome the copying infidelities of habit replication.

REPLICATING ROUTINES

We turn again to routines. A consensus has now emerged that routines relate to groups or organisations, whereas habits relate to individuals. Individuals have habits; groups have routines. I propose, therefore, to regard routines as the organisational analogue of habits. I do not refer here to habits that are simply shared by many individuals in an organisation or group. Routines are not habits: they are organisational meta-habits, existing on a substrate of habituated individuals in a social structure. Routines are one ontological layer above habits themselves.

To understand how routines work it is necessary to consider how any tacit or other information associated with a routine is preserved and replicated. A useful study in this regard is by Cohen and Bacdayan (1994). They use the distinction in psychology between procedural and other, more cognitive forms of memory, such as semantic, episodic or declarative memory. As psychologists Endel Tulving and Daniel Schacter (1990, p. 301) put it:

> "The domain of procedural memory is behavior, whereas that of semantic and episodic memory is cognition or thought. Cognitive memory systems have the capability of modelling the external world – that is, of storing representations of objects, events, and relations among them – whereas procedural memory does not have this capacity".

Procedural memory is triggered by preceding events and stimuli. It typically leads to behavioural responses and has a major tacit component. It is potential action that is energised by social or other cues. "Procedural knowledge is less subject to decay, less explicitly accessible, and less easy to transfer to novel circumstances" (Cohen and Bacdayan, 1994, p. 557).[1]

Routines depend upon a group of individuals, each with habits of a particular kind, where many of these habits depend upon procedural memory. The behavioural cues by some members of a structured assembly of habituated individuals triggers specific habits in others. Hence various individual habits sustain each other in an interlocking structure of reciprocating individual behaviours. Together these behaviours take on collective qualities associated with teams. But both individuals and structures are involved throughout. The organisation or group provides a social and physical environment for each individual. This environment is made up of the other individuals, the relations between them and the technological and physical artefacts that they may use in their interactions. This social and physical environment produces cues which can trigger behaviours, which in turn help can trigger the behaviour of others, perhaps produce or modify some artefacts, and help to change or replicate parts of this social and physical environment.

Partly because of procedural memory, organisations can have important additional properties and capacities that are not possessed by individuals, taken severally. The organisation provides the social and physical environment that is necessary to cue individual habits and deploy individual memories. If one person leaves the organisation and is replaced by another, then the new recruit may have to learn the habits that are required to maintain specific routines. Just as the human body has a life in addition to its constituent cells, the organisation thus has a life in addition to its members.

A routine derives from the capacity of an organisation to energise a series of conditional, interlocking, sequential behaviours among several individuals within the organisation. Cohen and Bacdayan (1994, p. 557) write: "The routine of a group can be viewed as the concatenation of such procedurally stored actions, each primed by and priming the actions of others." This statement captures the dependence of routines on procedural memory, but is somewhat ambiguous concerning the genotypic or phenotypic status of a routine.

As argued above, routines are not behaviour; they are stored behavioural capacities or capabilities. These capacities involve knowledge and memory. They involve organisational structures and individual habits which, when triggered, lead to sequential behaviours. Consider a firm in which all employees and managers work between 9am and 5pm only. During this working day a number of organisational routines can be energised. At other times the firm is inactive. But the routines do not all disappear at 5pm, to reappear mysteriously the next day. The routines-as-capacities remain. They can be triggered the next day by appropriate stimuli.

Routines are to be understood as like genotypes; they are dispositions or capabilities. But this does not mean that a routine can be fully codified. Routines are not necessarily nominal, codified or officially approved procedures. Routines

1. See also Bonini and Egidi (1999).

generally rely on informal and tacit knowledge, and this fact is clearly relevant for understanding their replication.

The temporal durability of routines and the way that they can embody knowledge "forgotten" by individuals is illustrated by an anecdote related by Elting Morison (1966). A time-and-motion expert was studying film footage of Second World War motorised artillery crews. He was puzzled by a recurring three-second pause just before the guns were fired. An old soldier also watching the film suddenly realised that the three-second pause had originated from the earlier era in which the guns were drawn by horses, and the horses had to be held and calmed in the seconds just before the guns went off. Despite its eventual redundancy, this part of the routine had survived the transition from horse-driven to motorised artillery. Part of the knowledge held in a routine can become obsolete, yet still be reproduced, like the examples of "rudimentary organs" discussed by Darwin (1859, pp. 450-8).

Just as habits replicate from individual to individual, routines replicate from group to group and from organisation to organisation. In studies of technological diffusion, organisation studies, and the strategic management literature there is some discussion of the diffusion or replication of routines (DiMaggio and Powell, 1983; Hannan and Freeman, 1984, 1989; Lazaric and Denis, 2001; Levitt and March, 1988; Rogers, 1995; Stinchcombe, 1990; Szulanski 1996, 2000; Zucker, 1987). Prominent mechanisms for the replication of routines involve the movement of employees from organisation to organisation, or independent experts or consultants that help to transfer knowledge and experience gained in one context to another. The above authors cite case studies involving the transfer of technologies, management procedures, corporate multidivisional structures, accounting conventions and much else. What is central to these transfers is the replication of practices and organisational relationships. What is generally critical is the capacity of the receiving organisation to accommodate and utilise these practices and relationships in the context of its own ingrained culture of habits and beliefs.

In some respects the replication of routines may be more difficult than the replication of habits from individual to individual. Take the mechanism of imitation. Among individuals, any evolved capacity to imitate others must involve the ability to sense the more significant actions, and the tacit rules and meanings associated with behaviour. This capacity would have evolved over millions of years. By contrast, complex organisations are extremely recent in human history. Many organisations may have evolved only limited capacities to discern and prioritise the important rules and meanings. It is likely that replication through imitation is even more difficult with (and at the level of) organisations than it is with individuals.

Nevertheless, as noted in the organisation studies literature, many examples of successful routine replication exist. They typically involve the combination of codifiable information and instructions with extensive personal example, advice and contact, where the receiving organisation has sufficient plasticity to usefully absorb and accommodate the routine. Sometimes routines are spread as a result of laws or rules that emanate from a third organisation, such as the state or an association of employers. Otherwise the replication of routines can occur as the result of the strategy of its receiving organisation, or it can result from lower-level contact, stimulation and imitation. Do these processes exhibit the four cri-

teria of causation, similarity, information transfer and duplication, and thus qualify as true replication? All these features are there. Causal involvement is also present, because the new routine would not be created without the existence of that from which it was copied. Routines replicate, and they do so on a substrate of organised and habituated individuals.

CONCLUSION

The results of this discussion and comparison of genes, memes, habits and routines are summarised in table 2. Note that two versions of the meme concept are considered. Instead of the meme, the linked concepts of habit and routine are promoted here. Human cultural and institutional evolution works on not two levels but three: on human genes and instincts; on individual habits; and on institutional structures and routines. Evolution on the third level is unique to the human species.

There are several threads in this essay. The novelty and importance of Nelson and Winter's (1982) work is recognised. We also noted the rhetorical paradox that Nelson and Winter prefer the description of "Lamarckian" for their work, despite its strong and implicit deployment of core Darwinian principles. In addition, there is some confusion whether routines should be defined (genotypically) as dispositions or (phenotypically) as behaviour. The strategy here has been to bring out and develop the Darwinian core of their work, and to refine and improve the definition of a routine. The key distinction between disposition and behaviour is vital for understanding and defining the routine as a replicator.

Bringing out the Darwinian core does not mean reducing economics to biology, or ignoring important differences between evolutionary processes in their two domains. Neither does it mean that humans become automata, bereft of deliberation or self-reflection (Hodgson, 2001c, forthcoming; Veblen, 1919; Vromen, 2001). Instead, it means the application of the general conceptual apparatus and approach of Darwinism to the real features of variety, inheritance and selection that are found in both socio-economic and biological systems. A refined definition of the routine is proposed that is consistent with some modern Darwinian ideas, thus realising a part of the Darwinian destiny of Nelson and Winter's work.

The approach here applies the framework of Universal Darwinism to the routine, thereby helping to refine and clarify its meaning. Future research in this area would submit concepts such as custom and institution to a similar process of refinement, but this cannot be completed here. Furthermore, and more generally, the vital tasks of conceptual refinement should be scrutinised and guided by detailed empirical and case studies. But science does not simply proceed by empirical enquiry, but also by the careful application of key concepts from one domain of enquiry to another. In this and other respects the work of Nelson and Winter (1982) is an inspiration.

Table 2. *Genes, Memes, Habits and Routines*

	Definition	Substrate	Genotype	Phenotype	Replication Mechanism	Replicative Similarity
Gene	Unit of inheritance in a chromosome, which may influence a particular inherited characteristic	DNA	DNA coding	Organisms, behaviours	DNA replication, operating directly and at the *genotypic* level only	Exists essentially at the *genotypic* level of DNA, but also gives rise to some similarity at the phenotypic level.
Meme1 (Dawkins, Dennett, *et al.*)	Unit of cultural information acquired through the imitation of others	Multiple possible substrates	Unclear: information, instructions or behaviours?	Behaviours, culture	Not always clear; but typically involving imitation in some direct sense	Memetics has tangled references to similarities of ideas, instructions, behaviours and other outcomes. The genotype-phenotype distinction is often unelaborated or ignored.
Meme2 (Aunger)	A configuration in one node of a neuronal network that is able to induce the replication of its state in other nodes	Neurons	Neuron states	Interpersonal signals	Intermediary signals that copy *genotypic* configurations of neurons in one brain to those in another	Exists essentially at the *genotypic* level of the neural configuration. May or may not give rise to some similarity at the phenotypic level as well.
Habit	Individual dispositions to engage in previously adopted or acquired behaviour, triggered by specific stimuli	Human psychoneural system	Acquired psychoneural connections and triggers	Individual human thoughts or behaviours	Indirectly through behavioural (*phenotypic*) expressions, which are then followed by incentive or imitation.	Essential similarity exists at the *phenotypic* level. Some other similarity may or may not also exist.
Routine	Organisational dispositions to energise conditional patterns of behaviour within an organised group of individuals, involving sequential responses to cues.	Habituated and socially structured individuals	Sets of rule-like instructions or responses held in an organisation	Structured sequences of habituated individual behaviours in organisations	Indirectly through their behavioural (*phenotypic*) expressions. Other organisations can create similar behavioural patterns that become embodied in individual habits.	Essential similarity exists at the *phenotypic* level. Some other similarity may or may not also exist.

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