The Generalized Theory of Evolution

Programme and Abstracts

Date	January 31 – February 3, 2018
Venue	House of the University
	University of Duesseldorf
	Schadowplatz 14, 40212 Duesseldorf
Organization	*DCLPS*: Duesseldorf Center for
	Logic and Philosophy of Science
Website	http://dclps.phil.hhu.de/genevo/

Contents

Aims & Scope

For several decades now, experts in several fields of the science of human nature, society and culture have been using evolutionary models to explain phenomena specific to their domains. This led to the prominent idea that the historical development of human culture in all or many of its facets ought to be described as a Darwinian process that is not based on genes but still driven by the principles of variation, selection and reproduction. At the beginning of the 21st century, a generalized theory of evolution seems to appear as an interdisciplinary theoretical structure, finding its place between likewise interdisciplinary frameworks such as system theory or action theory. Sub-disciplines like evolutionary psychology, evolutionary game theory, evolutionary epistemology and the theory of a cultural evolution in general seem to provide a set of models and explanatory tools that ultimately can be seen as varieties of one and the same basic theoretical structure: a generalized theory of evolution.

The generalization of the theory of evolution has not only had emphatic supporters, but has also been sharply criticized. In either case, various interesting questions can be raised within the framework. Is a Darwinian theory of cultural evolution a proper candidate to synthesize the social sciences? What is the surplus value of evolutionary explanations? More specifically, e.g., can language, meaning and content be explained in terms of evolutionary signaling games of coordination? Which facets of biological evolutionary systems can be applied to cultural evolutionary systems and where do they differ in relevant aspects? For example, are there any, and if, what is the methodological and ontological status of replicators in the cultural realm?

The conference aims to gather answers to some of these frequently raised questions and explores recent attempts to move beyond mere qualitative theorizing in the domain of generalized evolutionary systems. By bringing together researchers with a common interest in philosophical questions but with different backgrounds and toolboxes, we aim to inspire new insights.

Figures and Facts

Keynotes:

- Daniel Dennett (Tufts University)

- Eva Jablonka (Tel Aviv University)

- Ruth Mace (University College London)

- Alex Mesoudi (University of Exeter)

- Thomas Reydon (University of Hannover)

- Gerhard Schurz (University of Duesseldorf)

- Brian Skyrms (University of California, Irvine)

Organisation: *DCLPS – Duesseldorf Center for Logic and Philosophy of Science*: Karim Baraghith, Christian J. Feldbacher-Escamilla, Corina Strößner, and Gerhard Schurz

Sponsors:

Venue & Practicalities

Conference Venue:

House of the University

Schadowplatz 14, 40212 Duesseldorf

Website: http://www.hdu.hhu.de/en.html

All rooms are handicapped accessible. There are disabled toilets available and floors are connected via elevators. For support just contact the organizers.

Rooms:

- Lecture Hall: basement
- Seminar Room 2: 2nd floor
- Seminar Room 4: 3rd floor

Practical Information:

- Internet: Eduroam is available at the whole venue.

- ATM: the nearest is located at Schadowstr. 17.

- Police and Medical Assistance Emergency Number: 112

- Taxi: Call +49 (0)211 33333 or book at: http://www.taxi-duesseldorf.com/

- Conference Dinner: The conference dinner will take place on Thursday, February 1st, 2018, 19:00, at the brewery *Zum Schlüssel*, Bolkerstr. 41, 40213 Duesseldorf. Please note that you have to register (with the organisers) in advance in order to join the dinner.

Programme Overview

Wednesday, January 31st, 2018	
16:00 — 17:30	**Daniel Dennett: Tools Making Tools: the recursive de-Darwinization of human culture** **(Chair: Karim Baraghith)** **(Lecture Hall)**
17:30 — 18:00	Fingerfood and Drinks (Foyer, Ground Floor)
18:00 — 19:15 (ca.)	**Round Table: Cultural Evolution or Social Darwinism? Prospects and Problems of a Generalized Evolutionary Theory** **(Lecture Hall)**

Thursday, February 1st, 2018		
09:00 — 09:15	**Opening** **(Lecture Hall)**	
09:15 — 10:45	**Alex Mesoudi: The Viability of a Theory and Science of Cultural Evolution** **(Chair: Karim Baraghith)** **(Lecture Hall)**	
10:45 — 11:00	Short Coffee Break (Foyer, 2nd Floor)	
	Room 2: Complexity (Chair: Özlem Yılmaz)	**Room 4: Generalized Evolutionary Modelling (Chair: Hannah Rubin)**
11:00 — 11:30	Nicola Bertoldi: Complex Adaptive Systems and Evolutionary Explanations. Is the generalized theory of evolution a general theory of complexity?	Alex Aylward: A 'veritable key of the future' — R. A. Fisher and the Generality of Selection
11:30 — 12:00	Carolin Löscher: From Being Alive to Biological Complexity — A matter of communication	Aydin Mohseni: Disagreements in Evolutionary Dynamics
12:00 — 12:30	Mel Andrews: Adapting Evolution — Complexity and Culture in a Universal Darwinian Framework	Grant Ramsey: Does Evolutionary Theory Have a Unified Conceptual Foundation?
12:30 — 14:00	Lunch Break	
14:00 — 15:30	**Gerhard Schurz: Generalizing Evolution Theory: Evolution in nature and culture** **(Chair: Corina Strößner)** **(Lecture Hall)**	
15:30 — 16:00	Coffee Break (Foyer, 2nd Floor)	
	Room 2: Communication & Language (Chair: Henk Zeevat)	**Room 4: Generalized Evolutionary Modelling (Chair: Gustavo Cevolani)**
16:00 — 16:30	Fermín C. Fulda: Organismal Evolution and the Ecological Approach to Meaning: From Informational Content to Ecological Relevance	Özlem Yılmaz: Plant Stress Physiology
16:30 — 17:00	Rafael Ventura: The Emergence and Change of Linguistic Meaning	Walter Veit: The Evolution of Multicellularity: Cheating done right
17:00 — 17:30	Karim Baraghith & Christian J. Feldbacher-Escamilla: Success-Based Inheritance in Cultural Evolution	Mathias Gutmann: Human Evolution and Multi-Agent-Modelling
19:00 — 21:00 (ca.)	**Conference Dinner** **(Brewery: Zum Schlüssel, Bolkerstr. 41, 40213 Düsseldorf)**	

Friday, February 2nd, 2018		
09:00 — 10:30	**Brian Skyrms: Some Evolutionary Dynamics of Signaling Games** **(Chair: Gerhard Schurz)** **(Lecture Hall)**	
10:30 — 11:00	Coffee Break (Foyer, 2nd Floor)	
	Room 2: Generalized Evolutionary Modelling (Chair: Paul Thorn)	**Room 4: Generalized Evolutionary Modelling (Chair: Karim Baraghith)**
11:00 — 11:30	Hannah Rubin: Inclusive Fitness. How Not to Import Ideas from Cultural Evolution	Karim Baraghith: The Causal Interactionist Population Concept in Generalized Darwinian Systems
11:30 — 12:00	Marc Artiga: Natural Selection, Functions and Beyond	Pedro Atã & João Queiroz: Art Evolution as Niche Construction in Distributed Cognitive Systems
12:00 — 12:30	Cailin O'Connor: The Cultural Red King Effect	Caglar Karaca: Is Cosmological Evolution Led by Natural Selection? A misconception in the neo-Darwinian approach
12:30 — 14:00	Lunch Break	
	Room 2: Generalized Evolutionary Modelling (Chair: Alexander Gebharter)	**Room 4: Generalized Evolutionary Modelling (Chair: Alexander Christian)**
14:00 — 14:30	Ozan Altan Altinok: The Generalized Theories of Evolution	Philippe Huneman: Darwinian Cultural Evolution and the Ways of Capturing the Nature of 'Darwinian' Systems
14:30 — 15:00	Man-Him Ip: Evolutionary Debunking Arguments and the Conceptual Truth Objection	Francesco Suman: The Role of Culture in the Evolutionary Process: A pluralistic perspective
15:00 — 15:30	Gregor Greslehner: Synthetic Biology and Experimental Evolution: Expanding the structure-function space	Lorenzo Baravalle: The Theory of Cultural Evolution as Theory of Forces
15:30 — 16:00	Brian McLoone & Wai-Tong Fan & Adam Pham & Rory Smead & Laurence Loewe: Finite Populations, Group Structure, and the Evolution of Collective Action: Insights from a Discrete Analysis of the Snowdrift Game	Hugh Desmond: Delineating the Cultural Selective Environment: Fitness and Dominance
16:00 — 16:30	Coffee Break (Foyer, 2nd Floor)	
16:30 — 18:00	**Ruth Mace: No Need for an Upgrade: Using the toolkit from behavioural ecology to study cultural evolution** **(Chair: Christian J. Feldbacher-Escamilla)** **(Lecture Hall)**	

Saturday, February 3rd, 2018		
09:00 — 10:30	**Thomas Reydon: Towards Applicability Criteria for Generalized Evolutionary Theories: The concept of real populations** **(Chair: Corina Strößner)** **(Lecture Hall)**	
10:30 — 11:00	Coffee Break (Foyer, 2nd Floor)	
	Room 2: EvoDevo (Chair: Gregor Greslehner)	**Room 4: Generalized Evolutionary Modelling (Chair: Corina Strößner)**
11:00 — 11:30	Yoav Soen: Adaptation by Natural Improvisation: A theory of individual-specific adaptation	Florian J. Boge: Is 'Quantum Darwinism' really a Darwinism?
11:30 — 12:00	Íñigo Ongay de Felipe: Lamarckian Inheritance and the Generalized Theory of Evolution	Theo Stone: Creativity Within Evolutionary Epistemology
12:00 — 12:30	Sebastian Schuol: The Many Faces of Epigenetics (and their impact for evolutionary thinking)	Michael P. Schlaile: A Case for (Econo-)Memetics: Why we should not throw the baby out with the bathwater
12:30 — 13:00	Caleb Hazelwood & Lane DesAutels: Extending Evolutionary Individuality: An Appeal to Multi-Dimensional Heredity	Maarten Boudry & Steije Hofhuis: Parasites of the Mind. How cultural representations can subvert human interests
13:00 — 14:00	Lunch Break	
14:00 — 15:30	**Eva Jablonka: Generalized Selection Theory: selective stabilization and functional information** **(Chair: Christian J. Feldbacher-Escamilla)** **(Lecture Hall)**	
15:30 — 15:45	**Closing** **(Lecture Hall)**	

Abstracts of Keynotes

Tools Making Tools: the recursive de-Darwinization of human culture

Daniel Dennett

Human culture today does not look very "Darwinian" but when we look at the early millennia of human existence, when (proto-)language was evolving, we should not make the mistake of imagining our ancestors understanding what they were making and doing the way we understand these matters today. First there was competence without comprehension, and many of our most brilliant cultural treasures were no more intelligently designed than the termite's castle or the beaver's dam. The growth of comprehension in our species has been gradual, and we still overestimate our role as intelligent designers.

Generalized Selection Theory: selective stabilization and functional information

Eva Jablonka

Functional information in biological systems is produced through exploration processes followed by selective stabilization. I present George Price's distinction between Darwinian selection (selection among multiplying replicating entities) and Sample selection (selection without replication and multiplication of a subset from a set according to some value criterion) and discuss their broad manifestations and their interactions. Darwinian selection of epigenetic variations and Sample selection occurring during reinforcement learning, will be my main examples. I suggest that the selection that occurs during learning can be quantified using the difference between distributions of learned behaviors over consecutive learning-trial sets that incorporate the Prediction Error (PE) that drives this learning. The differences between norms of reaction incorporating selection differentials

can be similarly described in terms of functional information. Hence, a general notion of functional information can be articulated within the broad framework of Price's notion of selection.

No Need for an Upgrade: Using the toolkit from behavioural ecology to study cultural evolution

Ruth Mace

Here I will outline how Tinbergen established four questions, 'Four whys', to help frame our thinking about understanding the evolutionary basis of behaviour. I will argue that this framework is still relevant today and is useful in our study of human cultural behaviour. I illustrate the approach with examples of studies of evolutionary dynamics, and phylogenetic comparative methods, to answer two of the four whys, with examples from the evolution of human kinship and residence patterns, from both China and Africa. I argue that dispatching with his categorization is not essential and in some cases may not be helpful.

The Viability of a Theory and Science of Cultural Evolution

Alex Mesoudi

Soon after Darwin formulated his theory of evolution as applied to biological species, he applied the same evolutionary principles to cultural change, arguing that languages evolve through a similar process of descent with modification. This parallel between biological and cultural evolution lay dormant for most of the 20th century, but in the last few decades has received renewed interest across multiple disciplines. I will review some of this research, with the aim of providing an empirical background to

claims that there is a generalised evolutionary theory that underpins both genetic and cultural change. I will cover issues such as whether high fidelity transmission is required/present in cultural evolution, the relative importance of selection and transformation in cultural systems, the role of foresight/intention on the part of cultural actors, the necessity of replicators or 'memes', and the link between micro and macro cultural evolution. I will attempt to argue that not only is a Darwinian theory of cultural evolution theoretically viable (as long as it is not tied to a strict neo-Darwinian genetic version of evolutionary theory), it is also demonstrably useful in explaining cultural change relative to non-cultural evolutionary approaches and non-evolutionary cultural approaches.

Towards Applicability Criteria for Generalized Evolutionary Theories: The concept of real populations

Thomas Reydon

The notion of 'evolution' is often used in an overly loose sense, referring to processes of change in general. There is talk of the evolution of societies, of cities, of languages, of firms, of car models, of science, of the universe, of clothing fashions, and so on. As science writer Carl Zimmer put it: "Culture itself evolves. Languages evolve, airplanes evolve, music evolves, mathematics evolves, cooking evolves, even fashions in hats evolve. And the ways human creations change with time mirror biological evolution in uncanny ways." (Zimmer, 2001: 308). But to what extent do such different processes of change actually resemble biological evolution? In particular, to what extent can such a diversity of processes be accounted for by one single theoretical framework, in this case Darwinian evolution? Recent attempts at formulating a generalized theory of evolution have

suggested that such a theory will be able to cover a wide array of phenomena of change, but these proposals remain controversial. This talk will address the question which requirements have to be met for a generalized form of evolutionary theory to be applicable in a particular domain of investigation. A first-order answer would be that for a version of evolutionary theory to be applicable to a particular category of phenomena under investigation, these phenomena must be "proper" evolutionary phenomena. This answer, then, raises the metaphysical question when a particular phenomenon of change, be it in the natural realm, in the social domain, in economics, or elsewhere, is an evolutionary phenomenon in any proper sense of the term. I will attempt to formulate an answer to this question by focusing on the notion of populations. Populations are the entities that undergo evolution in the biological realm and thus it seems plausible that evolution outside the biological realm should involve entities that are populations or at least are sufficiently population-like in relevant metaphysical aspects. Based on recent work on the population concept in the philosophy of biology, I will explore how a general notion of populations can be conceived that could serve as a criterion to decide on the applicability of a properly evolutionary framework to particular cases in various domains of investigation.

Zimmer, C. (2001): Evolution: The Triumph of an Idea, New York: Harper Collins.

Generalizing Evolution Theory: Evolution in nature and culture

Gerhard Schurz

In the first part of the talk (the paper) I formulate four abstract principles of generalized evolution theory: reproduction, variation, selection and a certain amount of stability. I demonstrate

how these principles apply equally to biological evolution based on the reproduction of genes and to cultural evolution based on the reproduction of 'memes'.

In the second part I discuss crucial differences between the identity criteria of memes, the reproduction, variation and selection of memes and the classification of 'memetic quasi-species', compared to that of genes. Based on this discussion I will acknowledge a certain amount of critique against memetics and at the same time defend the general account of the theory of cultural evolution.

In the final part it is demonstrated how the mathematical laws of the generalized theory of evolution unify the theoretical laws of biologic al population dynamics, meme dynamics and evolutionary game theory. A major distinction between different kinds of evolutionary dynamics is that between three different kinds of selection parameters: (i) frequency-independent, (ii) reflexively frequency-dependent, (iii) interactively frequency-dependent.

Some Evolutionary Dynamics of Signaling Games

Brian Skyrms

Information transfer is a basic feature of life that includes signaling within and between organisms. Owing to its interactive nature, signaling can be investigated by using game theory. Game theoretic models of signaling have a long tradition in biology, economics, and philosophy. For a long time the analyses of these games has mostly relied on using static equilibrium concepts such as Pareto optimal Nash equilibria or evolutionarily stable strategies. More recently signaling games of various types have been investigated with the help of game dynamics, which includes dynamical models of evolution and individual learning. A dynamical analysis leads to more nuanced conclusions as to the out-

comes of signaling interactions. Here we explore different kinds of signaling games that range from interactions without conflicts of interest between the players to interactions where their interests are seriously misaligned. We consider these games within the context of evolutionary dynamics (both infinite and finite population models) and learning dynamics (reinforcement learning). Some results are specific features of a particular dynamical model, whereas others turn out to be quite robust across different models. This suggests that there are certain qualitative aspects that are common to many real-world signaling interactions.

Abstracts of Contributed Talks

The Generalized Theories of Evolution

Ozan Altan Altinok

Evolution has been one of the most important themes of our intellectual scenery at least since Darwin. Even the great ideologies of late 19th and early 20th century tried to ground themselves within the evolutionary theory. While laisses-faire capitalists liked the idea of a constant struggle in the nature as it is in the free market along the lines of Herbert Spencer, fascists favored the annihilation of the unfit and the inferior along the lines of Ernst Heackel, and the Marxists – even Karl Marx himself – were intrigued by the idea of emergence of a new entity in the form of species as a result of the struggle and a non-teleological understanding of the natural world.

The purpose of this work is not political, the three different approaches in politics is for the purpose of demonstration of the commonality of the theory of evolution. Albeit, the political doctrines should first bite the Humeian is-ought bullet to be able to apply their desired interpretation to society (at the price of other doctrines' exuding to the same domain).

However, all these have happened latest on the first half of 20th century, when the theory of evolution was far from a fully developed theory or a real encompassing understanding of the living world.

My aim on this work is to investigate the maturation of the theory of evolution to the modern synthesis, with a heavy emphasis on the cornerstones provided by Spandrels of San Marco and even further challenges to the modern synthesis by Jablonka on her Evolution in Four Dimensions concluding on the heated discussion on Nature in its 514th issue on the commentary section about the need of evolution to be rethought through the addition of new biological sub-disciplines to the new synthesis by Laland and Wray. As an intermediary conclusion, I advocate that rather than going into a simpler and unified understanding of evolution, we are going towards the very opposite direction.

Yet, I will use this intermediate claim in a positive sense, supporting my stance through Nancy Cartwright's claim on How the Laws of Physics Lie to support the higher explanatory power of the disunited and low level laws of evolutionary theory (compared to physics for example) on its proper objects. Given that the mechanisms of evolution are much finer tuned than the more encompassing theories of "harder" sciences, and the multiplicity of the mechanisms, I believe that it is easier in evolutionary biology to produce historical mechanisms than historical social sciences. In addition to that, evolutionary biology offers us a far richer domain of objects than fundamental sciences of which object of inquiry is more fundamental and fewer particles and mechanisms.

In conclusion, I propose the following: Biological domain is much richer in their objects. The mechanisms and explanations of evolutionary theory are thus mainly to the point and precise. This precision, together with the rare to find in the other fields historicity of evolutionary theory, makes the general theories of evolution best candidate to reach out other domains.

Adapting Evolution – Complexity & Culture in a Universal Darwinian Framework

Mel Andrews

Recent attempts to comprehend and to model cultural change within a canonically Neo-Darwinian framework have sparked contention and been critiqued as intellectually arid. Why should this be the case? Failed applications of the logic of adaptation and natural selection to the appearance of human cultural variance have historically been taken as evidence of human exceptionalism, or of some special, super-biological features of culture. Instead, we see the shortcomings of cultural evolutionary models to be indicative of the insufficiency of the Neo-Darwinian worldview itself. The Neo-Darwinian model of perturbation, inheritance, optimization fails to veridically capture the mechanism of major transitions, the appearance of complexity, and the dynamics of causality. This predominating, impoverished account of the evolutionary process can no more explain culture than it can explain the appearance of intentionality, selfhood, or mindedness. Looking to the scholarship of Terrence Deacon, Ilya Prigogine, Daniel Dennett, Richard Levins, and Richard Lewontin, we probe the explanatory power of natural selection, examining the scope and scale of its efficacy, and the tenability of a substrate-neutral reformulation. We investigate the relationship of evolution to existing notions of information, complexity, and meaning, asking ultimately whether Darwinian evolution can or should furnish us with a plausible origin story of consciousness, mentality, agency, and cultural transmission.

Natural Selection, Functions and Beyond

Marc Artiga

The notion of function is widely attributed in many scientific areas, such as biology, psychology or neuroscience, and plays a central role in some philosophical theories, such as naturalistic theories of mental content or health. Nonetheless, it is an extremely controversial notion. For one thing, it is unclear what grounds the fact that certain items have functions. The standard strategy for addressing this question appeals to some process of selection. More precisely, according to an important tradition, the notion of function can be explained by appealing to *being selected for*. On this view:

> **(FUN)** A mechanism M has the function F iff M has been selected for F.

For obvious reasons, however, this can hardly be a resting point: one also needs to provide a theory of *being selected for*. The most common approach seeks to analyse this notion in terms of natural selection (Millikan, 1984; Neander, 1993; Dennett, 2017). Thus, very roughly:

> **(NS)** There has been selection for F iff there is a population in which:
>
> – *Heredity*: Individuals in the next generation tend to resemble their parents.
> – *Variation*: There was genotypic/phenotypic variation. Only some individuals performed F.
> – *Differential reproduction*: Individuals that performed F had more offspring than individuals not did not perform F.

Accordingly, the received view on function holds that it can be analysed in terms of *being selected for*, and this notion in

turn be explained by appealing to natural selection. This picture, however, has been challenged from various perspectives. In particular, I will briefly present three objections, developed in Godfrey-Smith (1994), Buller (1998) and Garson (forthcoming). These difficulties suggest that *being selected for* is neither sufficient nor necessary for having a function.

I will argue that, to address these challenges, we need to interpret NS and FUN in a different way. I will develop this idea by employing some aspects of Godfrey-Smith (2009)'s understanding of natural selection and Millikan (forthcoming) approach to real kinds. More precisely, I will argue that we should interpret FUN as describing paradigmatic cases (rather than offering a *minimal* analysis) and I will offer a spatial representation of this idea. I will argue that adopting this perspective offers a useful methodological tool that can be used to defend the standard etiological approach from some recent objections. Nonetheless, I will also defend that this perspective shows that the relationship between different definitions (FUN and NS) is less straightforward than usually thought. Finally, I will argue that these results have some important consequences for other projects that employ the notion of natural selection and function, such as teleosemantics.

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Godfrey-Smith, P (2009) Darwinian Populations and Natural Selection. OUP

Millikan, R. (1984) Language, Thought and Other Biological Categories. MIT Press

Art Evolution as Niche Construction in Distributed Cognitive Systems

Pedro Atã and João Queiroz

Here we offer a model for art evolution based on niche construction dynamics (see Odling-Smee, Laland & Feldman, 2003) regulating the behavior of distributed cognitive systems. We exemplify with the emergence of classical ballet. Art evolution corresponds to the variation in time of the typical features of historically connected artworks. We stress that this evolution of artworks is closely connected and influenced by many environmental constraints: artwork ontologies, their symbolic and metaphorical meanings, their embedded social ideals and systems of value, as well as the material media and technical resources available for art production all coevolve. Historically connected artworks are commonly grouped as art traditions, styles, or aesthetic movements. We model them as distributed cognitive systems (DCSs), evolving through cognitive niche construction. A DCS is a network of agents and artifacts coupled together in the context of cognitive tasks (see Davies & Michaelian, 2016; Hutchins, 1995). In our description, an art tradition includes multiple embodied and situated agents (artists, curators, critics, audience...) in different spatial and temporal loci) connected through a variety of external media and artifacts (artworks, thinking-tools, written and oral language...) and exchanging information so as to solve a plethora of cognitive tasks. The main task of an art-tradition-DCS is the exploration of representational possibilities derived from a set of agreed-upon premises about the current state of a type of art postulations on what to do next

and how to do it. We purposely scale up the notion of DCS so as to encompass large temporal scales necessary to account for artistic evolution. In this context, DSCs evolve: their components are renovated both because the agents are substituted, and because the typical features of external media (including typical features of artworks) are updated. This update happens through niche construction dynamics. The sustained action of art-tradition-DCSs produce a number of changes in their environments, which in turn transform the environmental resources available. We provide the example of the emergence of classical ballet. The evolution of dance from court dance to classical ballet is an example of cognitive niche construction. There is a complex mutual connection between changes in performance space (from palace gardens and ballrooms to italian stages built according to one-point perspective), changes in formal arrangement of the dance performance (from geometrical disposition of dancers to more vertical morphology of body movements) and changes in metaphorical and symbolic meanings associated with it (the dancer as an ethereal figure – e.g., nymphs and fairies – whose vertical elevation is metaphorically meaningful

References

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A 'veritable key of the future': R. A. Fisher and the Generality of Selection

Alex Aylward

Ronald Aylmer Fisher (1890-1962) was a major architect of the Modern Synthesis, and a founder of Population Genetics. His mathematical-statistical approach to modelling evolutionary processes has been highly influential, particularly via his Genetical Theory of Natural Selection (1930), the final third of which explores the implications for Man, Society and civilization, of his more general theorising. Commentators on Fisher note his pan-selectionism, often attributing it to his great admiration of Charles Darwin. This paper seeks instead to explain Fisher's selectionism by reference to his conceiving the principle as one of great generality and fundamentality.

From his undergraduate days, Fisher believed selection to be operating at numerous levels of organisation, including those of customs, traditions, and languages, as well as in biological evolution at the organismal level. It was the generality of selection, and its pervasive operation including upon civilised man, which led Fisher to believe that its careful, scientifically-informed control was a 'veritable key of the future'. Fisher often emphasised that selection acted through differential reproduction as well as survival. Societal and economic parameters, due to their effect upon rates of reproduction of various groups, were thus central. If humankind could harness the power of this principle of selection, through tinkering with these parameters, then a state of 'permanent civilization' could be established. Furthermore, Fisher's treatment of selection as one of great generality meant that he could forego the dichotomy between 'natural' and 'artificial' selection in forwarding a vision of controlling selection within human society. Natural selection, unchecked, was operating in the 'wrong' direction; the poorer and 'lower' echelons of society were outbreeding the more desirable. But artificial selection, of the kind implemented by breeders, wherein the best

individuals are specifically and actively chosen for reproduction, would not do as a method for improving humankind. Fisher's case, then, demonstrates how in the 1920s and 30s, a generalized evolutionary vision which united civilized-man and animal in their being acted upon by selection not only strived for a greater understanding of Darwin's principle, but granted the humankind the power, and the responsibility, to control it.

The present paper, then, offers a corrective to the standard narrative which says that the evolutionary theory before and during the synthesis-period was purely 'biological,' with extension to the human realm only coming in mid-century, as anthropology was folded into the synthesis (Provine 1971; Smocovitis 1996, 2012), and the later emergence of the study of 'cultural evolution'. It demonstrates the crucial role which the generality of Darwin's principle of selection played in the theoretical contributions of R. A. Fisher, contributions which have been traditionally conceived as residing strictly within evolutionary biology.

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Provine, W. B. (1971). The Origins of Theoretical Population Genetics. Chicago: University of Chicago Press.

Success-Based Inheritance in Cultural Evolution

Karim Baraghith and Christian J. Feldbacher-Escamilla

Generalized Darwinism suggests to model cultural development as an evolutionary process where traits evolve through variation, selection, and reproduction (cf. Mesoudi 2011). Although this paradigm presupposes some strong similarities between natural and cultural evolution, it also clearly allows for several dissimilarities in the models. One such dissimilarity consists in different forms of inheritance: Whereas in natural evolution inheritance consists of the transmission of discrete units, in the cultural realm it is common to assume that inheritance is a more or less continuous mixing of traits. The latter is sometimes also called *blending inheritance*. In this paper we characterize blending inheritance in detail. In order to do so we first discuss classical models of cultural evolution and population dynamics (cf. Boyd & Richerson 1988, Schurz 2011). Then we hint at some problems of these models and introduce our model which combines relevant features of both. Thereby blending inheritance is implemented as a form of success-based social learning. This allows for general results about such a variant's fitness while at the same time problems and restrictions of the former models are avoided.

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The Theory of Cultural Evolution as a Theory of Forces

Lorenzo Baravalle

The aim of this talk is to address the following long-standing question: to what extent does cultural change constitute an evolutionary process? According to a recent interpretation advanced by Tim Lewens (2015), both cultural and biological evolutionary change should be conceived as statistical outcomes of aggregative interactions between individuals and between individuals and the environment. According to Lewens, evolutionary processes are best understood as epiphenomena, like temperature or pressure changes in statistical mechanics. I challenge this interpretation – also known as the kinetic interpretation of evolutionary processes – by arguing that it is unable to properly account for one of the main explananda of evolutionary theory, that is, the dynamics of trait frequencies across time. In order to supply this deficiency, I suggest (following Millstein 2006 and Shapiro & Sober 2007) to consider evolutionary change as the result of genuine population-level (i.e., non-aggregative) causal processes involving the environment and trait frequencies themselves (I call these population-level causal processes "evolutionary invariants"; cf. Woodward 2003; Caponi 2014). This causal interpretation is commonly accepted by the champions of the so-called dynamical interpretation of evolutionary theory, like Elliott Sober (1984), according to whom the theory of biological evolution can be best characterised as a theory of forces. A theory of forces includes a zero force law – i.e., in the case of the theory of biological evolution, the Hardy-Weinberg equilibrium – and a set of consequence laws – i.e., the equations of population genetics –, which unify specific (sets of) evolutionary invariants under a general theoretical framework. Given these premises, in this presentation I shall argue that: a) cultural change is an evolutionary process insofar as it involves irreducible population-level interactions between the environment and trait frequencies;

and b) this fact can be best understood if we consider the theory of cultural evolution as a theory of forces.

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Complex Adaptive Systems and Evolutionary Explanations. Is the generalized theory of evolution a general theory of complexity?

Nicola Bertoldi

If evolutionary theory should be regarded as a comprehensive framework for understanding life, then it should be able to capture some fundamental features that all living beings share. It has been repeatedly argued, for instance by Ernst Mayr (1982), Richard Dawkins (1983), John Maynard Smith and Eörs Szathmary (1997), that such universal features of life are precisely those that fall under the concept of adaptive complexity. From this assumption, it follows that evolutionary theory, in order to function as a comprehensive explanatory framework for biology, must be able to account for the origin of complexity, as well as for its growth through successive adaptational steps. This means that any attempt to extend evolutionary explanations to other domains, such as psychology, sociology, economics, epistemology or history, should focus on the problems raised by such a concept in all those different contexts.

Yet, how can adaptive complexity be defined and formalized within a generalized evolutionary approach? There exist at least four different definitions of complexity from an evolutionary standpoint. Mayr (1982), for instance, relies on a "compositional" definition of complexity. Maynard Smith (1969) equates adaptive complexity with natural design, whereas, in his essay on the major transitions in evolution (Maynard Smith and Szathmary 1997), he adopts a biological version of the computational definition of complexity. Richard Dawkins (1983), on the contrary, defines complexity as a statistical concept, i.e. in terms of "very low *a priori* likelihood of coming into being". How do all those different definitions of complexity relate to each other? Could they provide a unified account of adaptive complexity from an evolutionary standpoint? This being the case, how could such an account be extended to disciplines other than biology?

This paper aims to answer such questions in two subsequent steps. First, by comparing the various definitions of complexity that have been given in the context of evolutionary theory to the one provided by the emerging field of complexity science (Holland 2014), based on the identification of some classes of systems that display a set of typical properties: self-organization, chaotic behaviors, "fat-tailed" behaviors and adaptive interactions between their elements. Second, by understanding how a unified account of adaptive evolutionary complexity could relate to one of the best formal representations of natural selection, i.e. the Price equation (Price 1970). More precisely, this paper will assess the extent to which such a model can describe the behavior of a complex adaptive system, by analyzing its formal structure.

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Is ,,Quantum Darwinism" really a Darwinism?

Florian J. Boge

In quantum theory (QT), the state of a physical system S is represented by a state vector $|\psi_s\rangle$, implying two sources of ambiguity: (a) it can be represented in some basis of states $|\varphi_j\rangle$ as $|\psi_s\rangle = \mu_1|\varphi_1\rangle + \mu_2|\varphi_2\rangle + \ldots$, where each of the states $|\varphi_j\rangle$ may represent a possible outcome oj of some measurement of a physical quantity O on S, given in the quantum formalism as $O = \sum_j o_j|\varphi_j\rangle\langle\varphi_j|$, with $p_j = |\mu_j|^2$ determining the probability that result o_j will be measured. So $|\psi_s\rangle$ is ambiguous as to the outcome of such a measurement. And (b) $|\psi_s\rangle$ may be represented in a different basis of states $|\chi_j\rangle$ with an associated quantity $Q = \sum_j q_j|\chi_j\rangle\langle\chi_j|$, so that it is even ambiguous w.r.t. which outcomes $|\psi_s\rangle$ is ambiguous in the sense of (a), the o_j or the q_j.

The decoherence program (cf. Joos et al. 2013) in QT has been hailed for resolving at least ambiguity (b): The interaction of S with an environment E results in a preferred basis of states, which in turn leads to the assertability of definite 'classical' properties on S, such as a (more or less) definite speed and position at any point in time, which is not possible when S is viewed in isolation. Since this selection of a preferred basis leads to a loss of some of the information contained in $|\psi_s\rangle$ and the "proliferation" of other information contained therein, Wojcieh Zurek (e.g. 2009) has suggested to think of this process as a kind of "Quantum Darwinism": In a given environment E, only specific information about measurable quantities will "survive", and hence these quantities come out as the "fittest" in a selective process that is roughly Darwinian.

The term "Quantum Darwinism" is now widely used, but the question rarely being asked whether the notion is a mere metaphor or not. While Zurek in some places acknowledges this lack of clarity, Campbell (2010, pp. 7 ff) argues that the selective process should be viewed as *literally* Darwinian. In my talk

I will first demonstrate that to resolve ambiguity (a) in this context, one needs to appeal to a specific interpretation of QT. I will then argue, by appeal to the modules of the recursive algorithm underlying generalized evolution (e.g. Schurz 2011, p. 131) and examples of the evolution of other inanimate systems, that in this interpretation one characteristic trait of proper Darwinism is missing in the decoherence process: the existence of a suitable *resource* w.r.t. which competition is possible, and which determines the possibility of reproduction or retention in the selection process.

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Parasites of the Mind. How cultural representations can subvert human interests

Maarten Boudry and Steije Hofhuis

Are there any such things as *mind parasites*? By analogy with biological parasites, such cultural items are supposed to subvert or harm the interests of their host. Although the notion has been most popularly associated with Richard Dawkins' concept of the "selfish meme", the hypothesis of cultural parasitism has appeared in different guises in the burgeoning field of cultural evolution. To unpack the notion of mind parasites, we first clear some conceptual ground around the concept of cultural adaptation and its relation to human agency. We then formulate *Millikan's challenge*: how can cultural items develop novel purposes of their own, cross-cutting or subverting human purposes? If this central challenge is not met, talk of cultural 'parasites' or 'selfish memes' remains vacuous. First, we discuss why other attempts to answer Millikan's challenge have failed. In particular, we put to rest the claims of *panmemetics*, a somewhat sinister worldview according to which human culture is nothing more than a swarm of selfish agents, plotting and scheming behind the scenes. Next, we reject a more reasonable, but still overly permissive approach to mind parasites, which equates them with *biologically maladaptive* culture. Finally, we present our own answer to Millikan's challenge: certain *systems of misbelief* can be fruitfully treated as cultural parasites developing novel purposes of their own. In fact, we venture that this is the only way to properly understand them. Systems of misbelief are designed by cultural evolution without any regard to the interests of their human hosts, and with possibly harmful consequences. As a proof of concept, we discuss witchcraft beliefs in early modern Europe. In this particular case, treating cultural representations as "parasites" – i.e. adopting the meme's eye view – promises to shed new light on a mystery that historians and social scientists have been wrestling with for decades.

Delineating the Cultural Selective Environment: Fitness and Dominance

Hugh Desmond

A differences between the biological fitnesses of two organisms only gives rise to natural selection if the organisms share a 'common selective environment' (Brandon 1990). However, in some extensions of evolutionary theory, such as the extension to the cultural domain, it is unclear how a common selective environment should be defined. Whereas cyanobacteria and blue whales inhabit clearly distinct selective environments, is less clear how to individuate the selective environment inhabited by cultural variants, ranging from hand axes, moral norms, Che Guevara T-shirts, or classical symphonies. By what criteria can one say that one cultural variant is not in selective competition with another?

The problem of delineating one selective environment from another – the 'boundary problem' as I call it – is a relatively overlooked but important conceptual problem for cultural fitness (for an overview of other key conceptual problems, see Henrich et al. 2008 or Ramsey and De Block 2015). In this paper I argue that it can be partially resolved by means of the biological selective environment. However, this solution only works partially, and in cases it does not work I suggest that the concept of cultural fitness should be replaced by two alternative measures of evolutionary success used in ecology and paleontology: dominance and longevity.

Influential definitions of cultural fitness such as Henrich's[*] do not explicitly define a selective environment, but do identify a resource for which cultural variants compete – in Henrich's definition this resource is 'storage space in the head of an individual'. However, this gives rise to an definition of the selective environ-

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[*]Cultural fitness is a measure of "the degree to which a particular value of φ, representing stuff stored in the head of individual i in group j at time t, affects its proportional representation in the population at time $t+1$" (Henrich 2004: 21).

ment that seems overly wide: Beethoven's *Eroica* symphony and a triangular hand-axe could compete for such storage space.

I propose that cultural selective environments can be individuated in terms of biological selective environments. In particular, I argue for the following:

natural selection acts on two cultural variants φ and φ' if and only if the natural selection acts on individuals of type i bearing cultural variant φ and on the individual of type j bearing cultural variant φ' *in virtue of* biological fitness differences caused by the difference between φ and φ'.

Thus hand-axes of one design type are selected for over hand-axes of another design type if and only if the difference in hand-axe design causes a difference in biological fitness between the bearers of the cultural variants. However, there is no cultural selection for Beethoven's *Eroica* symphony over a triangular hand-axe design (or vice versa) if an individual who has memorized the *Eroica* symphony will neither have a higher nor a lower expected number of offspring than an individual who has memorized how to produce a triangular hand axe. However, not all differences in cultural variants have impacts on biological fitness: one symphony may spread more successfully than another without affecting the biological fitness of listeners. In such cases I argue that Henrich's definition of cultural fitness is actually a measure of *cultural dominance* available storage space: a measure analogous to ecological dominance, that quantifies how much of the available resources a variant is able to accumulate.

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Organismal Evolution and the Ecological Approach to Meaning: From Informational Content to Ecological Relevance

Fermín C. Fulda

Whether evolutionary theory can be extended to a theory of
meaning depends on which evolutionary theory its being ex-
tended and on what the desiderata for an adequate theory
of meaning are. I distinguish two versions of evolutionary
theory, Modern-Synthesis and Extended-Synthesis, and pro-
pose two desiderata for a theory of meaning, causal-location
and normative-role. Then I argue that while the Modern-
Synthesis version grounds the familiar representational approach
to meaning as informational content, the Extended-Synthesis
version grounds an alternative ecological approach to meaning
as relevance-for-action. I conclude that only the ecological ap-
proach satisfies both desiderata.

The Modern-Synthesis version of evolutionary theory represented by population genetics explains changes in trait frequencies in terms of random genetic variation and environmental selection. The central concepts are replicator and adaptation (Dawkins 1976; Dennett 1995). A replicator is sub-organismal entity whose informational content can be copied with high fidelity and which constitutes the basic unit of selection, inheritance, development and evolution. An adaptation is a trait that evolved by natural selection because it enhanced the relative fitness of their bearers.

The Extended-Synthesis version represented by evolutionary-developmental-biology explains evolutionary change in terms of organismal capacities such as facilitated phenotypic variation, phenotypic plasticity and niche construction. The central concepts are organism and adaptability (West-Eberhard 2003; Walsh 2015). An organism is a self-producing, self-maintaining, self-regulating entity that can respond in a robust adaptive way to its conditions of existence by changing its physiology, morphology or behavior in response to perturbations.

Under replicator biology a theory of meaning takes the form of a semantics for representational systems. A representation is an information-bearing entity that stands-for some external condition. The strategy is to extract meaning in the semantic sense of propositional content from non-semantic relations, such as informational, functional or coordination relations (Dretske 1988; Millikan 1984; Skyrms 2010).

Under organismal biology a theory of meaning takes the form of an ecological theory of agency (Fulda 2017). The basic idea is that "the meaning or value of a thing consist of what it affords" (Gibson 1982: 407-408). Affordances are reciprocally constituted by the organisms' gross behavioral capacity to respond purposively to them. The strategy is to extract meaning in the sense of ecological relevance from the interdependence between an organism and its network of affordances considered as a single, coupled, dynamical system.

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Synthetic Biology and Experimental Evolution: Expanding the structure-function space

Gregor Greslehner

Biology investigates the structures and functions of living beings on several levels of organization. While the lowest levels are governed by the laws of physics and chemistry, higher-level phenomena need to be explained by regularities which are being investigated by other disciplines. Evolutionary considerations play an important role in several of these disciplines and levels – which need not be restricted to biological systems or living entities.

Synthetic biology as an interdisciplinary area of research benefits from the exchange with other disciplines that study evolutionary systems. By pursuing the agenda of synthetic biology, i.e. to manipulate and engineer biological and evolutionary systems, it becomes apparent that in order to understand and intervene in evolving systems, a quantitative and dynamic understanding of these systems is required.

On the one hand, this might be a desirable trend to link functional and evolutionary biology (a distinction due to Ernst Mayr) by making use of our advanced theoretical understanding of evolution; on the other hand, synthetic biology might be a testing ground to investigate evolutionary hypotheses like, for example, the role of intermediates or different types of variation in evolutionary processes.

Techniques like SELEX (Systematic Evolution of Ligands by EXponential enrichment) use evolutionary principles to generate protein structures with specific functions that would be difficult to obtain by rational engineering. Insights from a generalized theory of evolution will be useful for both forward and reverse engineering of structures and functions in synthetic biology.

Synthetic biology can thus learn a lot from a generalized theory of evolution – and vice versa, provide an experimental framework, in addition to simulations and other *in silico* methods.

Human Evolution and Multi-Agent-Modelling

Mathias Gutmann

Since Darwin's "descent of man", evolutionary theory aims at a comprehensive, supposedly complete biological explanation of human nature. After about 150 years of theory development, we find an extremely differentiated field of approaches including strong Darwinian concepts of evolution as well as Neo-Darwinian extensions in terms of Hamilton's Theory of Selection, such as sociobiology and evolutionary psychology, which are predominantly concerned with reproductive mechanisms.

Next to this more or less orthodox theory-tradition, several alternatives are provided, which focus on a functional understanding of organisms as central evolutionary unit by applying insights from developmental genetics or behavioural sciences, represented e.g. by epigenetic approaches, Extended-Evolutionary-Synthesis or Developmental-Systems- Theory.

Finally, even the long tradition of Non-Darwinian approaches of evolution is to be considered, focusing on organismic as well as structural constraints originating in e.g. concepts of functional morphology of Dohrn, Uexküll and D'Arcy Thompson, the embryological tradition from v. Bear, towards Waddington and the structuralist concepts, or several types of engineering morphology such as those of Bock, Gutmann or Seilacher. Very recently a new type of simulation-oriented approaches appeared, which apply multiagent- modeling as a promising tool to integrate those different kinds of data-sets and models into one comprehensive framework of *human* evolution. The main idea consists in the simulation of different possible routes of hominine expansion "out of Africa" by representing relevant ecological parameters in space-time-sensitive distributions. The actual hominine organism is represented as a population of agents with the relevant capacities, features and properties (s. Hölzlein et al. 2016). On this basis "simulation experiments" are conceivable which might allow the testing of competing hypothesis differing

in presupposition, available data and conclusions.

From a methodological point of view, this type of explanation provides some serious threads:

1. "Linear" causal or functional explanation referring to "adaptive suits" (s. Henke, W. & Tattersall, I. 2007), representing a horizontally and vertically stratified parameter space, is improbable.

2. A direct proof of the "correct" migration routes seem possible only in terms of maximal coherence and consistency, by "testing" the respective hypothesis against heterogeneous environmental data sets.

3. A very strong description of the explanandum is necessary which allows us to estimate the validity of the respective experimental results.

The aim of this paper is the reconstruction and analysis of these three aspects by identifying the differences to classic explanatory concepts on the one hand, the invariances in the explanatory schema on the other hand. It can be shown that even in this extremely formal mode the fundamental structures of explanation are preserved. By applying a "scenariobased" description of the explanandum, even some of the normative and reflexive aspects of human constitution are scientifically explicable without running the risk of reducing humans *insofar as they are humans* onto their mere biological and paleontological concept.

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Extending Evolutionary Individuality: An Appeal to Multi-Dimensional Heredity

Caleb Hazelwood and Lane DesAutels

Developments in the life sciences, as well as in philosophy of biology, have added fodder to the continuing debate surrounding the notion of the "biological individual." In recent literature (Godfrey-Smith 2013; Pradeu 2016), the pursuit of a pluralistic conception of biological individuality is located at the intersection of two independently fruitful categorizations that do not always coextend: individuality understood in terms of evolution by natural selection and individuality understood by appeal to physiology.

Put roughly, physiological individuals are biological entities characterized by a functional or metabolic integration, and evolutionary individuals are biological entities characterized by their being "seen" by natural selection (Clarke 2011). That is, biological entities are individuated if and only if they constitute a unit of selection, thereby satisfying Lewontin's criteria of producing heritable variation and demonstrating differential fitness (Lewontin 1970). There is significant debate about just how we ought to identify evolutionary individuals. Godfrey-Smith, for example, makes a compelling argument for identifying evolutionary individuals via clearly defined parent-offspring lineages and vertically transmitted traits, specifically through reproduction (Godfrey-Smith 2013).

However, if we accept these characterizations of biological individuality, we must further accept that there are many instances where perfectly good physiological individuals are not evolutionary individuals; sophisticated host-microbial symbiont associations, referred to as *holobionts*, are often dismissed on these grounds. In cases where hosts inherit their microbiome through horizontal transmission, i.e., from the environment, they are not considered to possess evolutionary individuality, as they do not produce clear parent-offspring lineages. According to this

understanding of evolutionary individuality – with the criterion of heredity being *reproduction* – a host-symbiont association with no clear microbial parent-offspring lineages, though it may be a paradigmatic physiological individual, will not exhibit evolutionary individuality.

We argue that, in pursuing a proper conception of evolutionary individuality, limiting the scope of heredity to reproduction (i.e., vertical transmission) fails to account for the ubiquity of horizontal transmission of adaptations in nature that play an important evolutionary role. We aim to contribute to the development of a pluralistic account of evolutionary individuality that recognizes the myriad extra-genetic means of inheritance. We further contend that the Extended Evolutionary Synthesis (EES) may assist in such a development.

One specific aspect of the EES, ecological inheritance, is of particular importance with respect to holobiont individuality. Ecological inheritance (Odling-Smee, Laland, & Feldman 2003) is the legacy of niche construction, and may be defined as a process of heredity "through which previous generations as well as current neighbors can affect organisms by altering the external environment or niche that they experience" (Lamm 2012). We will argue that, through a horizontal transmission of microbial symbionts, holobionts partake in niche construction in a significantly heritable way, thus granting them some degree of evolutionary individuality.

Lastly, we'll consider extra-genetic means of inheritance in classic "problem cases" in an effort to reveal an otherwise overlooked compatibility between physiological and evolutionary individuality in holobionts. We believe this pluralistic conception of biological individuality – that of the *extended evolutionary individual* – is an appropriate extension that reflects advancements in evolutionary theory.

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Darwinian Cultural Evolution and the Ways of Capturing the Nature of 'Darwinian' Systems

Philippe Huneman

Darwinian cultural evolution theories have generally been facing two issues : the difficulty to define what would instantiate 'heritability' given that cultural items don't reproduce strictly speaking, and the fact that 'variation' in cultural traits is not straightforwardly random (e.g. Lewens 2015). Those problems are crucial since cultural systems should satisfy what Lewontin (1970) determined as the necessary and sufficient conditions (NCS) for evolution by natural selection: heritability, variation, fitness (namely, causal relation between heritable properties and reproductive success).

Yet those NCS are themselves problematic, because it's not obvious to see what exactly they condition : if variation is not blind, for instance, the conditions will be satisfied but there won't be *evolution by natural selection* (ENS, also labelled here 'darwinian'), since variation rather than selection will be the major cause of traits (Huneman 2017). If the NCS are satisfied but in a very small population, once again natural selection won't drive evolution, but drift will. And if one sees these NCS as conditions for *evolution*, then fitness isn't a *necessary* condition, since any population with varying heritable traits will evolve, just by a kind of diffusion process.

However, there exists another approach to capture the nature of 'evolution by natural selection' - here termed 'conceptual space approach' (CSA) -, closer to the practice of quantitative genetics: heritability, degree of variation' blindness, fitness differences (i.e. 'selection coefficient') and population size define four axes, and all heritable variable systems occupy this conceptual space. Systems with almost no fitness can be evolvable by natural selection if they have very strong selection coefficient, since the breeder's equation shows that the response to selection will still be significant (Falconer & Mackay 1996). Inversely,

systems with very low selection coefficient can evolve by natural selection as soon as they have a very strong heritability, as the breeder's equation shows it.

In short, the CSA approach takes into account the fact that when it comes to characterize ENS, the supposed Lewontian CNS are not independent, but what counts is their quantified relation. In such approach, systems likely to undergo ENS are distributed within a subset of the conceptual space that asymptotically reaches each of the axes. One could even assess the adaptationist character (defined as the domination of NS in driving evolution) of those systems by situating them within this subset.

After having sketched those two ways of capturing what makes a system into a Darwinian one, I'll first show that not all systems that are Darwinian for the CNS approach are Darwinian for the CSA. Then I'll show that the CSA, being more inclusive, is more likely to make sense of cultural evolution as Darwinian, even though the issues of fuzzy heritability and directed variation are not solved, and indicate as examples where some specific cultural systems (regarding music instruments (LeBonin et al. 2016)) can be expected in the CSA subspace of Darwinian systems. I'll finally confront this view to what Lewens (2015) label kinetic theories of cultural evolution, which names mostly population-level theories, and to Mesoudi (2011)'s view of darwinian cultural evolution.

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Evolutionary Debunking Arguments and the Conceptual Truth Objection

Man-Him Ip

Recently, philosophers have discussed epistemological evolutionary debunking arguments of morality extensively (hereinafter 'the EDA'). The EDA starts with an empirical claim according to which evolutionary forces have had a significant influence on what moral beliefs we have. Evolutionary debunkers then aim to show that the epistemic status of our moral beliefs is diminished due to this influence.

In this article, I will focus on one recent realist objection to the argument, that is, the Conceptual Truth Objection. According to the defenders of this objection, moral truths are conceptual truths. They then argue that, for this reason, we can gain moral knowledge by doing conceptual analysis and also that the evolutionary forces are unlikely to have any debunking influence on our ability to know conceptual moral truths in this way. The defenders of the argument are certain that we have evolved to have the capacity to come to know conceptual truths in other domains. They then suggest that we have evolved to have the more specific capacity of conceptually analyzing moral concepts because this capacity is merely an extension of our general ability of doing conceptual analysis in the other domains.

The objective of this article is to defend the EDA. I will argue that the defenders of the Conceptual Truth Objection have failed to explain why we would have evolved to have the competency for accessing the conceptual moral truths through conceptual analysis. I will also argue that this is because the defenders of the argument are mistaken about two important considerations.

Firstly, that one has evolved to have a certain simpler capacity does not always guarantee that one must also have evolved to have the relevant higher capacity. This means that, even if we have the capacity to know conceptual truths in other domains through conceptual analysis, this does not necessarily mean that

we have evolved to have the relevant higher capacity to know also conceptual moral truths through conceptual analysis. Secondly, in light of the bad track record of the suggested analyses of moral concepts, we should be skeptical about the idea that we have the ability to analyze moral concepts. Thus, it seems that the capacity to come to know the conceptual moral truths is not an extended capacity of knowing conceptual truths generally, or so I will argue.

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Is Cosmological Evolution Led by Natural Selection? A misconception in the neo-Darwinian approach

Caglar Karaca

It can be claimed that there are two ways of conceptualizing universal evolution: a strict neo-Darwinian application, which reduces cosmological evolution to a generalized principle of natural selection, and a perspective that is merely based on the emergence of complexity from simplicity, without any preconception about natural selection. I argue that the former approach suffers from a misconception about natural selection, which in fact is a side effect of scientific imperialism; a problem that is solved in the latter approach by acknowledging that the systems that are subject to evolution are partially autonomous and the cosmological evolution has a fragmented nature within its unity. Within this broader conception, self-organization could take its place among other mechanisms of evolution, as it has a major role in the universal increase of complexity (Mitchell, 2012). Self-organization is offered not to replace natural selection, but to emphasize the multiple dimensions of causal factors.

Concerning the assumption about the universality of natural selection, a critical question is how we should contextualize it in biological evolution. I believe that the concept of selection as it is popularized in the neo-Darwinian literature is not well grounded, as it is one-sided due to ignoring the reciprocity of the processes in which an agent is selected. This misconception is led by the categorical distinction between the selected and the environmental condition of which the agent is selected. What goes unnoticed within this distinction is that an agent is subject to selection by the requirements of its environment and also an active contributor to that environment at the same time. There is no one-way influence from the environment to the agent: rather, the agent is part of the dynamicity of the environment as well as being selected within the environment, a process normally referred to

as niche construction (Levins & Lewontin, 2009). Therefore, the agent vis-à-vis the environmental context cannot be taken into account separately. The two aspects of the same phenomenon should be considered with possible feedback loops due to reciprocal effects between the selected and the selecting factors.

I think Kauffman's (1993) theory based on self-organization repairs the fault in the concept of natural selection by acknowledging the factors deriving from the local reciprocity in causal relations. He questions the relevancy of a global optimum in different cases of fitness landscapes. According to the models he proposes, it could be the case that fitness level is trapped in a local optimum through an adaptive pathway. Kauffman (2000) also argues that a system co-constructs its own laws by self-organization like a biosphere does, which could be considered as an alternative way of generalizing evolution. In this sense, it supports the universality of the evolution in a better way.

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From Being Alive to Biological Complexity – A matter of communication

Carolin Löscher

Defining what makes life complex beyond pure (bio)chemistry is one of the unresolved fundamental questions connecting science and theology. Following up the idea of active evolution, we argue that consciousness is the major criterion for complex life (Popper 1994 and Margulis 2003), which finds its expression in the ability to perceive the environment and to communicate on purpose. Communication through electrical signaling is prevalent among biological systems. A well-known example is the action potential in neurons mediated by ion channels. Only recently it has been described that bacteria are able to communicate over distances in the range of several cm in a neuronal network-like way using potassium pulses when artificially stimulated (Prindle 2015). In our own experiments, we found a similar 'communication network' between a sponge and its bacterial symbionts, which puts neuronal network-like bacterial communication to an inter-kingdom level thus emphasizing the ubiquity of this communication type and its importance for species interaction. Symbiosis, as the closest form of interaction, is arguably fundamental for gaining genetic and metabolic complexity through evolution (Margulis 2003) and thus a major prerequisite for the development of complex life per se as it promotes the fusion of genomes and thus the development of genetic complexity. However, cells do not fuse by chance, nucleic acids aren't just randomly exchanged between organisms, particularly not if they belong to different species. Thus, we propose that the abilities to perceive other organisms in an ecological niche and to communicate in a neuronal network-like manner is the basis for symbiosis and thus for the development of complex life in evolution. We thus investigate the presence of a neuronal network-like communication system through a metagenomic mining from an early Earth-like environment (i.e. a deep sea hydrothermal

vent system which formed only recently) similar to where the last unique common ancestor has evolved (Weiss et al. 2016). We compared this example for non-complex microbial communities to communities from symbiotic systems (sponge-microbe, microbial mats) and biofilms. From this approach, we identified a key set of genes specific to a communication network, which was exclusively present in the more complex datasets. Using a Bayesian model approach we explored further when and under which geo-historical conditions the key functional genes for these early communication networks developed to ultimately understand the evolutionary origin of this indicator for complex life. Using this new metagenomics-based approach, our results offer a new perspective on the development of complex life forms.

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The Causal Interactionist Population Concept in Generalized Darwinian Systems

Karim Baraghith

In the following paper, I shall investigate whether a proper theory of cultural evolution (CE) – embedded in the framework of a generalized Darwinism - possesses the ability to synthesize the social sciences, and if CE is a good candidate for closing explanatory gaps between micro- and macrolevel phenomena in the social realm – at least in principle.

In order to achieve this, it should be possible to classify macrolevel patterns, types or clusters in CE. This is not an easy task, for the serious doubt is raised whether it is possible to identify something like "species" (classes defined by their phylogenetic history and intrinsic reproductive barriers and not merely defined by similarity) in CE. However, since this is a crucial requirement for any evolutionary classification, a macrolevel cluster of a similar sort is necessary to realize the expectation that this paper aims to realize. I will suggest to apply the "Causal Interactionist Population Concept" (CIPC), recently formulated by Millstein (2009, 2015) in the philosophy of biology. According to some critical authors, CE is in need of a valid population concept anyway (Reydon & Scholz 2015). Since CIPC is a nonformal hypothesis, I will also present rudiments of a possible formalization of CIPC using graph-theory. Finally, a possible candidate for the micro foundation of this model is presented within the framework of the evolution of language and meaning: the signaling game of coordination, which has been examined in the context of evolutionary game theory (Lewis 1969, Skyrms 2004, Huttegger 2008). It will be shown that this game theoretical micromodel can seamlessly be transferred into a macrolevel population cluster given by the CIPC.

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Finite Populations, Group Structure, and the Evolution of Collective Action: Insights from a Discrete Analysis of the Snowdrift Game

Brian McLoone and Wai-Tong Fan and Adam Pham and Rory Smead and Laurence Loewe

The Snowdrift Game is a social dilemma in which an individual can participate ("cooperate") or not ("defect") in producing a public good (Sugden, 1986). It is relevant to a number of collective action problems in biology, such as collective defense and resource extraction (Conlin et al., 2014; Gore et al., 2009), as well as to issues in distributive justice (Sugden, 1986). One can think of cooperation and defection in this game as a genetically hard-wired or a culturally transmitted behavior.

Traditional models in evolutionary game theory are generally concerned with a single, infinitely large population within which the frequency of behaviors evolves deterministically. It is well known that, when the individuals in such a population play the Snowdrift Game, the population will converge to a stable polymorphism of cooperators and defectors (Nowak, 2006).

However, all biological communities are finite, and many are small and organized into groups. This was certainly the case for ancestral hominins, which has plausibly influenced extant humans' pro-social preferences (Bowles and Gintis, 2011; Tomasello, 2015). Rigorously understanding how finite population size and group structure affect the evolution of cooperation are therefore crucial if we hope to understand the persistence and transmission of cooperative social behaviors within our species.

Using a two-level Moran model (Luo, 2014), we show that finite population size and group structure can qualitatively change the evolution of cooperation in the Snowdrift Game. As we demonstrate, stochasticity within groups, in combination with competition between groups, can increase the frequency of cooperation in the population well above what its value would be in traditional models. Moreover, there is a phase transition, unre-

ported in the literature, below (above) which cooperation will fix (go extinct), almost surely, as population size grows. Our results suggest a possible alternative explanation for high levels of cooperative behavior in finite, group-structured populations, one that does not require cultural enforcement mechanisms. They also call into question the explanatory reach of traditional deterministic models and elucidate the important insights into human cooperation one gleans from considering stochastic dynamics.

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Disagreements in Evolutionary Dynamics

Aydin Mohseni

The replicator dynamics (Taylor & Jonker, 1983) and Moran process (Moran, 1962) represent the main deterministic and stochastic models employed in evolutionary game theory. These two canonical models of cultural and biological evolution are mathematically connected by a meanfield relationship – the former describes the average long-run behavior of the latter (Weibull, 1995). However, there are conditions under which their predictions diverge. I demonstrate that the divergence between their predictions is a function of standard techniques used in their analysis, and of differences in the idealizations involved in each. Specifically, of the assumptions of infinite populations sizes and time horizons, and infinitesimal mutation rates and selection intensities. This analysis reveals problems for stochastic stability analysis of a broad class of games. These results have key implications, in particular, for models of cultural evolution, where mutation rates, or noise in the imitation or transmission of behaviors, may be quite high (Boyd & Richerson, 1988).

There has been a great deal of work analyzing stochastic evolutionary models (Young 1998; Taylor et al, 2004; Fudenberg et al, 2006; Nowak, 2006; Sandholm, 2010). There have been several proposals for how best to predict their probable outcomes. Central among these proposals are the ESSN (Nowak, 2006), which adapts the concept behind the ESS (Taylor & Jonker, 1983) into stochastic terms via fixation probabilities, and stochastic stability (Foster & Young, 1990), which picks out the probable outcome(s) of an ergodic process via its limiting distribution as the mutation rate approaches zero. My analysis demonstrates problems for both concepts for a broad class of games – namely, those that exhibit polymorphic equilibria. The assumptions of vanishing mutation, weak selection, and infinite time horizons allow for particularly simple characterizations of the behavior of the Moran process. Analysis of the Moran pro-

cess via fixation probabilities requires the assumptions of the absence of mutation, weak selection and infinite time. Stochastic stability analysis requires vanishing mutation and infinite time. These assumption are typically taken as acceptable approximations of the modest mutation rates observed in nature, diminutive contributions of traits of interest to the net fitness of organisms, and of long but finite time horizons. Perfect randomness of mutation is assumed.

What I show is that given these assumptions, stable polymorphisms become impossibility for the Moran process. This is problematic, as stable polymorphic states are empirically well corroborated (Sinervo & Lively, 1996). I demonstrate that even the infinite horizon behavior of the Moran process can qualitatively differ from what is shown under standard methods of analysis. But the results are not entirely negative. I also demonstrate a novel domain of agreement between the replicator dynamics and Moran process that characterizes precisely when it is admissible to use standard analytic techniques for the latter, and when we should anticipate the long-term persistence of diversity. I conclude by drawing broader morals for the effects of non-vanishing, and non-random mutation in evolutionary modeling.

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The Cultural Red King Effect

Cailin O'Connor

Some types of people get more and others get less. In this talk, I outline a cultural evolutionary pathway by which members of minority groups end up disadvantaged in bargaining scenarios simply by dint of the size of their group – the cultural Red King effect (Bruner, 2017). When a minority and majority group interact, the minority individuals tend to meet their out-group more frequently, while the reverse is not true, leading to differential learning rates. This means that the minority group will often quickly learn to make low, accommodating bargaining demands, which the majority will eventually learn to take advantage of. This is analogous to results in biology, showing that sometimes a slow evolving species can gain an advantage in mutualistic interactions by dint of this speed differential (Bergstrom and Lachmann, 2007).

In particular, I use explicitly cultural models of the emergence of conventions, first developed in economics (Young, 1993, Axtell, Epstein, and Young, 2001), to assess the potential relevance of this effect to the real world. As I show, a number of realistic factors strengthen the effect. When actors are risk averse, show in-group preference, or follow pre-existing discriminatory norms, the cultural Red King effect has greater potential to disadvantage minority members. These results are also robust on network models of interaction. I use these results to argue that the cultural Red King may be at play in the emerge of real cultural norms and conventions.

I also briefly discuss experimental evidence designed to test this effect. We find that actors in lab experiments, even those who are ignorant about the group structure they interact under, tend to get less in repeated bargaining interactions if they are in a minority group. This seems to be the result of a learning process whereby the minority group participants come to demand less and the majority group more over the course of experimental trials.

Lamarckian Inheritance and the Generalized Theory of Evolution

Íñigo Ongay de Felipe

Some controversial suggestions have recently arisen within the present-day debate about the Extended Evolutionary Synthesis (EES) to the effect that research in epigenetics, developmental biology and phenotypic plasticity and behavioral biology do in fact constitute a vindication of certain aspects of the Lamarckian theory of evolution which had been excluded in the Synthetic Theory. The contributions of a range of researchers including Denis Noble, Mary Jane West-Eberhard and Eva Jablonka to name but a few, provide an abundance of examples of that. While the question clearly has interesting conceptual implications for evolutionary biology and philosophy of biology alike, so far a detailed discussion of the problem is generally lacking. This paper approaches some present directions in empirical research on biology with a view to elucidating its relations to Lamarckism. To that end, an unraveling of what the Lamarckian theory is taken to mean is proposed as such clarification will cast light on the scope and meaning of the so called epigenetic Lamarckism.

The inheritance of acquired characters, as Jean Baptiste Lamarck classically envisioned it in his Philosophie Zoologique, consists of the idea that phenotypic traits acquired during the life span of organisms (perhaps by the use and disuse of certain body parts) are then transmitted on to the next generations of individuals. So described, such – clearly vague – notion, which of course was fleshed out in different ways within Lamarck's biological framework, has been historically conceived of as an important causal and explanatory factor in very many accounts of evolution including those put forward by writers like Robert Chambers, Erasmus Darwin, Herbert Spencer, Ernst Haeckel or William McDougall to name but a few. It is perhaps more noteworthy to consider that Charles Darwin himself fully embraced this notion in more than one way in such seminal works as The

variations of Animals and Plants under Domestication (1868) or The Expression of Emotions in Man and Animals (1872). I shall show that the notion of Lamarckism encompasses various components and so can be construed in a number of ways each bearing a different relationship to the Extended Evolutionary Synthesis. In particular, I will distinguish the teleological view of evolution which Lamarck proposed historically (L1) from other versions of soft inheritance which include no particular commitment to a directional teleological understanding of evolutionary change. I will argue that while neither L1 nor L2 are vindicated in the EES, some of the new developments in evolutionary biology seem to indicate that a softer and arguably more modest version of the (non-genetic) inheritance of acquired traits (L3) plays a proper role in Evolution in ways not contemplated by the Synthetic Theory.

Does Evolutionary Theory Have a Unified Conceptual Foundation?

Grant Ramsey

The theory of evolution by natural selection is often described in general, abstract terms. In Lewontin's (1970) classic rendering, evolution by natural selection involves variation, heritability, and fitness differences. Such general characterizations seem to imply a unity, that there is a general answer to questions like, what is fitness? But this apparent unity is called into question by biological practice. Concepts like fitness, selection, and drift are understood in vastly different ways in different areas of biology. Ask a population geneticist what fitness is and you may receive a reply that fitness is a rate of change of types of genes (alleles) in a population. By contrast, ask an organismic biologist about fitness and they are apt to reply that fitness is a property of individual organisms – it is something like their expected number of offspring.

In face of this apparent disunity, there are two ways we might proceed. One is to search for an underlying unity, the other is to argue for an ineradicable disunity. The disunity approach takes the diversity of concepts to indicate that there are no general concepts that we can use to theorize about evolutionary theory. This is the position argued for by philosopher Ken Waters, in his (2018) "no structure argument," which uses the example of genes and argues that there is a heterogeneity of genetic concepts and practices; what people take to be genes differs depending on the area of biology that they are working in and on what questions they are hoping to answer. It would be a mistake, argues Waters, to ask what, fundamentally, a gene is. He extrapolates from the example of the gene to argue that there is no general structure to biology, or to science in general for that matter. Thus, talk of the "causal structure of science" is mistaken.

I hold that for some concepts, Waters is correct: it is a fool's errand to search for a fundamental, general structure. However,

while some biological phenomena like genes and species don't seem to be amenable to singular definitions, I hold that this is not true of all concepts. What these and other phenomena incapable of a general, singular account have in common is that they refer to biological products. Species and genes are biological products and, as such, we would expect them to be diverse and lacking an essence. Not all biological concepts concern products, however. Fitness, selection, and drift refer not to the products of evolution, but to their processes or causes. And it is consistent to hold that perfectly general causes can lead to a heterogeneous set of outcomes. In this paper, I argue for a general foundation for evolutionary theory and offer general accounts of important foundational process and cause concepts in evolutionary theory, and then to say how these concepts are related to one another.

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Inclusive Fitness: How Not to Import Ideas from Cultural Evolution

Hannah Rubin

Inclusive fitness, first proposed by Hamilton (1964) to help explain the evolution of social behavior, looks at the reproductive success of an organism's relatives, rather than just the organism's own reproductive success. More specifically, inclusive fitness calculations include the offspring caused by an organism: how it affects its own fitness and the fitness of its social partners, weighted by its relatedness to its social partners. While it is often asked whether concepts from biology can be used to study cultural evolution, the opposite question is of importance here. I will argue that bringing in ideas from cultural evolution (i.e. personifying organisms and treating them as agents) in explaining the concept of relatedness has led to (at least) two major problems within inclusive fitness theory.

'Relatedness' is a measure of correlation – it measures the likelihood that organisms share genetic material. However, as an intuitive gloss, relatedness is often described as how much an organism 'cares' about its social partners (e.g., West and Gardner, 2013). The idea is that if we are thinking about an organism wanting to pass on its genes, and relatedness tells us the likelihood its social partner has these same genes, we can think of relatedness as measuring how much an organism cares about its social partner's reproductive success. While this interpretation of relatedness can be useful in cultural evolution (e.g. in representing altruistic preferences), personifying organisms in this way has led theorists astray.

First, it has led to erroneous claims that inclusive fitness fills an essential role in evolutionary theory. It is claimed that the main purpose of inclusive fitness is to allow us to view organisms as designed to maximize their fitness, that this preserves Darwin's insight about natural selection leading to the appearance of design, and that no other concept of fitness can fill this role

in explaining social behavior (West and Garner 2013). However, I argue that this reasoning is flawed: it rests on the assumption that inclusive fitness only includes the causal consequences of a trait, ignoring that relatedness is a measure of correlation.

Second, thinking of relatedness as how much an organism cares about its social partner perpetuates reliance on an unreliable heuristic method of estimating inclusive fitness, often called the 'simple weighted sum'. It is well known that this heuristic has a problem with double counting, but it is still relied on heavily, especially within the animal communications literature (e.g., Maynard Smith 1991). However, I argue a more troubling problem is that this heuristic is unable to account for correlations, which is exactly what relatedness is meant to capture, leading to drastically incorrect predictions about the likelihood of evolutionary outcomes.

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A Case for (Econo-)Memetics: Why we should not throw the baby out with the bathwater

Michael P. Schlaile

The dominant paradigm in economics fails to allow for both culture and evolutionary dynamics. Although evolutionary economics has contributed to our understanding of the economy as a complex and evolving system, also evolutionary economists seem to largely neglect cultural evolutionary dynamics. Moreover, some authors, including Dopfer and Potts (2008), Hodgson and Knudsen (2010), or Nelson and Winter (1982) have proposed units of selection (or even replicators in analogy with genes) but at the same time refrain from calling them memes and reject explanations making use of memetics. Thereby, one could get the impression that evolutionary economists (and many cultural evolutionists alike) keep throwing the proverbial baby out with the bathwater.

This contribution, therefore, aims to (re-)evaluate the (f)utility of memetics by making a case for a memetic approach to (socio-)economic evolution on several levels. Based on an informational perspective on memes (following Dennett, 1995, 2017) –as opposed to restricting memes to brains (see also Schurz, 2011, Chap. 9.4) – we first propose a threedimensional view on memes as depicted in Fig. 1.

Building on this trichotomy and the notion that "no meme is an island" (Dennett, 1995, p. 144), we argue that memes can be understood as entities of complex population systems (see, e.g., Hodgson and Knudsen, 2010, for this terminology). These entities interact with the environment and each other, face scarce resources (e.g., attention), struggle to survive, and may pass on their information through replicative imitation by humans. An exemplary complex population system of memes (i.e., memeplex) with different sub-populations is illustrated in Fig. 2.

Within the course of the contribution, we develop this perspective further by means of a network-scientific approach, where

not only the underlying social relations of human carriers but also the meme(plexe)s and their compatibility relations within an agent can be described as a network (as illustrated in Fig. 3).

Finally, in addition to the analysis of an agent-based model that makes use of this perspective to simulate the diffusion of memes, the contribution also presents a memetic perspective on the Ice Bucket Challenge, a viral Internet phenomenon from 2014 which had a tremendous economic impact in terms of fundraising.

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Figures
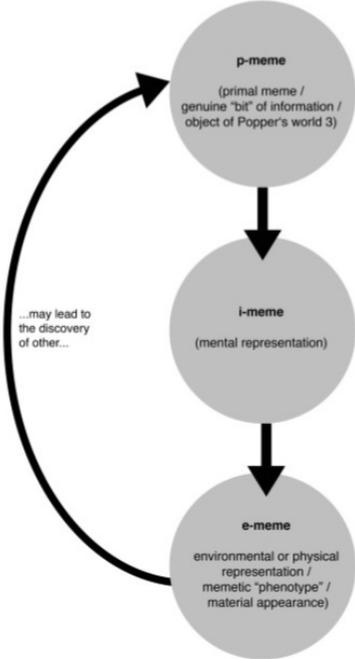
Figure 1: The three-dimensional (P-I-E) perspective on memes
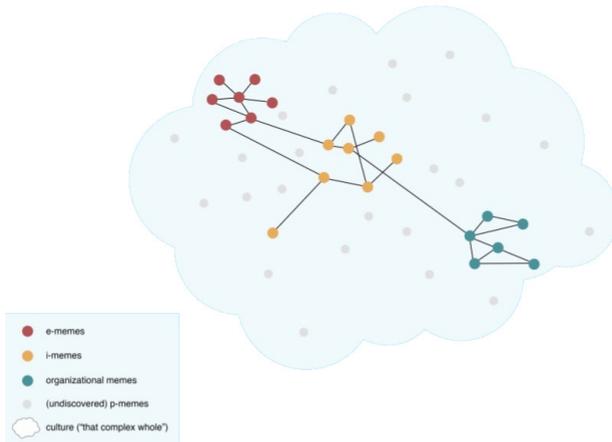
Figure 2: (Schematic) illustration of an exemplary complex population system of memes with different sub-systems. Memes are represented by nodes and compatibility relations between memes are depicted by edges.
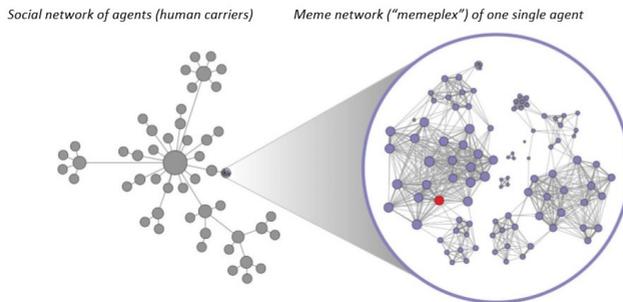

Figure 3: A network-of-networks approach, where memes and agents are represented as elements of different networks

The Many Faces of Epigenetics (and their impact for evolutionary thinking)

Sebastian Schuol

The current debate about a general theory of evolution is inspired by parallel discourses on epigenetics. In light of research findings on gene regulation, former insuperable theoretical barriers, as the nature/culture- or the body/mind-dualism, seem repealed and the way paved for a holistic way of thinking. Early research findings in neuroepigenetics show e.g., that mental states like fear or aggression have effect on the material level, (namely the regulation of genes), and this in turn determines long turn effects back again on mental level. In the light of epigenetics, it seems that formally gaps in theory could be spelled out mechanistically. Thus, epigenetics appears as "the" missing link for a general theory of evolution. Despite these spectacular research findings, this reputation rushes ahead and further research is necessary. In face of the complex biological phenomena and hitherto little-understood relationships from the macro to the molecular level seems less the factual knowledge, but rather the conceivable (the bare possibility of this link), that inspires thinking. Thus, it is important to examine the concept of epigenetics. Since epigenetics has a crucial role in the debate and there are different meanings of, these may influence the debate about the general theory of evolution on an epistemic level. My main target is not to define epigenetics - an ontological restriction will hinder the research. Instead, various independent connotations of epigenetics will be differentiated so that the related associations can be taken into account early on in the debate. Among these are the following:

1. Because of the ambiguity of the adjective "epigenetic", epigenetics and epigenesis are often equated.

2. The original concept of epigenetics refers to a synthesis between genetics and the theory of epigenesis.

3. The term was used in psychoanalytic research to investigate transgenerational transmissions of trauma.

4. The term was used in epidemiology as plausible explanation for the transmission of metabolic diseases.

5. In evolutionary theories, epigenetics refers often non-specifically to "soft" inheritance beyond DNA.

6. Similar to the term postgenomics epigenetics is also often used in a pure temporal, i.e. epochal meaning.

7. In a spiritual movement (New Biology) epigenetics refers to a metaphysical argument (mind over body).

8. Finally, epigenetics refers to a research program of molecular biology that investigates gene activation.

In short, my argumentation is the following: The general theory of evolution is discussed in terms of a network theory. Along most network theories, especially linkages are of crucial importance. In the actual debate on evolution, epigenetics is treated as a central linkage. The pre-understanding of epigenetics shapes the understanding of evolution.

Adaptation by Natural Improvisation: A theory of individual-specific adaptation

Yoav Soen

Every individual organism is endlessly challenged by internal perturbations in its somatic genome, epigenome and gut microbiome. This gives rise to an unimaginable number of novel combinations of changes that are unique to the individual. Coping with such a high frequency of individual-specific perturbations is not accounted for by the (population-based) theory of natural selection. How individual-specific adaptations is achieved is a fundamental open question with far reaching implications for every complex system.

To address this question we recently proposed a theory of individual-specific adaptation, based on a new principle of organization that is complementary to natural selection (Soen 2015). This concept (termed "Adaptive Improvisation") explains how biased random variations over time in every individual can safely and rapidly confer a wide range of newly-forming adaptations. While this principle applies to any kind of variation (epigenetic, physiologic, symbiotic, genetic, etc), it is not intended to point out the emergence of stochastic variations (which is easy), but rather to explain how these variations self-organize to provide solutions to novel perturbations. In some of the specific realizations of this concept, the newly acquired solutions can be also inherited, thus enabling further improvement and assimilation in a few generations.

Experimental (Stern et al. 2007, Stern et al. 2012) and theoretical (Schreier et al. 2017) evaluation of this theory provide evidence supporting a capacity to adapt by exploratory dynamics over time in a single generation. I will describe this Lamarckian theory and present new supportive evidence (unpublished).

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The Role of Culture in the Evolutionary Process: A pluralistic perspective

Francesco Suman

In evolutionary terms, culture is defined as information capable of affecting individuals' behaviors that they acquire by members of their species through imitation, teaching and other forms of social transmission (Richerson and Boyd, 2005). Given this definition, however, the role that culture plays in the evolutionary process may vary according to the evolutionary conceptual framework one adopts. Two issues will be taken into account: 1) whether culture is best understood as a proximate mechanism or as an ultimate cause and 2) the extent to which the genotype-phenotype distinction can be applied to culture.

Supporters of the Standard Evolutionary Synthesis (SET) argue that processes of cultural transmission should be treated exclusively as proximate mechanisms (Scott Phillips et al., 2011; Dickins and Rahman, 2012), while supporters of the Extended Evolutionary Synthesis (EES) argue that culture should be treated as an ultimate cause for the evolution of certain traits, as it is capable of altering environmental selective pressures, contributing to phenotypic expression and variation, interacting with the genetic level in gene-culture co-evolutionary dynamics (Laland et al., 2011; Laland et al., 2013).

An updated version of the assimilate-stretch principle (Dor and Jablonka, 2014) will be taken into account as a plausible conceptual model underlying the last major bio-cultural transition occurred in hominin evolution and the evolutionary and adaptive processes in play will be discussed in the light of both the SET and the EES conceptual frameworks.

Here it is argued that the SET view assigns a too restrictive role to culture, while the EES view provides a pluralistic perspective as it assigns different roles to culture in the evolutionary process. The latter perspective will be further discussed arguing it doesn't result clear whether culture is best understood as a

genotype (contributing to phenotypic expression and variation across generations) or as a phenotype (the result of organisms activity).

It is suggested that in order to justify this pluralistic perspective, the concept of reciprocal causation should be included in the conceptual and explanatory toolkit of the evolutionary research program; however, this concept has not been developed and conceptualized properly yet.

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Creativity Within Evolutionary Epistemology

Theo Stone

The general aim of Evolutionary Epistemology (henceforth EE) is to advance our study of knowledge by blending it with the concept of biological evolution, in order to ground it within a more naturalistic framework. However, it can be argued that EE has not succeeded in integrating with more recent developments within the surrounding frameworks; cultural evolution being a strong example of this.

This paper will explore how our culturally selective framework, as seen through a contemporary Darwinian lens, could used to both rethink and answer a continuing, unsolved disputes within epistemology. An example of one of the major, unsolved problems is the existence of Creativity, which is what this study shall focus on. Indeed, the existence of it is puzzling from the perspectives of both the evolutionary and the selective.

What I wish to argue is that Darwinian Evolution offers us the ability to model the evolution of cultural and scientific ideas in a manner that is more successful than Mesoudi's (2011) requests for a rediscovery of early evolutionary epistemology, and its like to the evolutionary and cultural understandings of science and its faculties. Indeed, we can say that, through the epistemological relevance that Darwinian Evolution holds for the origin of cognition, it thereby opens a gateway to explore the origins of more cultural concerns within EE.

I will further argue that this notion of the cultural adaption to Brigandt's (2012) concept of 'Epistemic Aims' ("assumptions about what issues are currently in need of scientific study and explanation" (ibid.). grants us a pathway to demonstrate how biases and preferences can shape the course of our cognitive evolution, and thus further the development of Creativity as a cognitive phenomena, as well as one that can be transmuted to reflect the development of Science as a concept; through its development as the outcome of selective processes that themselves

contain selective mechanisms.

As such, I will conclude that, when examined through the lens of Evolution, and applied to a cultural meta-framework, we are able to better-understand the nature of some of our most familiar, and yet most alien, cognitive features, and that the models presented to us through this methodology allow us to properly model a study of the conceptual changes in science.

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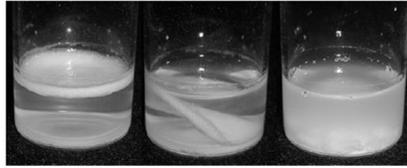
The Evolution of Multicellularity: Cheating done right

Walter Veit

For decades Darwinian processes were framed in the form of the Lewontin conditions: reproduction, variation and reproductive success taken to be sufficient and necessary. Since Buss (1987) and the work of Maynard Smith and Szathmáry (1995) biologists were eager to explain the major transitions from individuals to groups forming new individuals subject to Darwinian mechanisms themselves. Explanations that seek to explain the emergence of a new level of selection, however, cannot employ properties that would already have to exist on that level for selection to take place. Hammerschmidt et al. (2014) provided an experiment corroborating much of the theoretical work Paul Rainey has done since 2003 on how new Darwinian individuals on a multicellular level can occur with a relaxed version of the Lewontin conditions. In this paper I will evaluate the significance of their experimental results for future research and the debates surrounding multi-level selection and a more generalized theory of evolution.
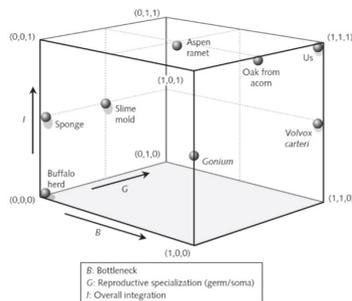
Godfrey-Smith (2009, p. 95)

Rainey & Kerr (2010, p. 875)

When it comes to the evolution of multicellular organisms and the emergence of new Darwinian individuals on a higher level, too much focus has been spent on cooperation alone. As Rainey noted, a mechanism of group reproduction and a mechanism to minimize the adverse effects of cheats are further necessary conditions that might together with cooperation be sufficient for the emergence of new Darwinian individuals. This neatly matches onto the threedimensional matrix for Darwinian individuality Godfrey-Smith proposed: a bottleneck during which a propagule marks the beginning of a new life cycle, a germ line being specialized for reproduction of the collective and overall integration of the individuals forming a new individual rather than just a group. All of these come in degrees, and the Hammerschmidt et al. paper beautifully shows how the first steps can be taken towards Darwinian individuality. The problem of cooperation, group reproduction and minimization of adverse cheats can be solved, by seeing cheats as the first single-cell propagules marking the beginning of a new life cycle through a bottleneck. This introduces the germ/soma distinction and makes further refinements possible. A cheat-purging regime did not manage to decouple mat fitness from the fitness of the cells, while contrary to intuition the cheat-embracing regime captures the first step towards Darwinian individuality, by showcasing that mat fitness increases independently from the decreasing cell fitness. The cells start to "work for" the organism. Their carefully conducted experiment corroborates much of Rainey's theoretical work over

almost two decades. Their MLS approach provides strong evidence that cheats and conflict, contrary to intuition are what drives the evolution of multicellularity.

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The Emergence and Change of Linguistic Meaning

Rafael Ventura

In this paper, I study an extension of Skyrms' (2010) model for the emergence and change of linguistic meaning. In the model, Nature selects one of three states of the world. Next, the sender observes the state of nature. The sender has three urns, each representing a possible state of nature. After observing the state, the sender chooses the urn that corresponds to the actual state of nature. The sender then draws a ball at random. At first, each urn only has a black ball. Whenever the sender picks the black ball, the sender invents a new signal. The invention of a new signal is represented by adding a ball of a new color into the urn. Each ball color represents a different signal.

The receiver does not observe the state of the world but observes the signal that the sender sends. The game starts with no signals, so the sender must first invent a new signal before the sender and the receiver can communicate. Whenever the sender invents a new signal, the receiver creates a new urn. In each urn, there are three balls of different colors. Each ball color represents a different act. Upon receiving a signal, the receiver chooses the corresponding urn and picks a ball at random. If the color of the ball matches the color of the state of nature, the act is successful. If the act is successful, the sender and the receiver return the ball to the original urn and add to that urn another ball of the same color. If the act is not successful, the sender and the receiver return the ball to the original urn but do not add another ball.

At the end of every round, there is also a chance that a signal is forgotten. If a signal is forgotten, the sender destroys all balls corresponding to that signal and the receiver destroys the corresponding urn. The probability that a signal is forgotten is inversely proportional to how successful the signal has been in past rounds.

In this model, signals quickly acquire meaning. As new signals are invented and old ones forgotten, signals also change. Signal change represents language users developing neologisms and words falling into disuse. Interestingly, this model of linguistic change recreates the relationship observed between the rate of lexical change and frequency of word use in natural languages Pagel et al. (2007). That is, words change in inverse proportion to their frequency of use. Indeed, simulations of the model presented here indicate that commonly used signals tend to be older than infrequently used ones.

This suggests that Lewis-Skyrms signaling games can be used to explain not only the emergence of linguistic meaning, but also other evolutionary aspects of natural languages – such as the rate of lexical change. It should also be noted, however, that the model studied here assumes that signals are lost with probability that is inversely proportional to their success rate. This assumption is intuitively plausible, as selection should prevent fitness-enhancing words from being lost. But this is an assumption that should be tested empirically. Despite this limitation, the present model of signaling with reinforcement learning provides a fruitful framework for understanding not only how meaning emerges, but also how signals evolve.

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Plant Stress Physiology

Özlem Yılmaz

In this talk, it will be argued: Plant stress physiology, which is an important area in plant science, is a very good example of "how thinking life as processes rather than things" (Dupré, 2012) is a good way for our understanding. There are many concepts in plant stress physiology literature, for example: Stress, Stress tolerance, Stress avoidance, Plasticity, Acclimation, Chronic stress, Transient stress, Strain, Plastic, Signalling, Adaptation, Constitutive traits, Adaptive traits, Developmental plasticity, Norms of reaction, Induced responses, Intraindividual plasticity, Induced differentiation, Active plasticity, Passive plasticity, Phenotypic flexibility, Maternal effects, Cross generational plasticity.. (and many more). Of course, it is very plausible that we use many concepts in this research area which deals with very complex phenomena. I argue, there is a need for a philosophical analysis of some main concepts in plant stress physiology, and I will do that analysis via process metaphysics. Process thinking is everywhere in plant stress physiology research. We can easily trace this processual character through descriptions, measurement methods and experiment designs.

There is always a dynamic interaction between an organism (a plant) and its environment and organisms express themselves through this interaction. Plants face stress conditions when there is a stimulus which is outside the 'usual' changes in environment. The stressor stimuli, which can be biotic (some species of bacteria or fungi, etc.) or abiotic (drought, high or low temperature, high light, etc.), are not related to daily or seasonal changes and they cause much more 'altered' phenomes which even may be called as 'injured'. There is a degree of injury (or death) in the stressed organisms depending on the resistance ability of the individual organism to the stressor and the wider context in which the organism encounters the stressor. The encounter is the key for responses of plants and it is constituted from all the envi-

ronmental parameters (including the stressor) and the phenome of the organism at that particular moment. The phenome has been constituted from the effects of all the previous encounters; it has abilities and plasticity because of all the previous processes of both its own life (in its phenome and epigenome, if it has encountered the stressor before, it may have acclimated in ways that affect its response in subsequent encounters) and of its ancestors (in its genome, through evolutionary processes). If it has adaptive features relevant to the stressor in its genome, its responses will be effected by this. Also in its epigenome, it has effects from more recent ancestors, notably parents. The organism's resistance reflects a tendency to survive and to reproduce (because of evolutionary processes), but this is not a tendency towards a specific phenome; it can become a vast number of phenomes depending on details of the encounter.

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