**Three Kinds of Constructionism: The Role of Analogies and Metaphor in the Debate over Niche Constructionism**

**Abstract**

Throughout the year a lively debate has flourished around Niche Construction Theory. The debate involves a persistent disagreement between the advocates of niche constructionism and its critics. The critics propose a distinction in narrow construction, limited to the production of evolutionary advantageous artefacts, and broad construction, of which they are unwilling to recognise the relevance in evolutionary processes. On the other hand, constructionists point out the universality and relevance of any construction process in evolution. I will argue that those two categories rely respectively on the figure of speech of analogy and on the figure of speech of metaphor. Afterwards I will introduce a further distinction in the figure of speech of analogy, offering a three-tier categorisation of constructionism: literal, analogical and figurative construction. Throughout this categorisation I will show that, unlike the current opinions, the real core of construction theory lies in the part of what has been so far classified as broad construction, and that the constructionist research programme has a different aim from the adaptationist programme, relying also on a different kind of causation. This approach offers an economical way to categorise construction cases, to compare them with other theories, and to throw light on constructionist theories. In the context of a broader overview of philosophy of science it also shows how metaphors have influenced the structure of the theories, and which kind of constraints arise from the way a theory is develop.

**Keywords**: evolutionary biology, niche constructionism, adaptationism, metaphor, analogy, extended phenotype.

**1 Introduction**

In 2003 Odling-Smee, Laland and Feldman presented *Niche Construction - The Neglected Process in Evolution*. Almost 10 years later, the debate over niche construction is still lively and attractive to scholars. To date, the most relevant discussions on this topic took place in *Biology and Philosophy* (issue 20, 2005). Sterenly, Griffiths and Okasha debated the main points of Niche Construction Theory (henceforth, NCT). Their remarks all point in the same direction: they recognise two kinds of construction activity. In short they claim NCT has a strong adaptive core with a weak ecological wrapping. They endorse the first position as a positive contribution to evolutionary biology, while they dismiss the second as irrelevant. It goes without saying that constructionists felt misunderstood and remarked the relevance of their arguments. It is time now to return to the debate from 2005 because it remained inconclusive, failing to offer a satisfactory solution for either party. A permanent disagreement has been established, a sign that the way the debate has developed may well fail to bring us a solution.[[1]](#footnote-1) In order to restart the debate I will argue that the key element of NCT, namely the metaphor of construction, can lead us to a better categorisation and understanding of the whole theory and its relation with evolutionary biology. I will propose a new categorisation identifying, instead of two, three kinds of constructionism to describe NCT). This is more than just a Godfrey-Smithsonian pun in my title. The three categories come from Roger White’s distinction (White 2010) of three types of metaphor/analogy, on which my argument is based. This paper illuminates the NCT debate in two main ways. First, the division into three types allows us to detect a relevant distinction in the cases of construction, increasing our understanding of constructionism itself. Second, it gives us an explanation of the persistent disagreement in the debate involving NCT and the standard evolutionary theory (SET).[[2]](#footnote-2) In addition, it offers us the possibility to restart the debate on niche constructionism from a fresh perspective and, in relation to the permanent disagreement for this particular debate, this analysis could be instructive for other debates of a similar, persistent, inconclusive character.

**2 On the use of analogies and metaphors in science and biology**

It is not possible to do the work of science without using a language that is filled with metaphors (Lewontin 1998, 3). Virtually the entire body of modern science is an attempt to explain phenomena that cannot be experienced directly by human beings. Metaphors allow us to refer to forces and processes that we cannot perceive directly because they are too small, like molecules, or too vast, like the entire known universe; the result of forces that our senses cannot detect, like electromagnetism, or the outcome of extremely complex interactions, like the coming into being of an individual organism from its conception as a fertilised egg (Genter 1982, 108; Pepper 1942, 91-2).[[3]](#footnote-3) For instance, the metaphor of adaptation has been extremely productive, as the metaphor of selection was productive before. Metaphors in science, as shown by Bartha and Brown, serve an explanatory role and are a stimulus to new experiments. Metaphors may be very simple and evocative initially, but soon they grow more detailed and refine themselves as research findings support or disconfirm inferences drawn from the initial metaphor/analogy (Bartha 2010, 11, 117; Brown 2003, 29; Henle 1958, 186).

Metaphors have been essential in the development of biology. The journey started in 1628 with the publication of William Harvey’s *Exercitatio de motu cordis et sanguinis in animalibus* (Object Lesson on the Motion of the Heart and Blood in Animals). Harvey, who was an Aristotelian, explained the circulation of blood as the result of a mechanical pump that moves the blood tissue and the valves and pipes that regulate the flow. Harvey used the metaphor of the organism/mechanism, soon to be elaborated by Descartes in part V of the *Discourse*. Descartes elaborated upon Harvey’s analogy, comparing the entirety of organismic functions to a machine. Descartes compared organisms to clocks with gears and levers and to mechanical pumping systems. This marked the rise of the *bête machine* metaphor, to be fully developed during the seventeenth and eighteenth centuries. The heart became a pump, bones and muscles were levers and pulleys, the circulatory system was reduced to plumbing and the spinal discs became shock absorbers. Darwin started from the analogy between the familiar artificial selection and natural selection (Darwin 1859).[[4]](#footnote-4) There is evidence that Darwin did not consider the internal factors more relevant than the external, especially when referring to “line of life” and thus leaving blank space for whom would have been keen to investigate feed-back loop relations between organism and environment (Darwin 1859, 303, 321; Wallace, 1853, 469 in Stauffer 1975, 379). Nevertheless Darwinists and Weismann diverted evolutionary studies toward a one-way, gene-centred causation. The genesis of this distinction dates back to Neo-Darwinians, Alfred Russell Wallace, and the German biologist August Weismann, who discovered the “germ-plasm” (chromosomes) in cells in 1883 (Bowler 1983; 1989, 89; 1992, 357-8; Hutton 1899; Weismann 1885). Organisms have an immutable set of genes that is passively selected by the environment and its challenges. The germ-plasm changes because of internal factors and the selection of these variations is the only way to transmit features to descendents (Bowler 1983, 41; 1988; Weismann 1883b; 1885). Weismann and Darwinists introduced an absolute separation between the internal process that generated the organism and the external process, the environment, in which the organism operated (Lewontin 1998, 42; Sumner 1922, 224-233). Building on this tradition in the Modern Evolutionary Synthesis by Fisher, Haldane and Wright, the authors focused on the metaphor of adaptation, and adaptationism became the main research programme in evolutionary biology.

The distinction between internal and external factors does not represent an issue for the *bête machine* metaphor, except in cases when that which is outside may interfere with the machine’s normal functioning, like selective pressure. As technology progressed, the ruling metaphors were adapted. The physical creation of the abstract Turing Machine, the computer, shows the separation between the mental labours (software) from the physical components (hardware) better than any of Descartes’ dualism. The immense ideological power of this metaphor extends from a model for the nervous system to a model for the entire organism.

The genes contain the strings of the programme (which we call a “code”) while the hardware (cells using ribosome, tRNA and mRNA molecules) simply reads the code and executes the instructions.

The last widely known analogy introduced in evolutionary biology before constructionism is contained in the Extended Phenotype Theory (EPT), in which the idea of genetic inheritance is moderately expanded (Dawkins 1982). From the *bête machine* to the extended phenotype, there is a common denominator: those metaphors are all strictly related to a one-way causation model, in which the role of causes and effects is mechanically and neatly defined according to the Cartesian-Newtonian model.

Richard Lewontin was the first to recognise that Darwinists created a dramatic rupture in the Darwinian intellectual tradition by alienating the internal from the external factors and favouring the future gene-centric vision. According to him, the adaptationism programme, although it started as the solution, in time became the problem. He accused adaptationism of being ideological and partial, and working with the population ecologist Richard Levins insisted that reductionism and overly mechanistic conceptions of evolutionary dynamics could be countered only by adopting a dialectical philosophy of biology that acknowledged the relevance of the interaction between organism and environment (Depew and Weber 1995, 104, 110, 362; Levins and Lewontin 1985, 276; Lewontin 1978; 1983; 1991; 1998, 38; Lewontin and Levins 2007, 53-5, 222-5; Sober 1985; Wilson 1941, 73).

**3 Analogies and metaphors in science**

In order to introduce the argument on three kinds of constructionism, it is necessary to explore the concept of metaphor. The word metaphor comes from the Greek words *meta* (over) and *pherein* (to carry), to carry over, to transfer a meaning or a feature from one set of objects, ideas, feelings, to a different set which is not necessarily heterogeneous. However, it is important to distinguish metaphor from analogy. A metaphor is a figure of speech, thus a linguistic construct; an analogy is a non-linguistic resemblance between objects or state of affairs. The relationship between analogy and metaphor, roughly, can be explained as follows. If the image of fluid is used to explicate the supposed action of electrical energy, then the fluid is functioning as a model to convey the nature of electricity. If, however, idioms like “rate of flow” or “electric current” are used, then a metaphorical language based on the fluid model has taken over. Strictly speaking “rate of flow” does not have the same meaning when used in the context of electrical phenomena as it does when speaking of liquid (Martin and Harre’ 1982, 96-8). The model produces a number of metaphorical terms (flow, quantity of electricity, resistance and so on) that are normally applied in the study of electric phenomena, but clearly without the intention to build a point by point comparison between the behaviour of liquid and electrical energy (Martin and Harre’ 1982, 100).

The argument of this paper relies on White’s distinction of three types of metaphor/analogy.[[5]](#footnote-5) White (2010, 69-70) recognises three possible ways to use the same word in very different context. The first two are analogies, the third is a proper metaphor. The word has a single sense applicable to a wide range of analogically related phenomena (type 1); the word has two senses, in which the second is the extension of the first (type 2); the word assumes a figurative, or properly metaphorical, sense (type 3). According to White (2010, 25), the first step in building a successful metaphor must be a comparison by analogy, which provides the means of using one situation as a model for another (type 1 and 2). The analogy, as Genter also states, is an immediate sign of its literal sense and a mediate sign of its figurative sense. Analogies are productive because of their ability to translate the structure of reality from one set of objects to another. But it is only through the literal sense (Henle 1958, 191; White 1996, 242-3) that we can arrive at the figurative (namely, type 3). Aristotle’s central claim in *Rhetoric III* is that successful metaphors always start from an analogy (Henle 1958, 175, 190; Aristotle in White 2010, 37-8). White argues that in *Rhetoric* there is a shift, from the *Poetics* conception of analogy. In *Poetics* the basis of an analogical scheme is this: A : B = C : D, where we call A “C” or “the C of B”, in Rhetoric *III* Aristotle introduced a concept where on the basis of such a scheme, we talk about A *as if* we were talking about C (White 2010, 39). Metaphorical figures of speech are therefore even more productive than analogies because they go beyond the mere resemblance, leaving, behind the contingencies, merely the pure scheme. It is possible to use White’s distinctions to categorise the cases of niche construction according to the type of metaphor/analogy they are built on. Since NCT has been built on a metaphor, it will be easier and clearer to follow the metaphorical types to categorise it. This way, constructions will be categorised according to the criteria used to detect them; instead of categorising constructions by the effects, lumping together cases because of external resemblance.

For NCT, the basic pattern is ever that illustrated by Aristotle A : B = C : D. *Mutatis mutandis*,we obtain “humans : build houses = beavers : build dams”. This analogy expresses what I called a literal type of construction (type 1). The analogy can be stretched further to life enhancing activities, on the pattern “houses : improve survival chances = feeding technique : improves survival chances”. The case of ravens learning to suck milk from bottles, improving their survival chances using cultural transmitted behaviours to integrate their diet (type 2), is famous. Finally the proper metaphors, which go beyond the mere contingencies, on the pattern “human activity : modification of environment = organismic activity : modification of environment”. The metaphor maintains the pure pattern, with little regard to what will fill the terms of the proportion. It is focused on the activity of organisms which modify their environment, such as releasing oxygen in water and atmosphere (Type 3). I will argue that the metaphor of construction has been developed using all the three acceptations (Type 1, 2 and 3) of the term. However, Odling-Smee and colleagues propose a categorisation based on four kinds of construction (Odling-Smee et al. 2003, 47), this may have contributed to a misunderstanding among the critics who in turn proposed a two-type construction categorisation.

**4 The 2005 debate and beyond: Disagreement on broad and narrow Niche Construction Theory**

In this part I will discuss a series of papers written by Samir Okasha, Kim Sterelny and Paul Griffiths as reviews of *Niche Construction – The Neglected Process in Evolution* (2003).[[6]](#footnote-6) In different ways these authors recognise a broad and a narrow kind of construction, with diverging opinions on their usefulness in evolutionary biology.[[7]](#footnote-7) They acknowledge several merits of the insights set out in the book, which, building bridges between biology, ecology and evolution, introduces new perspectives of research in evolutionary biology and philosophy (Griffiths 2005, 19; Okasha 2005, 10; Sterelny 2005, 35). Nonetheless, several arguments have been found to be unsatisfactory. The main complaint from the critics is related to the alternate use, by constructionists, of two different points of views,[[8]](#footnote-8) which at times satisfy adaptational issues in terms of genetic inheritance (Odling-Smee et al. 2003, 177, 180-1, 381, 343; Griffiths 2005, 13, 19; Okasha 2005, 2, 5-6; Sterelny 2005, 24, 26-7), and at other times address issues connected to ecological inheritance (Griffiths 2005, 13, 19; Odling-Smee et al. 2003, 129, 161, 258, 292, 350, 354; Okasha 2005, 2, 5-6; Sterelny 2005, 24, 26-7). As a result, this dichotomy eventually suggests the existence of two versions of the theory. One is a narrow, strong version which confirms the achievements in classic evolutionary biology. The second is a broad, weak version which extends the relevant factors of evolution to ecological inheritance. As a result the narrow version is acclaimed as valid, the weak as unsatisfactory (Griffiths 2005, 13; Okasha 2005, 2; Sterelny 2005 29, 32). The immediate reply offered further evidence of the relevance of broad constructionism (Laland et al. 2005). Years later, in spite of the great number of examples in support of or against the case of NCT, the debate has not progressed. A persistent disagreement was established between the two parts because offering further examples is not the way to solve this debate. I will propose a categorisation that shows the profound reasons certain cases of construction activity are unwelcome in classic evolutionary biology, and which kind of misunderstandings afflict the debate. As a result it will be possible to reconsider the NCT debate in a different light and to offer new bases from which to restart the debate.

The idea that the word construction can hide two meanings is not new to philosophers of biology who deal with NCT. For instance, Peter Godfrey-Smith reached this conclusion by analysing the meanings of the word construction as used by Lewontin in his book *Complexity and the Function of Mind in Nature* (Godfrey-Smith 1996, 143-4). Through his analysis of the term construction Godfrey-Smith, offered a concise summary of Lewontin’s argument to support the constructionist view (Lewontin 1977, 53; 1983, 99-100; 1991, 116).

1. Organisms select their environment
2. Organisms determine what is relevant
3. Organisms alter the external world as they interact with it
4. Organisms transform the statistical structure of their environment (through their size, longevity and storage ability)
5. Organisms change the physical nature of signals that come to them from the external world

He claimed there is a difference between the arguments proposed by Lewontin. For instance, the third argument is clearly based on the causal impact organisms have upon the world. The second argument instead is based on a different criterion since it does not represent a construction as in the previous one. It does not involve causal impact on (or physical alteration to) the world. After a detailed analysis, Godfrey-Smith concludes that those five points can be reduced to two categories, which rely on two different senses of the word construction: a literal causal sense, and a constitutive or ontological sense (Godfrey-Smith 1996, 145). To the first category belong organisms whose activity is a matter of physical, causal intervention in the world, like nests or webs. The second category comprises organisms which construct their environments in a non-causal ontological dependence (Hora, 1930; Godfrey-Smith 1996, 144-5).

Godfrey-Smith is not alone in pursuing this argument. Tim Lewens developed a complex argument in his *Organism and the Artefact* aiming to save the adaptationist model. His point is to deny the necessity invoked by Lewontin of swapping from the metaphor of adaptation to that of construction (Lewens 2004). Lewens invoked the same distinction drawn by Godfrey-Smith. However, he changed the way he refers to the two uses of the word construction, addressing them as “causal” and “logical sense”. He argues that Lewontin invokes two quite distinct meanings of construction, building on Godfrey-Smith’s argument (Godfrey-Smith 1996, 145-8). The first is a causal one, in which the organism acts so as to maintain and sometimes to alter the composition of its environment. The second is a logical one, in which he argues that a niche cannot be defined except by reference to the organism that occupies it (Lewens 2004, 80). Lewens adapted Godrey-Smith’s categorisation to his point, but clearly they are drawing the same distinction.

A further confirmation of this dichotomy, that the word “construction” has two main meanings, comes surprisingly from Kevin Laland and Kim Sterelny.[[9]](#footnote-9) They acknowledge the double meaning of construction when they state that niche construction is the process whereby organisms, through their metabolism, their activities, and their choices, modify their own and/or others’ niches (Odling-Smee et al. 2003). In fact, they claim the defining characteristic of niche construction is not organism-driven modification of the environment *per se*, but rather modification of the relationship between an organism and its relative niche. Hence the term “niche construction” includes both activities in which organisms modify their niche, and activities in which they modify the environments even if such modification affects others’ niches (Laland and Sterelny 2006, 1751). Laland and Sterelny do not admit explicitly that there are two kinds of construction. Nevertheless it seems they leave space for this idea, which has been embraced by Godfrey-Smith, Lewens, Okasha, Sterenly and Griffiths. An interpretation of their words might be that what really matters is the change of relationship between organism and environment, and that the production of artefacts is included in this idea, as a specific way of changing the relationship. I will explore this line of thought more thoroughly in part 5.2.

**5 Three kinds of constructionism**

The critics debate on two meanings of the word construction. I recognise those two meanings as being related to the distinction between analogy and metaphor (Henle 1958, 174). However, I find it rewarding to push this distinction further, building on White’s tripartition. I therefore identify three main meanings of construction which I called respectively: literal, analogical[[10]](#footnote-10) and figurative construction (respectively type 1, 2 and 3).[[11]](#footnote-11)

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| --- | --- | --- | --- | --- | --- | --- |
|  | **FIGURE OF SPEECH BASED ON:** | **WHITE’S****CATEGORISATION** | **KINDS OF CONSTRUCTION** | **TYPES OF ACTIVITY** | **RESULT OF CONSTRUCTION** | **RELATION WITH BROAD OR NARROW DISTINCTION** |
| **CONSTRUCTION** | ANALOGY | TYPE 1 | LITERAL | CONSTRUCTION AS PRODUCT | ARTEFACT | NARROW CONSTRUCTION |
| TYPE 2 | ANALOGICAL | CONSTRUCTION AS PROCESS | BEHAVIOR | BROAD CONSTRUCTION |
| METAPHOR | TYPE 3 | FIGURATIVE | CONSTRUCTION AS INTERACTION | RELATIONSHIP |

Table 1: Kinds of metaphors and their connections with construction activities and EHs.

The figure of speech of analogy is the basis for literal and analogical construction. Literal construction (type 1) involves a series of artefacts that organisms produce, like dams (*construction as product*). Analogical construction (type 2) is about behaviours and ontogenesis in general, like using tools (*construction as process*). The figure of speech of metaphor is the basis for figurative construction (type 3), which is about the pure organism/environment relationship, like releasing oxygen into the atmosphere (*construction as interaction*). In the next part I proceed to explore in turn the three types of construction that each meaning produces: *construction as product*, which concern the production of artefacts; *construction as process*, which is related to behaviours; and *construction as interaction,* which is the pure organism/environment relationship. The reader might find it helpful to keep an eye on the table above, which is the scheme of the argument which will be developed soon. The scheme connects, going left to right, the metaphors with their types of construction and results.

**5.1 Niche construction through analogies**

***Construction as product – literal construction***

Among the different types of construction, literal construction is based on White’s type 1, and it has been defined as a narrow construction. In this kind of construction the production of artefacts is central in changing the organisms’ living conditions. The production of artefacts represents an adaptation, it is compatible with SET, and can be listed as the organism’s extended phenotype. Although the literal construction is considered as the most representative kind of construction, only a small percentage of this type of construction can be classified as such. The literal construction modulates the condition of the constructor’s environment with a high degree of control, modifying it in a profitable way (Forshaw 1998; Hansell 1984; Gullan and Cranston 1994; Lorenz 1973, 1978, 1941; Paxton and Eschmeyer 1998). Typical examples of those structures are spider’s webs, the systems of burrows dug by moles, foxes, rats and rabbits, the nests of ants, termites and bees, or the nests and chambers built by birds, turtles and some species of fish to shelter their offspring (Hansell 1984; Hölldober and Wilson 1994; Nowak 1991; Pearce 1997; Skutch 1987). The critics of niche construction agree on the relevance and importance of those activities. For instance, Griffiths praises how beavers’ dams, eucalypti’s fire regime and human culture are relevant examples of niche construction.[[12]](#footnote-12) Similarly, Okasha recognised the human cultural construction and the activities of beavers and earthworms as valid, and Sterelny lists among significant niche construction activities beavers’ dams and other forms of extended phenotypes (Griffiths 2005, 11, 13; Okasha 2005, 2, 4; Sterelny 2005, 22, 24, 31). It is not surprising that literal construction activities are recognised as valid in evolutionary terms. The literal construction activities possess a series of features that allow them to be compatible with underlying SET and EPT metaphors. As those authors remark; the species that performs the construction activity benefits almost entirely from it (Griffiths 2005, 14; Okasha 2005, 4-5; Sterelny 2005, 25-6). To be relevant in classic evolutionary terms, construction activities must represent an adaptation of some kind, and be transmitted through genetic inheritance to future generations. A literal construction in fact always involves the production of an artefact, the realisation of structures with an adaptive value and the ability to build such structures is part of an organism’s extended phenotype. Because of its adaptationist features, this kind of construction is welcome in the standard EH. We can also enlarge the list to include a series of necessary conditions that occur when a literal construction is taking place. Those conditions are:

1. physical modification of its own environment
2. representing an extended phenotype (*sensu* Dawkins)
3. being encoded in the genome
4. creation of artefacts, tools, structures, energy deposits (i.e. food storage)
5. profitability
6. representing an adaptation

The absence of disagreement on literal constructions however does not imply that the NCT claims are accepted in SET and EPT. NCT is not assessed in its own right but is considered interesting due to the fact that constructionist results coincide with and confirm the standard findings and notions. In this sense it would be inappropriate to state that their claims coincide, as they reached the same conclusion for slightly different reasons, and each one from its own point of view (see note 46). At best we might claim that there is a coincidence of conclusions and that in both theories the findings are considered relevant.

***Construction as process - analogical construction***

Analogical construction is based on White’s type 2, and it has been defined as “broad construction” often with no distinction from metaphorical construction, which is type 3. The analogical kind includes in construction any kind of activity in the world that enhances the survival chances of the individual or their descendants, extending the meaning of construction. Analogical construction is different from literal construction because it does not produce artefacts, tools or structures. This kind of construction relies more than the previous one on ecological inheritance, having little connection with genetic inheritance. It is mainly associated with the behaviour of organisms, and consequently it is more sympathetic to Environmental and Ecosystem Engineering approaches than to the standard approach.

The analogical construction produces behaviours; therefore this kind of construction exists as such in that the organisms are acting to change the organism-environment relationship in its ontogenetic history. Therefore it does not represent an organism’s extended phenotype (i.e. spiders’ webs). Typical examples of analogical construction are migrations. Thousands of species of birds migrate, as do bats, zebras, wildebeest, whales, Thomson’s gazelles, plant succession, salmon and Bluefin tuna (Cogger 1998; Jones et al. 1994, 1997; McFarland 1987; Paxton and Eschmeyer 1998). It is possible to list some conditions that can help identifying analogical construction. Those conditions are:

1. physical modification of its own environment
2. profitability
3. cultural products/being teachable

This kind of construction is problematic because it is contaminated by other kinds of construction.[[13]](#footnote-13) Some behaviours are genetically inherited, thus they appear to be extended phenotypes, but still they need training and learning to be fully developed. The woodpecker finch, for instance, picks insect out of cavities using a needle, and this is a behaviour that involves the construction of tools (Eibl-Eibesfeldt 1970; Lorenz 1941, 1973, 1978; Tebbich et al, 2001). From a constructionist perspective what is relevant is the way an organism is able to change the condition of living and improve its fitness. This behaviour might be sporadic and non-genetically transmitted, however it matters from a constructionist perspective insofar as it can have an impact on the organism’s survival chance. From a SET point of view, on the other hand, analogical constructions are sporadic and of little relevance and this is the reason why they are discharged.

**5.2 Niche construction through metaphor**

As mentioned in part 4, the figurative construction is the construction that most characterises NCT from among the three types of metaphors, and in this sense can be understood as the kind of construction which is most representative of the theory. I argue that figurative construction constitutes the core of NCT, contrary to the current opinion that literal construction is the kind that best represents NCT.

***Construction as interaction - figurative construction***

The figurative construction relies on White’s type 3, in which the mere structure of the figure of speech of analogy is applied to the world. In this kind of construction the pure organism/environment relationship is assessed. The figurative type of construction concerns physical modification of the environment, but it does not involve tools, artefacts or behaviours. It is not an extended phenotype nor does represent an adaptive solution. I will try to show that the construction as interaction involves the very definition of niche-construction activity. In NCT and Dialectical Biology the organism is considered a single entity together with its environment. Those two elements lose importance in favour of the relationship occurring between the two of them, the relationship being the sum of the two elements plus the interaction itself, which adds meaning to the elements just mentioned. The relationship between organism and environment has been pointed out by Laland and Sterenly as “the defining characteristic of niche construction” (Laland and Sterelny 2006, 1751). This might suggest to us that the organism/environment relationship is the core of metaphorical construction, behind all the contingencies that may or may not occur. Therefore features like being an adaptation, being encoded in the genome or being part of the extended phenotype; creating artefacts, tools, structures, energy deposits or cultural devices (i.e. maths), are just forms in which construction can manifest its presence in the world. What is interesting for advocates of construction theory is the relationship that exists. All the other features are contingencies, which are attributes of the particular organism and environment that are considered for any given case. Even in this type of construction we can recognise a feature that characterise it. It is only one condition, the basic condition for construction activity:

1. physical modification of the environment

Although *prima facie* disappointing, I will argue below the reasons this single feature represents the core of niche construction. The common understanding of NCT’s, by which the main feature is the literal construction, comes from an adaptationist understanding of NCT. But if we make an effort to understand NCT’s claims from a constructionist perspective, it becomes apparent that the figurative construction represents the basic feature from which more complex kinds of constructions (analogical and literal) arise. However, those two kinds represent specific cases in which contingencies make it easier to understand that a construction process is taking place.

**5.3 Metaphorical construction as NCT’s core**

Metaphorical construction, according to the usual interpretation of NCT, appears to be weak and marginal, while literal construction activities have been recognised as the most representative type of construction. This conception is the consequence of evaluating the NCT using the SET’s point of view. Instead, if we assume the NCT perspective, the literal construction represents just a particular case, namely the most obvious to perceive when analysing NCT from a conventional point of view. Figurative construction instead is meant to be the core of construction processes, the fundamental feature on which literal and analogical kinds build and develop the construction activity. It might be suggested that any construction is rooted in a figurative construction, since the concept of niche needs an organism occupying a landscape to be defined as such (Lewontin 1978, 159). To clarify, for the purposes of this theory, figurative constructions are those in which the construction activity is carried out by the sole relationship existing between organism and environment. There are many examples. Basically, almost all the activities of the first and second kingdom can be considered as figurative construction (Begon et al. 1996; de Brouwer et al. 2000; Emerson et al. 1997; Falkowski 1997; Jones et al. 1997; Karl et al. 2002). Moreover, this can also include some of the activities in the fourth kingdom like gas-conversion, modifying the local climate, and the impact plants have on other species (Carvalho et al.; Holland, 1992; Houghton et al. 2000; Shukla et al. 1990). It is easy to understand that from the SET point of view those activities do not represent a valid argument in defence of NCT because they are deficient in matters of inheritance and fitness profitability and they often do not affect the niche of the organisms that produced the change in a relevant way.

At this point of the analysis, few considerations on the concept of construction are due. Identifying the construction activity with the interaction itself is a significant problem.Any physical entity has to be somehow located in the space-time continuum; thus, *ipso facto*, any existing being will automatically exist in relation with this space-time continuum (the environment), and thus constructing it. The issue is that construction appears to be a self-referential property, in which being[[14]](#footnote-14) coincides with constructing. According to this definition, the mere organismic existence is a sufficient condition to confirm construction processes are taking place and, needless to say, this is a (bad) tautology. We need to become more subtle here because if we remove all the differences which give form to the concept of construction we will end up like Schelling in “a night in which all cows are black”, unable to distinguish construction processes from life itself.

In construction processes we deal with three elements: the organism, the environment and the mutual relation between the two of them. The existence of the organism and of the environment, from a constructionist perspective, coincides. In fact we do not have empty niches, nor do we have a living organism *per se*, out of the space-time continuum. Thus the mere existence, or non-existence, of one of the two cannot represent a condition for constructing. Because one cannot stand without the other, ergo none of the two of them alone can be the condition of construction; otherwise we would have unilateral constructions, like Australia waiting for rabbits. Thus, we need to ascertain whether the condition of construction is in the relationship organism/environment itself. The relationship is of a particular kind: it is a dialectical relationship.[[15]](#footnote-15) The relationship has an added value to the mere union of organism and environment because it allows each of the elements to enter the structure of the world in a more complex manner, explaining and connecting those elements to the larger web of relations that occurs around them in history, independently from the evolutionary effects it might have.[[16]](#footnote-16) The condition of niche construction is the existence of the dialectical relationship, and there are two ways to interpret the word existence. Dialectic is a movement in history by definition, therefore when we say existence, more than existence as “being” (in the sense of existing, like the organism and the environment), it is an existence as “being active”, it is “action in the world”[[17]](#footnote-17) and for this reason construction activity can only make sense through an historical perspective in which being active or not makes the difference.[[18]](#footnote-18) This temporal perspective concerns ontogenesis, an important element in some developments of evolutionary biology (Avital and Jablonka 2000; Galloway and Etterson 2007; Gray 2001; Griffiths and Gray 1994; 1997; 2005; Griffiths and Knight 1998; Godfrey-Smith 2001; Jablonka and Lamb 2005; Leimar et al. 2006). It is the activity of organisms and environment that makes the relationship, not their presence. The adaptationist perspective instead, as explained in part 2, is focused on phylogenesis, a perspective oriented on adaptations in which genes are inherited passively from one generation to the next according to a strict cause/effect vision. This difference in emphasis is enough to make two theories which share the majority of the same ideas (and are thus ideally compatible) enter a situation of disagreement. To conclude this part, it is possible to identify two kinds of causation at the root of the disagreement: the dialectic causality (which can be pictured as a spiral developing in history, and the linear causality (which can be pictured as a line of causes/effects).[[19]](#footnote-19)

The idea that niche construction might not bring evolutionary benefits to the species that produced it is particularly disturbing for many authors (Griffiths 2005, 13; Okasha 2005, 4-5; Sterelny 2005, 27). The general complaint is that niche construction must be profitable for the organism that produces it; otherwise we cannot distinguish construction from casual events (Griffiths 2005, 14; Okasha 2005, 5). With regard to individual cases, I agree that sometimes thinking in terms of construction is not rewarding. However, thinking in terms of niche construction to investigate biological issues is no different from thinking in terms of adaptation to investigate biological issues. In fact in response to the criticisms of the “The Spandrels of San Marco” article, adaptationists point out that even if characters do not always represent an adaptation, thinking in terms of adaptation is the best way to tackle evolutionary issues (Dennett 1995; Gould and Lewontin 1979; Orzack and Sober 1996; Sober 1998). From the perspective of SET, maintaining the same research programme is definitely the best way to explain the relationship between organism and environment and how this relationship has affected the evolution in general and in particular for some species even when the constructionist explanation seems not to be particularly convincing. The adaptationist approach has proven to be fruitful and rewarding. Similarly, NCT has collected a series of findings relying on its own approach. In this way NCT is consistent with its mission (explain the relationship between organism and environment and how this relationship has affected the evolution of the species), which is different from the SET mission.

**6 Concluding Reflections on the three kinds of constructionism**

In this part I will offer some further reflections on the three kinds of constructionism, like their relationship with other theories and their differences from the categorisation of Odling-Smee and colleagues proposed on the different cases of niche construction. As a rule of thumb, all the construction activities based on literal construction are compatible with SET’s metaphors, while only some cases of analogical construction are compatible with it and none of the cases of figurative construction. In particular, analogical construction, being connected with the behaviour and thus with the ontogenetic processes, finds little enthusiasm in SET and EPT, theories with a strong genetic and adaptationist stance. Instead Environmental and Ecosystem Engineering is more likely to value processes which involve the behaviour of the organisms, like bird migration and interaction between different species (Daborn et al. 1993; Daily et al. 1997; Jones et al. 1997). However it would be wrong to consider them as NCT without pretensions of grandeur. The difference is that the metaphor of engineering is close to and compatible with the metaphor of *bête machine*, selection and adaptation; and so their theories. Environmental and Ecosystem Engineering still draw their conclusions under the adaptationist view (the same as the extended phenotype and the SET). Nevertheless the results and conclusions are often similar because their approaches do not only consider organisms altering the environment for their benefit, but they also consider relevant the benefits that larger connections between organisms offer. This includes the activity that organisms like beavers produce in their environment (Casas-Crivillé and Valera 2005; Gutiérrez et al. 2003; Hacker and Gaines 1997; Lill and Marquis 2003; Wright et al. 2002). Figurative construction is the construction type that should be considered the core of NCT. Dialectical Biology and Developmental System Theory (DST) instead are compatible with figurative construction, because in their underlying metaphor there is not a sharp division between organism and environment–in fact they are both cause and effect at once (Avital and Jablonka 2000; Gray 2001; Griffiths and Gray 1994; 1997; 2005; Griffiths and Knight 1998; Leimar et al. 2006). Indeed, they rely on different kinds of transmission besides the genetic one, like the transmission of knowledge, traditions and feeding techniques from one generation to the next, or epigenetic inheritance processes. They value the way the aforementioned factors can influence the evolution of the organism in relation to its environment and to other species in it, sharing a very similar vision with NCT (Galloway and Etterson 2007; Godfrey-Smith 2001; Jablonka and Lamb 2005).

It is interesting to compare the four-type categorisation proposed by Odling-Smee and colleagues (Odling-Smee et al. 2003, 47) with the tripartition of the metaphor I have proposed. I believe one of the main reasons leading to persistent disagreement may come from the fact that critics build their arguments on this categorisation. Constructionists often use inceptive perturbation as an outstanding example of construction activity. This categorisation is confusing because it includes examples which are both SET-friendly - like the beavers’ dams (literal construction) - but also example which are SET-unfriendly, like the dispersion of bodily waste (figurative construction). Critics, having found heterogeneous cases, were encouraged to detect the existence of two kinds of constructions. Afterwards, connecting the two kinds to the classic evolutionary biology, they concluded that only one part was compatible. Instead, adopting the metaphorical tripartition we have been able to recognise the metaphor as a key element of NCT, and to use it to redefine the categories and explain why a part of NCT is accepted while the other part is rejected. The characterisation of Odling-Smee and colleagues is superior to mine in several respects. However, while I believe it is extremely useful for didactical purposes, it is not effective in persuading an audience which is not sympathetic with NCT of the existence of phenomena which are highly considered in NCT.

In conclusion there are only a few components in NCT which make it enter into disagreement with SET. Those components are to be found for the theoretical part around the metaphor of construction, and for the practical around cases of figurative construction. Further studies are required to assess the compatibility of this part of NCT with SET. Literal constructions are already part of SET and EPT, the issue is with the analogical constructions. This kind of construction has been categorised as broad construction, along with figurative construction. However this judgement is unfair. The processes based on analogical construction in fact are compatible with DST and the Environmental and Ecosystem Engineering approach. Therefore analogical constructions, which contain cases that possess features from the literal and figurative construction, are far closer to the classic evolutionary biology than figurative constructions, and deserve a category of their own. The current disagreement is based on reciprocal misunderstandings. On the one hand critics have assessed the less representative side of NCT, the literal constructions. Although they are more immediately understood, they represent a very special case, while the core of NCT rests in the figurative construction. On the other hand constructionists have promoted inceptive perturbation activities (beaver’s dams) as a fundamental example of construction. Those cases represent a specific application of constructionist processes, and although easy to grasp (and thus a good example), in the long run promoting them as exemplar constructions turned out to be a strategic error. Another source of confusion has been the categorisation by effect. Both constructionists and critics consider the cases from the point of view of the product of the construction, making any case a special case. Those remarks showed more clearly that there is a difference in scope between the two theories, or better their research programmes. In SET the aim is to find evolutionary advantageous features, and thinking in terms of adaptation is the best way to tackle evolutionary issues. In NCT on the other hand, what is relevant are the evolutionary consequences of the organism/environment interaction, and how these relationships have affected the evolution in general (environment) and in particular (organism) for species. As in the responses to the to the famous article “The Spandrel of San Marco”, pursuing a programme of research sometimes entails obtaining scarce results, but this should not invalidate a programme that offered meaningful insight throughout. Therefore, promoting a classification based on the principles, namely the particular acceptation of the construction metaphor, we are in a privileged position from which to evaluate fairly the two research programmes. For instance, without analysing any particular case, we can anticipate how a case of construction will fit in SET, and recognise its position as natural consequences of the nature of the research programmes and the kind of metaphor on which that particular case relies.

I believe the debate on NCT can be better understood from a distance using the metaphorical approach than from close-up examples as has been done so far.

With regard to NCT, the metaphorical approach has thrown light on the theory, recognised the metaphor as key element and offered an economical way to categorise its cases and to compare them with other theories. Taking a broader overview of philosophy, it reminds us of the importance of metaphors in science. When metaphors are introduced they influence the structure of the theories. However with time they become a natural part of the theory, and they are no longer noticed. It is not possible to carry out scientific works without using a language that is filled with metaphors, however “the price of metaphor is eternal vigilance” (Rosenblueth and Weiner 1951).

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1. This paper contains the results gathered applying to NCT a unity of analysis developed to investigate persistent disagreement, the Epistemic Horizon (EH) in: Epistemic Horizon in HPS (Archetti, forthcoming). [↑](#footnote-ref-1)
2. I chose to use the idiom SET following the example of Odling-Smee and his colleagues, who used this expression 50 times in their book to refer to the classic stands in evolution (See for instance: Odling-Smee, et al. 2003, 1957, 205, 209, 255, 289, 306, 313, 371, 376, 379). [↑](#footnote-ref-2)
3. See also: Black (1962, 229) for examples on Rutherford’s solar system and Bohr’s model of the atom. [↑](#footnote-ref-3)
4. On the analogy between artificial/natural selection see: Radick, Hodge and White, forthcoming. [↑](#footnote-ref-4)
5. White uses this expression in the ‘analogy and ambiguity’ section (2010, 62-5). “if we say that a word like ‘good’ ‘is said in many ways’, in such a manner that when we acquire the meaning of the word ‘good’ we simultaneously learn to use it in all these ways. In fact, what we learn is not a set of isolated, if related, ways of using the word, but a system of uses”. Authors often assimilate analogy and metaphor, as they were synonym, especially in linguistic applications. Aristotle instead clearly regard these as two different phenomena. [↑](#footnote-ref-5)
6. Their articles can be found in *Biology and Philosophy* issue 20, along with a reply by Laland, Ogling-Smee and Feldman. The themes surveyed are vast and complex; the scope of this paper is limited to clarify the reasons those authors recognised a narrow and broad conception of NCT, and to what extent we should endorse such position. [↑](#footnote-ref-6)
7. I chose “broad and narrow NCT” to represent a series of terms to which those authors referred to as constructionism. Griffiths refers to it as extended NCT (2005, 13-4, 19) and broad conception (2005, 13); Sterelny uses control and mere effect on environment (2005, 24, 26, 35) and broad and narrow NCT (2005, 29, 32-4); Okasha refers to broad and narrow (2005, 2-4, 9). [↑](#footnote-ref-7)
8. I remind the reader of the tone of general criticism against the exclusivity of the use of genetic inheritance in evolutionary biology (Odling-Smee et al. 2003, 16, 27, 41, 49, 367, 370). [↑](#footnote-ref-8)
9. It is remarkable that one of the authors of the classic *Niche Construction* is aware of the double meaning of the word construction, yet he doesn’t perceive it as a problem. I will show the kind of misunderstanding it generates. [↑](#footnote-ref-9)
10. Unfortunately, in this triad of terms, the word “analogical” is the most appropriate and I am not going to change it. This, however, might create confusion with the term couple metaphor/analogy. Please do not identify the analogical construction with analogy (the figure of speech). The figure of speech of analogy is at the base of the literal and analogical construction, while metaphor is the basis for figurative construction. [↑](#footnote-ref-10)
11. In a riveting discussion with Roger White himself, I was educated in this fundamental difference between analogy and metaphor. The analogy establishes (and is based on) a relation between objects of the world, whereas the metaphor establishes a relation between linguistic objects; the first is a fact of the world, refers to the real world, and the second is a figure of speech, belongs to the semantic world, and in this sense it transcends the literal meaning. [↑](#footnote-ref-11)
12. Eucalypti’s fire regime is particularly interesting. From standard point of view the interesting part is the adaptive value of the cyclical fires. However from a strict constructionist point of view the creation of an energy deposit that will stir up the fire represents the construction activity, which locally also has a high adaptive value. [↑](#footnote-ref-12)
13. It is important to notice that the grey areas, which are mostly associable with analogical construction, are present also in the other two kinds. In real cases the three kinds, or a random combination of them, can be present at the same time. The production of cheese, for instance, involves all three kinds, being an artefact, a cultural product and a modification of the environmental niche with profound consequences on the human race’s ability to digest milk (Aoki 1986; Cavalli-Sforza, L.L. Feldman, 1981; Cowley 2004; Durham 1991; Feldman and Cavalli-Sforza 1989; Holden and Mace 1997; Laland and Brown 2006; Laland and Sterelny 2006, 1756; Mameli 2001; Sterelny 2003; Ulijaszek and Strickland 1993). [↑](#footnote-ref-13)
14. When I say ‘being’, I mean ‘being in relationship’ and ‘being through time’ (so in a historical perspective). [↑](#footnote-ref-14)
15. The relation is dialectical because of the feedback loop between organism and environment. The reason we find this kind of causality in NCT is due to the influence of Lewontin, who is fully aware of the dialectical processes because of his socialist background. Lewontin incorporated this train of thought (dialectics) in his research. [↑](#footnote-ref-15)
16. Odling-Smee and colleagues claim out loud that construction is a universal process (2003, 50-67), a logical prerequisite to support their further claim that construction is as second process in evolution. I will not explore this issue; however, universality and the idea that construction represents a second process in evolution generate suspicion amongst critics (Griffiths 2005, 13; Okasha 2005, 2; Sterelny 2005 29, 32). [↑](#footnote-ref-16)
17. The expression “niche construction activity” is present six times in Odling-Smee and colleagues (2003, 115, 139, 147, 215-6, 346), and is implicit in many other passages. Niche construction is defined as an organismic activity; it is the ‘process of organism-driven environmental modification’ (Odling-smee et al., xi). Genes, on the other hand, are static because there is no way an organism can change them. [↑](#footnote-ref-17)
18. Another way of seeing this question is to make an analogy with another supposed tautology: the virtuous man acts according to virtue. Also in this case, we have a mere being in the virtuous man, which is an ontological condition; and a being in the world in the (supposedly) same man acting in the world, who is a being through action in history. In the same sense, construction exists only when the relationship modifies in time, which it is doing in the world on an historical perspective. [↑](#footnote-ref-18)
19. The way we can try to reconcile the two kinds of causation, dialectical and linear, will be the subject of my next article. [↑](#footnote-ref-19)