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A Functional Place for Language in Evolution:
The Contribution of Contextual Behavioral Science to the Study of Human Evolution

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Selection, the central process of evolution, is common to evolutionary sciences and to behavior analysis (Catania, 2001; Cziko, 1995; Donahoe, 2012). Based on this overlap, behavior analysts long ago argued for a marriage between behavior science and evolutionary sciences (e.g., Skinner, 1981). It never occurred.

One of the main reasons appears to be the limited place granted to behavior in many approaches to evolutionary sciences, at least historically. In the hands of well-known evolutionists, behavior is often considered simply as the phenotypic expression of the genome, and as a dependent rather than an explicative variable (e.g., Maynard Smith & Szathmary, 2000). A second reason might be that the behavioral approach has had a hard time “when dealing with species for which a theory of mind seems essential” (Kokko & Jennions, 2010, p. 293). As a consequence, traditional behavior analysis has not been able to propose a convincing hypothesis for the processes and role of language in human evolution.

Recently, however, there have been dramatic changes, both in evolutionary sciences and in behavior analysis, in these two areas. Thus, the time seems right to re-examine the relationship between evolutionary sciences and behavioral perspectives.

In evolutionary sciences, the place of behavior is being actively reconsidered. Epigenetic inheritance allows for a fresh look at the role of behavior as an important variable in evolution (Danchin, Giraldeau, Valone & Wagner, 2004; Jablonka & Lamb, 2005; Mameli, 2004; Pigliucci & Muller, 2010). In addition, multi-level and multi-dimensional approaches to evolution are now being seriously considered, in which the processes of variation and selective retention act simultaneously on different dimension of selection (gene, epigenes, behavior, culture, symbolic events) as well as on the individual and group levels (e.g.,

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Jablonka & Lamb, 2014). In behavior science, Contextual Behavior Science (CBS) is shedding light on language mechanisms in a convincing manner that is linking behavioral principles to evolutionarily plausible accounts of language and cognition (e.g., Hayes & Sanford, 2013). Specifically, empirical evidence in support of Relational Frame Theory (Hayes, Barnes-Holmes, & Roche, 2001) appears to be underlining the importance of language in human evolution, by showing how language transforms the relations between humans and their environment.

It is a central argument of this chapter that language has become a true inheritance stream responsible for a large part of human evolution. Among others gifts, language gives human beings a kind of intentionality that alters their place in non-directional evolution in its broad sense.

This chapter first describes behavior as a central driving force in evolution, and then discusses the major influence of the specific kind of behavior called "language" on human evolution. Both series of arguments suggest that CBS has an important role to play among the evolutionary sciences.

1. The central role of behavior in evolution

1.1. A generalized selectionist approach

Selection occurs in any complex system capable of both variation and transmission of adapted patterns. In the life sciences, selection simultaneously occurs on several dimensions, each contributing to the differential selection not just of genes, but also of epigenes, behaviors, symbolic events, and culture, in other words, on any inherited variant. I will first introduce the selectionist model application at the behavioral level, the core subject of this chapter, and will then turn to the implications of multi-dimensional and multi-level approaches to evolution.

1.1.1. Selection at the behavior level

Selection by consequences is a mechanism which biological evolution and operant conditioning share in common (Skinner, 1981). One of the major contributions of behavior analysis to psychology is the way it highlighted the importance of consequences on the actions of organisms. In biological and behavioral evolution, “cause”, in a sense, works backward. One needs to focus on what happens after the event being considered, be it behavior or other phenotypic expressions, in order to understand how actions and gene/epigene systems become strengthened. The consequences of behavior become the causes of its subsequent occurrence, in the same way as an organism’s adaptation to its current environment sets its capacity to reproduce and transmit its genetic and epigenetic organization.

Natural selection at all levels automatically emerges as soon as three conditions are fulfilled: variation, selection, and heritability. At the behavioral level, the primary unit of analysis is the operant, and the study is done at the ontogenetic level. Behavioral variation is ubiquitous, such as individuals vary within populations. Even two occurrences of the apparently same action, with exactly the same consequences, are seldom identical. For example, a door can be opened with left or right hand, facing it or not, pushing vigorous or slowly and so on. Second, as adaptation to the environment determines each organism’s survival, the different consequences of behaviors will dertermine their future. For behaviors, the reinforcement process corresponds to the survival criterion in natural selection. Depending on their consequences, behaviors differentially reproduce, that is, their future probability varies, much as the genetic pool of an organism is transmitted to the next generation through the number of offspring it breeds (Donahoe, 2012).

CBS broadens the unit of analysis of behavior science by fully taking into account the context of occurrence. “History, circumstances, and consequences are aspects of the act itself in a functional sense” (Hayes, Barnes-Holmes, & Wilson, 2012, p. 3). The act and its context are not fully separable in a contextual approach of behavior. Hence, context -- considered both historically and situationally -- represents a part of the selection unit in a selectionist and contextual view of behavior. In the present chapter, the ongoing situated act-in-context is taken as the unit of analysis for the selectionist approach of behavior. As such, the ongoing act-in-context can be selected, and can “reproduce” (can be repeated), provided that the context retains enough common characteristics with the initial context in which behavior first occurred and was reinforced.

1.1.2. Multi-dimensional and multi-level selection

Natural selection has been proposed to address problems in various fields, such as epistemology, economics, psychology, anthropology, or medicine and robotic (Cziko, 1997). A selectionist approach can be adopted at any level of analysis, as soon as a system is capable of variation and selective persistence.

In the study of species’ evolution the hypothesis of a unique effect of selection at the organism level has been prevailing for a long time. However, the question of the level on which selection operates - gene, cell, organism or group – has been an issue in evolutionary sciences from its earliest days. Multi-level selection proposes that selection operates simultaneously at different levels so as to maximize survival and reproductive success of the concerned unit of selection. Contextual conditions determine the balance that exists between levels. Disadvantegeous behavioral patterns for one individual in the context of within group competition may favor group members in the context of between-group competition.

Cooperation is one of the best examples of this mechanism: altruistic behavior is selectively disadvantageous within groups but may be favored at group level, if groups whose individuals cooperate are more prone to survive and reproduce (Wilson, Van Vugt, & O'Gorman, 2008; Wilson, & Wilson, 2008). Thus, different levels of selection can act simultaneously, and patterns selected at one level can impact other levels, depending on the specific context of selection.

Evolutionary sciences are beginning to leave an era in which the gene was considered to be virtually the only mechanism by which heritable changes could appear and be transmitted across generations. Well developed multi-dimensional approaches have been proposed, for example byJablonka and Lamb (2005; 2014) who argue that four inheritance systems play a role in evolution: genetic, epigenetic, behavioral, and symbolic (see also Danchin & Wagner, 2010; Danchin et al., 2011). Variations exist in each system and can be selected and transmitted when adapted to the environment. Ultimately, each of these dimensions may have an effect on evolution. The three last systems -- epigenetic, behavioral and symbolic – insert a new principle into Darwinian theory: changes during organisms' lifetime can also play a role in evolution, and consequently behavior takes a central role in evolutionary processes. In part this is because behavioral and symbolic changes can persist directly across lifetimes in the form of cultural adaptations and then be transmitted to the next generation; in part it is because they alter the conditions under which genes are expressed and are selected on the basis of phenotypic variation.

Evolutionary sciences and CBS study how environmental regularities bring about changes in organisms and populations. However, the influence of the environment is non-distinctive: it does not influence only genes, or only behaviors, at an individual or group scale. It operates on everything, simultaneously, in a "unified fabric of evolutionary development" (Hayes & Sanford, 2014, p. 116). Evolution constitutes a unique process to which any dimension (genetic and epigenetic, behavioral, and symbolic) contributes regardless of the relevant configuration on which the environments acts (cell, organism, group).

1.2. Behavior as a driving force in evolution

Beyond selection at the ontogenetic level, behavior increasingly appears to be a central driving force at phylogenetic level, even if it has long been considered as a simple phenotypic expression of the genome. Behaviors enhance their own transmission across generations, have a direct action on gene expression as shown by epigenetic studies, and finally contribute to their own evolution by modifying the environment.

1.2.1. Behaviors enhance their own replication

With the arrival of selection by consequences through operant learning, the behaviors of organisms were more able to change at an ontogenetic level. Slow behavioral adaptations by mean of genetic variation and selection cycles across generations were no longer needed for an organism to adapt to its environment. Operant learning brought plasticity to behaviors and gave rise to a much broader variety of behaviors. Within this behavioral diversity, different patterns of interaction with the environment were tested. Eventually, individuals who found a “Good Trick” (Dennett, 1991), survived and reproduced more than those who did not discover this efficient behavior. Consequently, operant learning created a new selection pressure. Individuals exhibiting behaviors very far from the Good Trick could then be adversely selected, leading to behavior being selected across generations, provided that the determinant part of the environment stays the same (but see the section “Context and the behavioral evolutionary loop”), thus transforming a learned behavior into a genetically transmitted one. In fact, learning itself may have been selected because it allows just such rapid phenotypic adjustments, which would eventually be selected at genetic level. Generally speaking, this effect (the selection of genetic consitituitve variations that substitute for facultative variations) , called the Baldwin effect (Simpson, 1953), enhances the ability to respond rapidly and efficiently to new stimuli. The final result is that “species with plasticity will tend to evolve faster" (Dennett, 1991, p. 186), because the adapted behaviors will tend to enhance their own reproduction in the succeeding generations. Through this process, ultimately, behaviors stand as a true selection process for themselves, accelerating the evolution of species. In addition to the epigenetic modulation of DNA, the Baldwin effect represents one of the central arguments to state that "genes are followers, not necessarily leaders, in phenotypic evolution" (West-Eberhardt, 2003, p.158).

1.2.2. Behaviors directly modulate DNA

Epigenetics is the study of genes expression modifications mediated by environmental variations or developemental noise acting at the ontogenetic level. These modifications can result from environmental events or from the organism's behaviors. Dietary choices, niche selection and niche transformation are among the behaviors that can be responsible for modifications of genes expression. To date, the main mechanisms studied to apprehend phenotypic expression variation are DNA methylation and histone acetylation, and RNA-mediated genetic control of gene expression, but these are only some of a much larger set of such epigenetic processes (Jablonka & Lamb, 2005).

A remarkable characteristic of epigenetic modifications is their role an as inheritance system in its own right. To a degree, changes in genetic expression through methylation and RNA-mediated control are transmissible across generations without any change in nucleotide sequences. Expression of cellular DNA can be transformed by epigenetic processes that are transmitted to daughter cells during mitosis, and at times across generations due to modifications in gametes. These modifications of genes expression can extend across several generations even when the original cause is withdrawn. For example, Dias and Ressler (2014) conditioned male mice to fear a specific odor, and looked for changes two generations later. Through epigenetic changes in sperm, offspring showed an increased behavioral sensitivity to the odor conditioned two generations before, without having encountered it in their own lifetimes.

The fact that genes can be differentially expressed across different contexts, even across generations, alters the role of genes, environment, and behavior in determining the organism's fate. If genes are differentially expressed in different contexts impacted by behavior, behavior assumes a far more central role in the biological evolution of the organisms emitting these behaviors. An organism's behaviors can have consequences for offspring, even if the descendants never reproduce these behaviors and live in a very different environment.

Like learning, epigenetic mechanisms help organisms who are confronted to various and ever changing environments that forbid an exhaustive programming at genome level. Epigenetic mechanisms allow rapid biological adjustments, far quicker than gene selection across sexual reproduction. Learning processes also allow adaptation to environments new to the species. The combination of both provides an ontogenetic regulation mechanism that fosters rapid biological adjustments. Behavioral plasticity is conveyed by learning processes that in turn mediate gene expression plasticity, so that learning processes serve as an interface between organism and environment, driving changes in both.

1.2.3. Context and the behavioral evolutionary loop

Each of organism's behaviors occurs in a precise context, and CBS proposes that "history, circumstances, and consequences are aspects of the act itself in a functional sense" (Hayes, Barnes-Holmes, & Wilson, 2012, p. 3). This point explains why CBS chooses the ongoing situated act-in-context as a unit of analysis. In addition, at a psychological level of analysis, one has to focus on the situated actions of whole organisms (Hayes, 1993), and to consider behaviors as interactions in and with a context (including other organisms), that is considered both historically and situationally (Hayes & Sanford, 2014).

Most studies of behavior and learning processes conduct that analysis at the organism level. The study of reactions to stimuli, and ontogenetic transformation of behaviors according to their consequences, brought precise and reliable knowledge on respondent and operant learning, respectively. However, it is also the case that the environment itself changes, in part due to operant behavior that "operates" on it. This has been less studied, even though any change in the environment can have tremendous importance for the evolution of organisms and the further modification of their behavior. In a larger evolutionary context, considering the effects of consequences on the organism should go hand in hand with consideration of the environmental modification that results from the organism's behaviors.

In a hypothetical example, imagine that a chimpanzee finds edible termites after pulling away a strip of tree bark. The reinforcing effectiveness of eating termites would determine the future probability of pulling away bark strips from trees. As the behavior appearred more frequently, the chimpanzee would find more termites, and its behavior would continue to be reinforced. The repetition of this behavior in its ecological niche, however, could produce large scale environmental changes that would lead the termites to become scarcer due to exhaustion of the supply of trees in which termites could grow. Pulling barks away would then be less and less reinforced, and would progressively extinguish. The conditions leading to extinction of the behavior were created by the very success of the behavior that was driven to extinction. The consequences of the behavior changed the environment in such a way that, in return, the environment itself caused the extinction of the very behavior that initially modified it.

In most research on learning processes in the laboratory, environmental modifications are not much considered. Indeed, in most such experiments, these modifications are controlled so that they cannot appear. However, in the natural environment it is common place, as pointed in the previous example, for the future of behavior controlled by consequences to be impacted by changes in the long terms probability of consequences coming from the environment that are partly organised by the behavior itself. Among other things, this means that taking environmental changes into account is essential to understand the long term role of behavior in an evolutionary context. Such a systemic approach does not represent a different domain of study; rather, given the central place of the environment in the selection of behaviors, a systemic approach helps capture the act-in-context in its whole complexity at a psychological level.

The point of view I defend here is that behaviors are at the center stage of evolution because they modify the very context in which actions appear (see also Odling-Smee, Laland, & Feldman). In a sense, operant behaviors change themselves, in a sort of evolutionary loop.

This behavioral evolutionary loop is amplified when an important part of the environment consists of other organisms also capable of rapid adaptation to environmental changes through learning. A behavioral evolutionary loop – the modification of behavioral evolution by mean of the consequences this very behavior creates – is considerably enhanced in the case of consequences produced by other organisms with similar learning abilities. When social creatures behave in the presence of others, behavioral consequences may often be mediated by the social context and the actions of others. The behaviors of others changes in relation to my actions, and others would be sensitive to the changes they create in my behavior. A kind of social interlocking system can emerge, in which behavioral evolutionary loops exist as a natural result of complementary social contingencies. Consequently, the diversity and maintenance of consequences to my behavior will be broader and more robust than in an environment deprived of organisms with learning abilities. As a highly social species, humans emit behaviors in systems in which the evolutionary loop is common and notably influential.

2. The crucial role of language in human evolution

Behavior plays a central role in evolution because it is a true unit on which selection operates, because it modulates DNA expression, and because it contributes to its own selection. In human species, symbolic behaviors and language constitute a very special category of behaviors, which dramatically changes evolution, and which due to patterns of retention can function as inheritance streams in it own right (Jablonka & Lamb, 2006, 2014). Language brings modification for each step of the selection process: it selects behaviors, it modifies the value of the stimuli potentially responsible for their selection, it increases variation in behaviors, and it changes their retention and inheritance. Finally, language can give rise to behaviors that are seemingly incompatible with process of evolution itself. CBS helps capture the modifications language engenders on human evolution by studying the mechanisms operating at the core of language and symbolic behavior.

2.1. CBS definition of language

CBS relies on Relational Frame Theory (RFT, Hayes, Barnes-Holmes, & Roche, 2001) to apprehend language. RFT proposes a special learned unit, aribitrarily applicable derived relational responding, to account for language in human species. Derived relational responding has three specific properties. First, when a human being is taught a relation between a stimulus A and a stimulus B (e.g., A=B), they are also taught, initially through multiple exemplars, to derive the inverse relation (e.g., B=A). This mutual entailment property permits any verbal stimulus to “stand for” or “refer to” any other stimulus, providing that they have been put in an equivalence relation. The second property of derived relational responding is combinatiorial entailment, meaning simply that mutually entailed relations combined into networks of relations. When at least three stimuli are set in an equivalence relation by pairs (e.g., A=B, B=C), relationships are derived between the two stimuli which were not previously related (e.g., A=C, C=A). Eventually, when trained to derive relations between stimuli, human beings learn to do it independently from the intrinsic properties of stimuli, under the control of arbitrary relational cues (Blackledge, 2003). The last property of aribitrarily applicable derived relational responding is transformation of stimulus functions. If you are bitten by a piranha (A), and that I inform you that piranhas are characidae (A=B), and then, in presence of another fish you are told that this fish is a characidae (C=B), you might be scared of this one as well because of the combinatorial relational (A=C) and the transformation of emotional functions from A or C, even though you never had any direct experience with this animal, and that the only new stimuli in your environment are the words you heard. Transformations of stimulus functions are under the control of functional cues that select the relevance of specific functional dimensions. These properties (contextually controlled mutual and combinatorial entailment; contextually controlled transformation of stimulus functions) are argued to apply to all words and symbols we use. The easiest example is a relationship of equivalence. When any event is set into an equivalence relationship with a word or symbol, the word acquires some stimulus properties of that event, and “stands for” that event.

2.2. How language selects behaviors

Language is so pervasive among humans that it is very difficult to act without any occurrence of language being automatically involved. Although arbitrarily applicable derived relational responding emerges originally as a result of specific social contingencies (e.g., Luciano, Gómez-Becerra, & Rodríguez-Valverde, 2007), as it develops it helps people predict and control their environment in ways that are impossible to avoid. As a symbolic system, and because of the properties presented above, language dramatically impacts the selection processes impinging on human beings.

2.2.1. Language changes how stimuli select behaviors

A beefsteak has a reinforcing value for any animal that eats meat, at least when they are food deprived. No doubt a piece of steak consumed today would have had much same reinforcing value for our pre-verbal ancestors. However, a piece of beefsteak consumed today may also evoke verbal health or ecological concerns (such as worries over cholesterol, or objections to the amount of land and water needed to raise cattle, and so on) that could undermine or even eliminate its reinforcing value for some contemporaries. The steak's taste and nutrients have not changed as compared to a similar steak eaten by our ancestors. What is different is the relational network that surrounds meat. The punitive value of steak was not acquired by eating: it was acquired by language. Stimulus functions, originally appetitive, were transformed: meat now reminds consumers of the risk of heart attacks, or occasions guilt about polluting the planet. Through aribitrarily applicable derived relational responding and the transformation of functions, stimuli can acquire virtually any stimulus function. Quoting Epictetus, "What upsets people is not things themselves but their judgments about the things." RFT explains how these "judgments" are built and are contextually regulated. The comprehension of the behavioral processes responsible for these symbolic effects alters our views of the role of behavior, including verbal behavior, in the evolution of humans.

Due to the symbolic functions afforded by derived relational responding, verbal organisms evolve in a sort of parallel reality populated with the verbally derived significance of events in addition to the intrinsic properties of the events they interact with. In a very specific way, behaviors can be selected by these symbolic functions, even though they may never have any direct consequences for the organism. Stimuli select actions due to what they represent, not to what they are directly. In other words, symbolic stimuli can select behaviors based on the derived functions they embody.

2.2.2. Language as a selection variable for behaviors

In addition to the modifications of usual sources of behavioral selection, language can constitute a stream of selection in its own right. In many cases, behaviors are controlled by language alone. Rule-governed behavior (Hayes, 1989) can be defined as behavior, either verbal or nonverbal, that is under the control of verbal antecedents (Catania, 1991; Zettle & Hayes, 1982). One type of rule-governed behavior is “pliance” – rules that are followed because of a history of socially mediated consequences for the correspondence between a rule and relevant action (Hayes, Zettle, & Rosenfarb, 1989). The social approval engaged by pliance can totally mask other effects – to the point that the person becomes insensitive to the direct consequences of their behaviors (Catania, Shimoff, & Matthews, 1989, 1990; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Monestès, Villatte, Stewart, & Loas, in press; Shimoff & Catania, 1998). An example occurs when actions are engaged because doing so is “right” or “proper.” Such an appeal to verbal consequences can maintain behaviors even when these behaviors are ineffective or even deleterious to the organism.

Due to the derivation of stimulus functions, verbal stimuli can gain a punishing or reinforcing value from the relational networks in which they participate. This happens for example when I thank you for your help in moving my washing machine. Verbal stimuli become factors of selection in these circumstances capable of modifying the probability and frequency of the behaviors they follow, with the particularity that this source of selection is always available, inexhaustible and, to some degree, can be self-administrated.

2.3. Language creates an explosion of behavior variation

Variation is one of the pillars of evolutionary processes. Without variation, any differential selection or adaptation to environment modifications is impossible. At the biological level, variation is so important that it is itself selected. The transmission of noncoding DNA, representing 98% of the human genetic pool (Elgar & Vavouri, 2008) highlites s the importance of source of variation. Some of this so-called “dead space” is regulating the active genome thus creating orders of magnitude more variation from which new patterns can emerge and be selected (Jablonka & Lamb, 2014). Sexual selection provides another example: asexual reproduction is inheritantly less variable, which is why organisms capable of both sexual and asexual reproduction shift to the former strategy in the case of drastic changes in the environment (e.g., Nevalainen & Luoto, 2013).

At the behavioral level, variation also plays a paramount role, although it received less attention than the variables responsible for selection (Dewitte & Verguts, 1999). The very existence of learning abilities points to the determinant role of variation in behavior. In addition, the capacity for variation has been demonstrated as a true dimension of behavior, which contributes to new patterns of response (Grunow & Neuringer 2002), and which can also be reinforced (Neuringer, 2002; Page & Neuringer, 1985). The high frequency of variation in behavior topography is one of the reasons why function is targeted by behavior science: behaviors with different topographies can have an identical function and be functionally equivalent (Kantor, 1938).

Regardless of the unit of selection (e.g., gene or behavior), variability is so decisive that it is systematically selected, even though in the abstract one would think that the tendency to select perfectly adapted patterns would lead to transmission of successful patterns without variation. With regard to language, the three properties of derived relational responding – mutual entailment, combinatorial entailment and transformation of functions – create an explosion of variation in verbal organisms’ behaviors. With mutual and combinatorial entailment, one can derive four relations after being taught only two relations between three stimuli. Generally speaking, when someone is taught X relations, they derive X^2. The three properties of derived relational responding also apply to relations between relations, which allows the creation of thousands of derived relations after being initially taught only eight object-sign relations, for example (Hayes & Long, 2013). In addition, since relations among stimuli are not restricted to equivalence but can comprise a wide variety of other types of relations, such as comparison or conditionality, verbal networks can ultimately award the opposite function ,from reinforcing to punishing, for example. This creates an exponential increase of behavior variation in relation to any stimulus: since stimuli may acquire new functions by mean of derivation and transformation, they can evoke behavior that would never appear otherwise. In the context of large relational networks, such as exists in any educated human, the number of possible derived relations or functions (and thus sources of variation) is literally incalculable.

Finally, language itself is capable of tremendous variation. Because the stimuli composing language are arbitrary, they can endlessly be transformed and blended to create new linguistic configurations, which eventually split, much as distinct species appear through the geographical separation of several individuals. Linguistic stimuli can also be combined and associated to form new meanings, detached from direct experience, as it is the case in fiction, poetry, metaphor, or science. These possibilities linked to language variation likely played a central role in the enrichment of human incredibly broad repertoire. Although the famous discovery of the Blombos perforated shell beads (Henshilwood, d'Errico, Vanhaeren, Van Niekerk, & Jacobs, 2004) moved the early signs of symbolic activity back to 75,000 years ago, the spreading of symbolic activity around 40,000 years ago corresponds to a period of prodigious explosion of behavior diversity which has continued to become more complex since.

2.4. Modification of behavioral heritability through language

Before language, transmission of behaviors between individuals relied on such processes as imitation, or inducing others to contact environments in which actions would be shaped. Imitation and social learning represents a faster means of behavior transmission than genetic inheritance, but suffers from serious limitations: a unity of time and location is required between the organism who emits the behavior and the one who reproduces it. At times a strict environmental configuration is necessary to allow the occurrence of the behavior. For lithic reduction to be transmitted through imitation, an individual who doesn't know how to use a hammerstone needs to meet someone who does, and the relevant stones must be available around them. With derived relational responding and the possibility to symbolize stimuli and behaviors by mean of vocal sounds or drawn signs, behavior transmission is fundamentally altered and enhanced . The ability to use arbitrary language stimuli withdraws the obligatory encounter between the model and the learner. Verbal stimuli can be transmitted across time and space, whatever the context, which dramatically increases the possibility of behavioral transmission, horizontally between contemporaries, and also vertically across generations. Finally, written forms of language, which appeared more recently in human history, allows for retention for an almost infinite duration and without volume limitations, that is, independently from human memory capacities. This form of heritability nowadays has been fleshed out in books, tapes, digital media, and the like. Relatively speaking, such media are extremely reliable, allowing for essentially perfect reproduction and conservation of information, resulting in an accumulation of perfectly transmitted behaviors.

Intuitively, one could think that such a large and perfect transmission of behaviors would result in the diminution of behaviors variation. On the contrary, transmission of behaviors by mean of language contributes to the variation of behaviors and to the appearance of new behaviors. The invention of currency around 4000 BC in Sumer constitutes a good example of this phenomenon. Globular envelopes were used to lock up clay tokens representing, for example, a number of sheep confided to a shepherd. Progressively, these envelopes were engraved on their surface to replace tokens, and then flattened out. These tablets were then exchanged, giving rise to trade instead of the prevailing barter

(Herrenschmidt, 2007). Without the symbolization allowed by derived relational responding, currencies and trade would never have appeared, and nor would a large part of human behavior.

2.5. Evolution has no purpose but humans do

When observing a perfectly adapted organ, such as an eye or a wing, the first conclusion that comes to mind is that such a perfect adaptation cannot be anything but designed. According to the famous assertion by William Paley, if something perfectly fits its environment, that design implies a designer, and a goal to be reached, a designed function or a plan. This teleological argument has long been disproved, notably by Darwin himself (see also Gould, 1989, 1996, 2000), and the consensus among evolution scientists is that evolution has no goal, and is non-directional.

This point is rather difficult to apprehend since the selection of the most adapted patterns easily and mistakenly leads to the conclusion that adaptation, or progress, constitute the final goals of evolution. This is a mistake at the level of process: there is no goal, and no place for teleology in evolution.

While this viewpoint is agreed upon among evolutionists in the life sciences, the non-teleological argument is more difficult to accept for psychologists, and that for a simple reason: human beings seem to act with intentionality. This leaves us with a puzzle: how can a species, an outcome of the evolution process, emit goal-directed behaviors if there is no goal for evolution?

Relational Frame Theory allows CBS to deal with verbal purpose and intention, without questioning the non-directionality of evolution. For a verbal organism, “verbal time is the past as the constructed future in the present” (Hayes, 1992, p. 114). Contrary to non-verbal organisms, a constructed future exists for humans in the form of “before … after” or “if … then” relational framing, which can influence present behaviors. Derived relational learning allows stimuli to control behavior even when these stimuli are absent. With derived relational responding, behaviors' functions cannot be analysed by considering exclusively past experiences: the analysis must also include a temporal extension because such temporal extensions are themselves part of human language and cognition (Hayes & Long, 2013).

Intentionality and goal-directed behaviors do exist in human repertoire. However, in order to avoid circularity, "the theory must explain how purposiveness of this type has come into existence at this stage of evolution without using the very notion of purposiveness that is being explained" (Maxwell, 2010, p. 266). The RFT proposition reaches this condition. Although verbal organisms can emit goal-directed behaviors, language, the very condition for these behaviors to occur, did not appear for a purpose. Derived relational responding results from selection at both phylogenetical and ontogenetical scale and is, as such, the product of the non-directional evolution.

On a phylogenetical scale, several hypotheses have been proposed to explain language evolution within a selectionist account, one of the most convincing being that symbolic behavior evolved as an extention of human cooperation (Hayes & Sanford, 2014; see also Tomasello, 2008). At an ontological scale, RFT states that arbitrarily applied relational responding is an operant (Hayes, Gifford, & Wilson, 1996 ; Hayes et al., 2001), and is the product of a multi-exemplar training history (Healy, Barnes-Holmes & Smeets, 2000). As such, arbitrary applied relational responding is selected without a goal, but according to its consequences. RFT fleshes out Dennett's (1995) intuition that "intentionality doesn't come from on high; it percolates from below, from the initially mindless and pointless algorithmic processes that gradually acquire meaning and intelligence as they develop" (p. 205). The fact that human beings can set goals for their behaviors does not imply that evolution is goal-directed. At the evolutionary scale, the possibility for human beings to act in a goal-oriented manner is a by-product. Actually, human capacity for goal-directed behaviors conversely helps to understand why humans grant intention to processes which do not have any: how can one possibly imagine that evolution is non-directional when most of our actions are?

Analysing the possibility for human beings to act with intention and in a goal-directed manner raises a fundamental question: can human beings now set a purpose for their evolution when evolution writ large has none? Goal-directedness alters a great many things in the application of evolutionary principles to human action. For example, although derived relational responding was likely selected in part due to its resulting increase in variability, CBS researchers in Acceptance and Commitment Therapy target the psychological rigidity (and thus the *decrease* in variability) that results when avoiding emotions or following rules dominates over other sources of behavioral regulation. Goal setting as a by-product of evolution can promote social ills (e.g., seeking comfort or ease can lead to ecological issues that threaten life on a planetary scale) but it can also lead to the deliberate use of selectionist ideas for social good (Wilson, 2007).

Contextual behavioral perspectives are useful in part because they empower us to consider how best to use evolutionary processes to promote human welfare. That is what is occurring in psychotherapy, or any applied domain. Everything is possible, and evolution does not care about the direction human beings will choose. Humanity has to take this responsibility.

Conclusion

Appreciating the global role of behavior in evolution erases the division between hard and soft science. Due to its influence on the environment, on DNA expression, on its own replication, and at different levels of selection, behavior plays a central role in the evolution of complex organisms. From a CBS perspective, language, because it changes the selection processes and represents a true selection force, a variation stream, and a prolific medium of symbolism, is at the very heart of human evolution. All these reasons put “contextual behavioral approaches into the center of evolution science itself" (Hayes & Sanford, 2014, p. 114).

Based on the comprehension of language and symbolic behavior that Relational Frame Theory brings, Contextual Behavior Science has a role to play in the study of human evolution as it has shaped us so far, and would help predict and influence our future evolution. In the words of Skinner (1988), "the whole story will eventually be told by the joint action of the sciences of genetics, behavior, and culture" (p. 83). It appears that the time has come for joint action between CBS and the evolutionary sciences, in order to address the challenges human race is facing, such as overpopulation and environmental destruction. Such a common action is already on its way (Wilson, Hayes, Biglan, & Embry, in press).

In these times of unequalled rapid and massive information transfer, scientists have the responsibility to fully understand the tremendous influence of language on our behaviors. Since evolution gave us the opportunity to act with intentionality, it is up to us to use this possibility to the greatest effect, in the interests of human kind itself.

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