Cultural-Historical Activity Theory: Toward a Social Psychology from First Principles

Wolff-Michael Roth

Applied Cognitive Science, University of Victoria

Abstract

In the early part of the 20th century, a form of (social) psychology emerged that is entirely grounded in a dialectical materialist method. The dialectical materialist approach leads to a non-dualist, non-reductionist account of culture, cognition, and consciousness that begins with single-celled organisms and ends up with present-day science. In this paper, I present such an account initiated particularly by A. N. Leont'ev and K. Holzkamp, who constructed a form of psychology that operated with categories consistent with evolution rather than reifications of common sense. The account is based on an approach whereby quantitative changes in the individual organism and the surrounding environment lead to qualitative changes in the evolutionary process, e.g., new dominant structures or functions. In other words, the account is based on a method that explains the emergence of structure (morphogenesis) that ultimately leads through anthropomorphosis and the associated qualitative shift to culture (society) as the carrier of knowledge. I show, drawing on some simple examples, how this verbally articulated transformation of quantitative into qualitative changes is consistent with mathematical models of morphogenesis as these were developed in catastrophe theory (René Thom).

> The problem of the biological and social is decisive for a scientific psychology.
> (Leontyev 1981, p. 132)

One of the big questions of science as a whole is how life on earth has evolved from being environmentally determined through evolutionary processes to eventually give rise to anthropomorphosis, whereby cultural history and human cognition have come to be the dominant mode of our species to interact with the natural environment. Cultural-historical activity, founded and developed by such psychologists as Lev S. Vygotsky (1896–1934), his student Alexei N. Lenot'ev (1904–1979), and Klaus Holzkamp (1927–1995)—who implemented the program that the former had begun in the most consequential way—has actively sought answers to these questions. Today cultural-historical activity theory is mostly known in the version created and propagated by Yrjö Engeström (1987), especially as captured in the now emblematic mediational triangle (Figure 1c), which articulates the structures of productive human *activity*.[1] My representation actually retains four important concepts grounded in Karl Marx's thought that motivated the development of the theory (production, consumption, exchange, and distribution). Although these concepts are not used in most research today, they have played an important role in the change over from evolution to cultural-historical development.

Engeström also provided a brief description and associated representations of how the structure of human work-related activity has emerged from the relations that existed among animals and their natural environment (Figure 1a) with the emergence of tool making and tool use, the rudiments of cultural practices (patterned actions as observable among chimpanzees and orangutans), and division of labor (Figure 1b). What Engeström does not provide are the reasons and mechanisms for such a turnover from a system regulated by evolutionary pressures to one that develops because of cultural-historical principles. This version of the theory therefore does not explicate why the human psyche and mind

[1] Here, the term "activity" denotes collectively motivated life sustaining (Ger. Tätigkeit, Rus. деятельность [deyatel'nost']) rather than doing tasks that keep a person busy (Ger. Aktivität, Rus. активность [aktivnost']). There are other difficulties with the English translation, for example, when it does not make the distinction between "социально" and "общественно," which are rendered in the German translation as "sozial" and "gesellschaftlich," but as "social" in the English translation rather than in terms of the corresponding "social" and "societal."

fundamentally are collective phenomena—to tweak the title of Vygotsky's (1978) book, society is in the mind because mind is in society. This version of

world, and that it often records as a datum, as an empirical given in dependent of the act of knowledge and of the science which performs it,

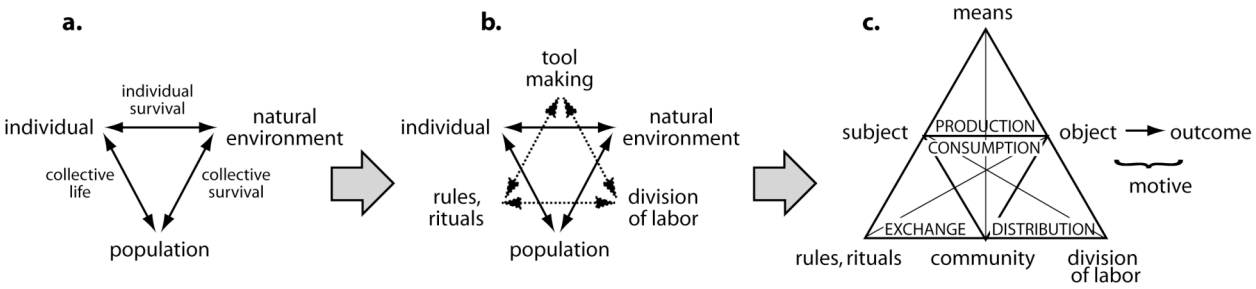

Figure 1. Cultural-historical activity theory as per Yrjö Engeström (1987). a. The animal world. b. Anthropogenesis and the emergence of labor. c. Structure of human activity systems.

cultural-historical activity theory also does not articulate and address a major problem that has beleaguered psychology, the separation of thought and affect: "their separation as subjects of study is a major weakness of traditional psychology, since it makes the thought process appear as an autonomous flow of 'thoughts thinking themselves,' segregated from the fullness of life, from the personal needs and interests, the inclinations and impulses, of the thinker" (Vygotsky, 1986, p. 10). This separation, whereby affect is only a factor external to cognition rather than an internally constitutive one, also leads to the fact that psychology does not have a way of theorizing or studying "the influence of thought on affect and volition" (p. 10).

There is a different lineage of work much less known and yet more important for the purposes of this symposium and for the elaboration of a viable theory of mind, consciousness, and affect: Vygotsky–Leont'ev–Holzkamp. In this lineage, theorists were concerned with establishing psychology as an objective, materialist science that is based on first principles rather than using mundane concepts operationalized scientifically. Vygotsky (1986) had noted that language is (a) a generalized reflection of reality, (b) as old as consciousness itself, and (c) a practical consciousness-for-others and consciousness-for-myself. Language therefore is "a direct expression of the historical nature of human consciousness" (p. 256).

Grounding himself in Karl Marx, Vygotsky wrote that scientific concepts are unnecessary if they reflect "mere appearances of objects, as empirical concepts do" (p. 173). In the eyes of critical ethnographers, psychologists, and sociologists, traditional forms of research in their respective domain fall prey precisely to this observation:

> It would be easy to show that this half-scholarly science *borrows its problems, its concepts, and its instruments of knowledge from the social facts, representations or institutions which are the product of a prior stage of science*. In short, it records itself without recognizing itself. (Bourdieu, 1992, p. 236, original emphasis)

Bourdieu, as Leont'ev (1978) before him and other sociologists of the critical school after him, is especially critical of Western scientism. For Leont'ev it was Vygotsky's (1986) *Thought and Language* that had framed the theoretical approach to a truly Marxist psychology, a science that has as its major task to reconstruct those categories that are foundational to creating a non-self-contradicting system explaining the emergence, function and structure of the psychic reflection of reality, which mediates the lives of individuals. The categories to be reconstructed in such a program are concrete activity, human consciousness, and personality.

Critiquing traditional psychology for merely reifying mundane, everyday (empirical) concepts, Leont'ev and, following him, Holzkamp (e.g. 1983) and colleagues established a program—*Critical Psychology*—that realized Vygotsky's intuition about scientific concepts: they require categorical reconstruction that takes into account how the phenomena they describe could have arisen as part of evolutionary and subsequently cultural-historical processes.[1] This therefore required the same dialectical materialist approach that Marx had chosen for the reconstruction of political economy: beginning with some very basic form—in *Capital*, this was "value," which expressed itself as use-value and exchange-value—a system evolves until eventually it gives rise to the human psyche. Thus, "we must create our own *Das Kapital*" for "*Das Kapital* must teach us many things—both because a genuine social psychology begins *after Das Kapital*

[1] Not surprisingly, Holzkamp (1983) entitled his book *Grundlegung der Psychologie* ("Laying the foundations of psychology").

and because psychology nowadays is a psychology *before Das Kapital*" (Vygotsky, 1927/1997, p. 330, 331). Accordingly, "the historical approach to human psychology, a concrete psychological science of consciousness as a higher form of the reflection of reality, and the study of activity and its structure were developed" (Leont'ev, 1978, p. 12). Fundamental for Marx had been the idea that cognition is the product of the development of human activity in and on an objective (societal and material) world. For Vygotsky internalization constitutes internal structure rather than projecting activity onto an already existing structure. In his *concrete human psychology*, it was life that was the foundation of consciousness rather than meaning and consciousness that constituted the foundations of life[1]: "it is clear *why* everything that is internal in higher function was necessarily once external: i.e., it was for others what today it is for itself" (Vygotsky, 1989, p. 56) and "*the relation between higher psychological functions was at one time a physical relation between people*" (p. 56, original emphasis), and "To paraphrase Marx: *the psychological* nature of man is the totality of social relations shifted to the inner sphere and having become functions of the personality and forms of its structure" (p. 59). For a truly Marxist psychology, it is insufficient to articulate and provide evidence for the societal mediation of mind; a truly scientific psychology has to show how evolution brought forth society, how societal-historical factors become dominant over evolutionary processes, and how the mind became societal.

The Method

Toward Dialectical Materialism as Foundation for a Scientific Psychology

Consciousness has a long prehistory in the evolution of the animal world, but it appears in human beings as they organize work and societal relations. Consciousness, being the co-product of and an inner reflection (refraction) of productive labor, therefore is marked by societal structure as a whole. A scientific psychology had to show how in the phylogenetic development from primitive forms of life anything like the human mind could develop, and especially, how the transition to a qualitatively new consciousness could emerge.

> Dialectics covers nature, thinking, history—it is the most general, maximally universal science. The theory of the psychological materialism or dialectics of psychology is what I call general psychology.
>
> In order to create such intermediate theories—methodologies, general sciences—we must reveal the *essence* of the given area of phenomena, the laws of their change, their qualitative and quantitative characteristics, their causality, we must create categories and concept appropriate to it. (Vygotsky, 1927/1997, p. 330)

Vygotsky was most concerned with the way in which psychology had parsed psychological phenomena into factor (elements) that were studied independently of one another and, when they were related at all they were so in an external way, as factors external to one another. Following G.W.F. Hegel (1806/1977), he understood that factors, "being externalities, they are indifferent towards each other, and lack the necessity for one another than ought to lie in the relation of an outer to an inner" (p. 188 [¶314]) could not establish psychological laws (e.g., the mentioned relation between thought and affect). Again realizing a thought originally articulated by Hegel, Vygotsky conducting unit analysis rather than the for psychology typical analysis by elements, which would lead to the unity of inner and outer within and outside the mind: consciousness for oneself (thought □ word) and for the other (word □ thought) are two sides of the same coin. Following Vygotsky, Leont'ev and Holzkamp articulated a method that allowed the reconstruction of the nature of human psyche in the way the former was only able to sketch. Taking the dialectical law of the "turnover [transformation] of quantity into quality" (Engels, 1962, p. 517).

With the development of a dialectical materialist approach, new possibilities arose for psychology to deal with its permanent crisis. It became possible to open up for investigation—with respect to method and content—the heretofore eliminated historical dimensions of the biological, societal (cultural) historical, and individual developments as self-movement that arise from the inner contradictions within a system that encompasses organism and environment. The first to realize such a program was the Russian (Marxist) psychologist Alexei N. Leont'ev, with his idea about approaching psychological problems and objects historically. He proposed a trajectory of the psyche from some most foundational categories—sensibility and object-oriented movement—to the human psyche today. This trajectory was brought about by differentiation whereby cumulative quantitative changes and inner contradictions led to qualitative changes where new characteristics and functions came to predominate. This approach is consistent with the kinds of historical analyses that have emerged with dialectical logic as articulated in a lineage of philosophical works from G.W.F. Hegel

[1] In his text, Vygotsky actually uses Marx and Engel's (1970) expression from the *German Ideology*.

and Karl Marx into psychology via Lev Vygotsky, and into sociology through the various schools the critical sciences. For example, German Critical Psychologists felt that constructs such as motivation were merely picked up from everyday discourse and subsequently refined and operationalized independently of the individual and society as a whole (e.g., Holzkamp-Osterkamp, 1976). Not surprisingly, a new subfield emerged, psychology of motivations, which was connected, if at all, only externally to other aspects of the human psyche. More so, Critical Psychologists charged that the motivation concept was employed politically in the sense that psychologists sought ways to make people (students, factory workers) do what they did not inherently wanted to do themselves (learning, working hard and diligently). Psychology therefore came to be but a tool in the oppression of certain classes and in the disciplining of human bodies to fit the various pigeonholes that someone else had predestined for them.

In a dialectical materialist approach, development goes from the most abstract, that is, least differentiated through progressive, concrete realizations of inherent possibilities, which continually unfold as realized possibilities give rise to new developmental possibilities. In this way, the human psyche is regarded but the present-day endpoint of evolutionary and cultural-historical processes that have their origin in some ancestral capacity from which later capacities (e.g., those observed in primates) evolved and that set the stage for anthropogenesis and the taking over of society and its cultural-historical development as the main carrier of development. In this way, the psyche, in its most general human characteristics, can be described and explained as the result of phylogenetic and anthropogenetic processes, whereby present-day characteristics come to have evolved from phylogenetic origins through an uninterrupted process of inheritance as the substantial carrier of development. This development is an irreversible progression of accumulation and structuration of genetic information.

Methodologically, the derived categories have to reflect the differentiations that are objectively given in the functional aspects by means of real, objectively given genetic processes. The inner structures of organisms reflect (refract) its outer conditions. The inner structures evolved such that it allowed organisms to better cope with the external conditions; the inner structures therefore are the result of cumulative organism-environment relations. Organisms change not merely because of direct external influences, by *mediated* by evolutionary processes, change their inner structure such that they can survive precisely and especially under these conditions. At the population level, there is an equilibrium generated by the equality of birthrates and death rates. The poles of contradiction exist in the generative possibilities from mutation, on the one hand and from the changes in the environmental conditions that threaten the population. An inner contradiction exists when the reproductive capabilities are enhanced even in adverse environmental conditions, because of those organisms with higher system capacities. The external conditions therefore constitute a form of pressure whereby particular functions (genes) come to be enhanced and others are suppressed because they are selected against.

Five Steps in the Analysis of the Change from Quantity into Quality

Any biologically realistic explanation has to demonstrate five sets of conditions for change processes to occur that include both quantitative and qualitative changes (Holzkamp, 1983). First, there has to be a demonstration of the real-historical conditions of the preceding level within and upon which the qualitative functional change develops. This requires an articulation of all those moments that are relevant to the subsequent stage so that the only remaining task is the demonstration of how the qualitative reversal operates by omitting all concomitant but irrelevant changes. From the dialectical materialist perspective, this is precisely the articulation of the conditions that are "negated" in the qualitative turnover.

Second, it has to be shown that there were objective changes in the external conditions that allow the internal contradictions, which will give rise to the qualitatively new function, to have its equivalent in the external environment. It is thereby especially important to articulate those conditions that endanger the organism such that there is a pressure in the direction of the new function; and it is important to articulate those aspects that make it possible for the mutants that have the new function to thrive and reproduce. In this way, the organism population continues to be in balance with the environment.

Third, it behooves the analyst to articulate a functional turnover that relates the pre-existing dimensions in a new way, and thereby the evolution of the first qualitative change of the specific nature of the new function that makes the organism better adapted. This is a change at the organism pole of the developmental contradiction. The negation here occurs at a subordinate level, that is, it is not the dominant function at the previous level but only a

partial, co-existing function. The function is not yet a determining factor for the organism as a whole.

Fourth, there a change in dominance must be demonstrated, whereby the previously dominant function is negated and the co-existing new function becomes the dominant one. This is a second qualitative change, for a qualitatively specific function becomes the dominant function for the system as a whole. In this way, evolutionary change does not have to be radical. Rather, it always happens on the grounds of already existing qualitatively different functions that are selected for under changing external conditions. New organism-relevant functions do not suddenly emerge and become dominant so that they become dominant with their first occurrence; rather, they emerge slowly (quantitatively) as variants. If once can nevertheless observe a qualitative turnover in the evolutionary process, this is because the change to the new developmental level is not based on a single dimension but on the turnover of the relation of two continuously changing dimensions. Although the two functions undergo continuous change toward the turnover, the latter does not happen continuously but in a singular reversal that makes the subordinate function dominant and the dominant function subordinate in the needs spectrum of the organism. This allows us biological evolution to be a continuous process all the while leading to the emergence of new qualities—e.g., the emergence of the roots of the psyche from antecedents that have no psyche-related qualities at all.

Fifth and finally, the analyst must demonstrate of the restructuring process that gives the evolutionary trajectory of the system as a whole a new direction following the becoming dominant of the specific function to the system-sustaining determinant function. It also requires the demonstration of what happens to previously dominant functions, how they have no longer or different functions under the new conditions in the continuing evolutionary history of the system. The system develops, evolving new subsidiary functions until we are at the beginning of a new process of functional turnover.

From Matter to the Origins of the Psyche

A first major step in the reconstruction of psychological categories is the demonstration that anything qualitatively different subsequently developing into the psyche could emerge and how it possibly emerged. The psychical here is to be defined such that it can be articulated as a specific moment in the phylogenetic process as a qualitatively new level of development in the life process that becomes the dominant process. Leont'ev (1981)/Holzkamp (1983) insist on the fact that not only the psychical has emerged from life processes but also life itself has become, at one point in time, a historical process. This first step is one from the pre-biological to the biological. Concerned with the emergence of the psychical, Holzkamp leaves this first demonstration to biologists. He focuses instead on the emergence of the psychical in organisms that up to a certain point were merely passive. The general dimensions of the developments include the improvement in assimilative exploitation of energy and the improvement of the capacity to process information in the sense of selective irritability for materials that can be assimilated, not assimilated, and noxious to the organism. At a structural basis of these functional developments are the transitions from single-celled to multi-celled organisms and the increasing differentiation into cell types and the corresponding division of labor for the system as a whole. Life first and foremost is an interaction between an organism and its environment.

Leont'ev takes sensibility, which reflects objective external reality, as the elementary, most general form of the psyche, and then treats the problem of the origin of the psyche in this concrete form as the problem of the genesis of a capacity for sensation. Sensation and movement are linked—as we know from the experiments where, for example, images are fixed to the same emplacement on the retina, which leads to the extinction of the image. Sensibility is defined as the "capacity to capture the real relationships between metabolically neutral and metabolically relevant instances in the environment in such a way that it results in a oriented movement of the organism to attain the metabolically relevant resources" (Holzkamp, 1983, p. 71). The metabolically neutral thereby becomes the signal that the organism "interprets" with respect to the location of metabolically relevant conditions. Movement now is *mediated* by a signal.

Two real-historical boundary conditions have to be satisfied and empirically proven. One, because sensibility implies orientated (intended) displacement, the capacity for displacement has to exist so that signal can, in a qualitative change, become a mediating entity. The second condition is that the organism can register metabolically neutral conditions.

For the sensibility that will make the origin for the psychical to come into being, a qualitative change needs to occur that leads to this qualitatively new function, where undirected motility becomes directed mobility. Because the organism does not change in itself, there a contradiction is required as deriving from the external conditions, such as the lack or gradation of food. Those organisms that can

orient with respect to lack or gradations of food have a selective advantage. Heterogeneous structures in the environment (food gradients, absence, and noxious substances) therefore come to be reflected in the selection of an internal structure that corresponds to intended orientation.

Initially the two capacities, motility and irritability, stand side by side in the pre-psychic situation. As soon as the two come to be correlated, and the organism "intentionally" orient to have access to food that otherwise would not exist, there is a qualitatively new function has taken over. This is a qualitatively new way of relating to the environment that allows the organism to access food and avoid noxious conditions. But the presence of this qualitatively new form does not mean it is the dominant one of relating to the environment. The organisms still have the capacity to direct uptake of nutrients from the environment until such a point that the selection pressures, perhaps in response to additional external changes and differentiation of availability of nutrients are such that the new function becomes the dominant one at the population level. At this point, sensibility (as Leont'ev defines it) becomes the dominant mode of nutrient uptake.

The orientation within gradient fields exists from the single-cellular organism that begins the analysis to the highest forms as an elementary form for orienting. There are, for example, elementary sensibilities for dark and light or rather to gradients of darker and lighter. (Smell functions in this sense as oriented according to gradients.) The new functions that develop are those where the orienting function can deal with information in a distance. That is, properties of the environment become relevant to the organism even though they do not change along a gradient. The system that adapts to the environment is not the individual but the population as whole. With respect to the individual organism this only means an increase in the probability of reproduction not of securing its own survival. A further functional level with its own evolution that differentiates itself from the basic form of sensibility is that of discrimination of different units of "meaning." The organism becomes capable not merely to isolate a single aspect from the environment but to capture the relation of different environmental conditions. There is a differentiation from a mere "toward" and "away from" to qualitatively different content-determined activities (prey = attach, predator = running away/hiding, food = feeding).

All of these orienting and sensing are directed toward the outside. There is a corresponding development on the inside, which become the pre-forms and early forms of emotionality. In the early organism, there emerges a relation between specific changes of state in the organism and the actualization of "meanings," the former being the translation of the latter. Mere expression of differences now becomes actualization of "meanings" and the translations of relevant activities. The objective function of actualized meanings constitute (e)valuations of specific environmental conditions with respect to their suitability for overcoming disturbances in the equilibrium that the activations have brought forth. The distance of the disturbed state from the equilibrium state is a measure of the valuation. The earliest forms of these valuations already exist when an organism begins to orient toward higher gradients, where higher levels of food are "expected." Disturbances from the equilibrium state are signed negatively, and the return to the equilibrium state therefore comes to be signed positively. The meaning units are signed positively when, during actualization, the disequilibrium is removed by orienting toward the meaning unit but are signed negatively when the disequilibrium is decreased by turning away or distancing from the meaning unit. This intermediate form of the psychic form is captured in its determinations in the following way: Emotionality is the valuation of the orientation of "cognized" environmental conditions whereby the current state of the organism is the measure of the degree and type of readiness for activity/action. Emotionality thereby becomes the intermediate (mediating) term between "cognition" and "action."

In this way, the individual organism relates to its environment in mediated form, whereby emotionality mediates between objective environmental (external) conditions and internal states. The environment (objective life condition) is functionally represented in the valuations in terms of the individual's current state. A relationship is established between objective conditions, potential meaning structures, and the thereby conditioned actualization and translation into activity of certain aspects of the meanings. This aspect of emotionality thereby becomes an objective regularity that has emerged in and changed with evolution. Emotionality is not the mere inner phenomenon without function as traditional psychology represents it. In cultural-historical activity theory, therefore, emotion plays an integral role in the orientation of the subject towards its goal and in the orientation of the collective toward the object/motive. Holzkamp thereby provides an avenue out of the shortcoming of psychology that Vygotsky had formulated some 40 years before: the separation of cognition and affect. In the process of differentiation, there evolve different dimensions of need that may compete, for example, being safe and being satiated. Finding food and eating may put the organism into danger, because it has to come out

from hiding. The relevant valuations therefore go in different directions and the organism has to arrive at a way of arriving at an overall valuation despite the competing individual valuations. (Later this leads to the pursuits of activities associated with the promise of positive valuations although it requires realizing subsidiary goals that are associated with negative valuations—hard work, lack of sleep while studying for an exam.)

In his description of psycho-phylogeny, Holzkamp shows the evolutionary basis of dimensions that subsequently became dominant features of the psyche. This includes the emergence of rudiments for orientating and attributing meaning, emotionality and needs, and communication and social structures. Communication allows the coordination of collective activity and leads to particular social structures—e.g., the communication and hierarchy in bee and ant colonies. Holzkamp derives an intermediate level between the total phylogenetic process, the systemic maintenance of populations as potential carrier of evolution and the level of the individual organism: the social structure of the animal and its systemic preservation. In the context of evolution, social structure is subordinate to the population, for the corresponding increase in information density brings mutation and selection to a new level. On the other hand, with respect to survival, social structure is super-ordinate to the individual organism, because what imports is average preservation rather than individual preservation. This level is required to be able to prepare for a later state a shift from the individual to the collective as carrier of the information that is used in coping with environmental conditions. It is an important condition for the subsequent genesis of the specifically human psyche, where the control over the environment is achieved in a division of labor and consciousness is a reflection (refraction) of the fundamentally collective way in which adaptation to the environment occurs.

Anthropogenesis

The specific qualities of the psyche emerge at and arrive with the new "human" level where there exists a mediated relation between the individual and a qualitatively new process, that is, a societal-historical process. The qualitative turnover occurs between the previous level and to the now emerging specifically human level. This new level is not something integrated into phylogeny but a new process sui generis. A description of the five steps during anthropogenesis differs from all previous ones because a new kind of phenomenon evolves that does not happen within biological evolution but is a societal-historical level with its own laws of development. This is precisely to be shown to be able to make an argument how biological evolution can give rise to anything specific to societal, cultural, and historical development. In this turnover from psycho-phylogeny to the development of the specifically human psyche, the first three steps still occur at the previous level: conditions, developmental contradiction, and first qualitative shift. The next, fourth step, which is the turnover to a qualitatively new dominant level is the important one in the change over, and step 5 is then to be described in terms of the new overall process, now a societal-historical. A description of this process is especially important given that primate researchers have shown that many of the behavior kinds previously said to be specific to human already exist at the prior level. There are, among others, production (fashioning of) tools, tool use, collective activity (hunt, grooming), exchange relations, hierarchical structural relations that appear to mediate other collective activities, and rudimentary cultural practices (i.e., patterned actions that are learned rather than genetically encoded). Because Holzkamp focuses on the linkage of such capacities as the basis for the formation of new qualities that eventually become the dominant ones, his approach is promising one for describing and explaining anthropomorphosis. An especially important aspect of the demonstration has to be the transition between evolutionary processes and societal-historical processes as dominant means in the development of the population.

Analytic Step 1: Real-historical Conditions

The first step analytic step requires showing the real-historical conditions that served as the "material" with and upon which the qualitative changes occurred. This level is characterized by the development of manipulative capacities to deploy tools ("means") and the individualized social contacts in the rainforest biome prior to the separation of hominid and other lines. Anthropogenesis required a certain level of hominid development along a number dimensions that served as the ground for the qualitative change that describes the difference in the organism-environment relation between pre-hominids and hominids. The development just prior to the differentiation that produced hominids included a change to omnivorous behavior, a transition from night- to daytime foraging, and a change from the dominance of short-range senses (smell, temperature, tactile) to that of long-range (acoustic, optical) senses. Further developments adapted the pre-hominids to the life in the tropical forests, the increasing use of hands especially for the locomotion by means of swinging hand-over-hand climbing and a coincident vertical orientation of the body, which further freed the "hands." The manipulation of

objects encouraged a further differentiation of visual capacities to include binocular depth perception, which further supported the development of fine-motor skills in object manipulation.

These evolutionary trends were required for early forms of tool fashioning and tool use to emerge, such as those that characterize chimpanzees or orangutans (van Schaik et al., 2003). Readers recall the observations Jane Goodall made on chimpanzees in the wild, who fashioned tree branches to "fish" for termites through holes in the mount (e.g., Goodall, 1986). These early forms of fashioning and using tools were accompanied by an increasing differentiation of learned social relations, including signal exchange, increasing bonding to children and other individuals within the group, and further differentiation and articulation of independent forms of relations such as grooming to maintain friendship. Goodall also described what we can understand as differentiated coordination of hunting activities (i.e., division of labor), such as chimpanzees' pursuit and cutting off practices in hunting down Colobus monkeys. (For a critique of this work see Busse, 1978.) Some members of the group cover all available escape routes while one adolescent male climbs after the prey and captures it; the others then rush up and seize parts of the carcass for themselves. Existing dominance hierarchies appeared to play a role in providing a basic structure for organizing the hunt. Such dimensions would have constituted a fertile ground for anthropogenesis, in fact, are central to theories of human social and moral evolution (de Waal & Berger, 2000). However, as the presence of these dimensions in chimpanzees shows, these are necessary but not sufficient conditions for being specifically human. For the change toward the emergence of human nature to occur, "contradictions" in both environment and organism poles are required to function as evolutionary pressure.

Analytic Step 2: Objective Changes in the External Conditions—Contradictions in the Savannah Biome

Bipedalism, freeing of the hands, development of learning capacities. Under what conditions might there be a turnover in dominant behaviors to new ones that subsequently became characteristic of early humans and leading to the split of the last common ancestor into extinct and present primate lines, on the one hand, and the Hominin line, on the other hand? The key change that likely precipitated anthropogenesis was climatic cooling, the diminution of the forested areas and the corresponding increase in C_4–plant dominated savannah and steppes, and the corresponding split among those primates that remained in the forest and those that sought fortune in the new environment (Elton, 2008), though there is evidence of complex tool making among chimpanzees living in the tropical forest as well (Mercader et al., 2007).[1] In fact, the increasing cognitive capacities allowed hominins to reenter the tropical forests that would have been normally disadvantageous environment for obligate bipedalists. In the latter, there was less food, less protection from predators, greater range requirements for finding food and protection, and high grass. These conditions constituted "contradictions" for the displaced hominid primates, but contradictions for which they were prepared, in some sense, by previous evolutionary steps and differentiation processes. For example, these primates could cope with high grass by orienting their body in a vertical direction. Thus, the earlier development toward vertical orientation would have been a "fertile" ground for further vertical orientation. Such orientation in the new environment would have further supported the previous evolutionary changes toward increasing bipedalism, freeing of the hands, development of manual fine-motor skills, depth perception, and visual orientation capacities—all of which further supported the fashioning (production) of tools and tool use. The playful trial-and-error manipulation and fashioning of objects, a form of "thinking with objects," eventually may have accompanied the fashioning of tools for immediate use, giving rise to the production of objects that were only some time later used as tools.

Emergence of complex social groups with large membership above the individual family. These changes in functional relations with the natural environment were likely accompanied by changes in the social organization, which constituted further adaptation to the new savannah environment. For example, the formation of large groups comprising many family units and flexible relations between individuals would enhance the concentration of information and experience, and lead to an increased capacity for the reproduction of learned behaviors and traditions. Such formation of traditions has been reported among chimpanzees as well; research reported no less than 39 learned behavior patterns that vary across chimpanzee communities in Africa (Whiten *et al., 19*99) and at least 19 learned behavior patterns among orangutans in six South-East Asian study sites (van Schaik et al., 2003). For example, chimpanzees at Gombe (Goodall's site) use objects such as stems, twigs, branches, leaves, and rocks in

[1] There appears to be a shift away from considering human evolution in terms of adaptation to savannah, grassy environments appeared to have played an important role (Elton, 2008).

nine different ways in the context of feeding, drinking, cleaning themselves, investigating out-of-reach objects, and as weapons. In other communities, chimpanzees use objects for different purposes and in different ways. In each community, behaviors are passed from one generation to the next through observational learning so that we might see in this phenomenon the roots of the phenomenon of culture (de Waal, 1999).[1] Interestingly, primate cultural transmission occurs in the absence of language as a formal system of representation but requires physical co-presence with other primates. Transmission cannot occur through vicarious experience in the absence of language.

At this level, the capacity for learning has to evolve so that the individual, rather than being determined in what it knows, can acquire skills from its surroundings generally and from its societal relations in particular. That is, there has to be a development whereby forms of social learning are developed in addition to those that already exist by means of social influence. The former include stimulus enhancement, observational conditioning, imitation, and goal emulation, whereas the latter includes contagion, exposure, social support, and matched dependent learning (Whiten, 2000).

Functional splits and coordination of activity: social motivation and social generalization of provision. Increased coordination between individual and collective behavior also meant that new forms of relating within the group could emerge. For example, the leader no longer needed to be the strongest individual; rather, the individual who could rally the most support from other members of the group could be the leader, a situation that can be observed already among chimpanzees (de Waal, 2000). Similarly, increased dependency on the group to guarantee individual survival also meant that "aggression" had to be managed in new ways. Again, chimpanzees individually and collectively exhibit rudiments of learned and culturally transmitted "conflict resolution" behavior through post contact touching and kissing. Even today, where humans have language to mediate conflict, touching, embracing, and kissing play an important role in intra-family conflict; in some Islamic societies they continue to play an important role in institutionalized conflict resolution (Antoun, 1997). Furthermore, increasing conflicts among siblings and increasing conflict resolution strategies can be understood only in relational models, that is, if individual and collective form an inextricable unit. These developments are at the origin of an increasing shift to a generalization of provision, where the contributions of the individual organism serve the (future) sustenance of *collective* life (food, protection of predators, enemies). Avoidance of threads to the individual life (e.g., hunger) has to be seen in terms of the avoidance of danger to the collective as the primary need satisfaction.

Analytic Step 3: Emergence of New Function

Goals-means reversal in the social production of tools by means of functionally distinct activities of generalized provision. Learned social coordination would have been a prerequisite for the first qualitative step in anthropogenesis, whereby members of a group are responsible for only a part of the overall structured activity, and thereby guarantee appropriate life conditions at the collective level. This, in fact, constitutes the use of a division of labor as a means to securing food, paralleling the use of tools as material means. But such division of labor also means that there is a social motive *inherent* in the activity, whereby individuals participate in the overall activity but take on tasks that are not immediately linked to killing and feeding. By participating in the collective provision for life, the individual provides for his or her own provision all the while opening up spaces for making decisions about how to participate in the collective endeavor. The anticipation of collective success thereby could motivate individual actions, despite their indirect relation to the overall goal. Associated with these changes was an increased use of inter-individual signals, tools that facilitated and mediated the coordination of social activities. Initially, however, these signals, like the tools used at this stage, were tied directly to the activity (praxis) and constituted a non-representational "telling," that is, fashioning of the auditory environment that assisted in the collective survival (e.g., warning calls).

The crucial first step in anthropogenesis was the functional change from individual production of tools and tool use to the generalized production and use of tools by the collective, leading to a new quality of the social coordination (Holzkamp, 1991). In other words, the production and the use of tools became separate activities, inverting, in a sense, the goals-means relation: tools were no longer just means to secure food, but they became a goal in their own right. And yet, a concurrent generalized division of labor allowed toolmakers to eat even though they may not have participated in hunting. It is a production of tools for the generalized goal of securing food. Here, the object orientation in tool production and the social orientation to food

[1] The potato washing technique reported among one group of monkeys, invented by one female and eventually becoming a standard practice exemplifies the capability of reproduction of acquired behaviors.

provision have been integrated at a qualitatively new level—the cognitive motive of tool making for generalized purposes and the social motive of collective provision are merely opposite sides of the same developmental process. This became the nucleus for the decisive step in anthropogenesis, which was achieved when the cultural-historical processes became of much greater importance in the adaptation to the environment than the previously dominating evolutionary processes. In fact, with the emergence of cultural-historical processes, humans actively changed the environment (e.g., farming, drilling wells and building aqueducts) rather than merely reacting to it.

Analytic Step 4: Turnover in Dominance

From the development of the psyche in direction of phylogenetic versus societal-historical overarching processes. Here we observe an overturn from phylogeny as the dominating process to the dominance of development of societal-historical development. Here, the intermediate level of societal organization takes over from the evolution as the overarching process in the system maintenance of the population. Of particular importance is the emerging, special relation of individual and their life conditions, on the one hand, and the societal-historical processes, which constitute control over the natural environment and generalized satisfaction of need, on the other hand.

The turnover that constitutes the second qualitative change circumscribes not only the level of individual capacities to learn and develop but also, precisely, the level of the entire process, which leads to the dominance of the societal-historical processes, which take over from the phylogenetic processes. These new processes become the special condition for the ontogenetic development of the human psyche, which is marked by cultural more so than by genetic characteristics.

Generalization of tools to means of production: Objectification-assimilation as planed anticipation in conscious societal control of reality and accumulation of experience. One of the important aspects in the development of the pre-humans was the generalization of tool production. As research among chimpanzees in the wild shows, they pick up a twig, for example, fashion it with their hands or teeth, and then use it to fish for ants and termites. In generalized production of tools, one material is used as a tool to fashion the required tool, such as when stones are used to knap other stones in specific ways to yield sharp edges as this the case for the Olduvai stone tool manufacture (Wynn 2002); the emergence of bi-faces and symmetrical tools is associated with increased cognitive capacities, which in turn provide the basis for additional practices for fashioning tools, for example, producing tools with three-dimensional congruent symmetry. This allows us to reverse the argument that biological evolution must have acted first in selecting brains capable of cultural processes after which culture took over; once cognition-changing cultural practices have emerged, new selective pressures exist "to which biological evolution could respond" (Hutchins, 2008, p. 2012)

An intermediate step in the development may well be one similar to the recent observation that about 4,300 years ago, chimpanzees transported rocks from outcrops and soils to focal points, where they used them, among others, to crack nuts (Mercader, Panger, & Boesch, 2002). The chimpanzees had fashioned the stones by flaking/knpping them; and they transmitted the required skills over more than 200 generations to the present day (Mercader et al., 2007). Knapping stones, though a rather complex cognitive skills, lies within the range of competencies characteristic of chimpanzees (Wynn, 2002).

Later might have come the production of spears from wood and stone (bone) splints or bow and arrow. In chimpanzee societies, age and sex-specific divisions are associated with particular social functions: groups of juveniles patrol the territory, adult males hunt, females and their offspring largely produce and use tools and are associated with other subsistence technologies (Sherwood, Subiaul and Zawidzki 2008). Sex and age segregation are characteristic of great apes absent in other species.

The generalized principle characterizing the evolution at this point is this: There is an increasing active appropriation of nature through manipulative objectification of generalized purposes in the making of life. For the chimpanzees to carry stones from an outcrop to another site to be fashioned there for subsequent use as tools, these stones have to be rudiments of object in the elementary forms of cognition. This process of objectification through appropriation and modification of the environment are the early forms of work as use-value generating change of life condition and therefore to the production of food. Tools are the early forms of means of production. And tool use provides a change of context for cognition so that it makes possible a qualitative shift from pre-symbolic to symbolic forms of reasoning of which even chimpanzees are capable (Hutchins, 2008). At the same time, because of the existing collective life, including the tradition of behaviors, conditions are such that there emerges a collective objectification of changes of nature and the control of natural forces for the purpose of a provident control over collective life conditions.

Formation of the specifically societal nature of the human species, which occur as selective advantages of populations with collective features over those with less collective features. The emergence of traditions is not yet sufficient evidence for the presence of forms of cognition that can be denoted as human. For this to happen, one has to show that the societal-historical forms of material control and social relations, which are handed from generation to generation, become the dominant form. There will be an interphase where both evolution and societal-historical processes operate simultaneously. It is not surprising, therefore that Australopithecus, Homo erectus, and the Neanderthal disappeared (see below).

Thus, "biological developmental conditions reign over the societal ones as long as hominids die out despite tool use" (Schurig, 1976, p. 254). This shows that there are two processes at work, both evolutionary and cultural-historical: societal forms of life emerged and continued to develop because they entailed evolutionary advantages. At this stage in anthropomorphosis, "the evolution of human society is a specifically successful selection factor and is subject to the laws of biological selection" (p. 324). This means, on the one hand, that the societal-historical processes are subject to the laws of evolution, but, on the other hand, societal-historical processes feed back onto genomic information. In this way, the genomic information supporting the abilities to form and function in collectivities, with its special forms of taking control over the environment, is selected over other genomic information. Human nature is its societal capacity. (This should put an end to the nature *versus* nurture debate.)

Preparation of change in dominance from phylogenetic to societal-historical development via "transitional laws" to the autonomous continuity of the societal process. The turnover in the dominance between evolutionary and societal-historical processes is prepared when the inner contradiction between providing for life and system-endangering environmental condition no longer are removed by optimization through evolution but by adaptations and optimization within the societal-historical processes, which are mediated by objectifying work practices that can be handed down (tradition). In this stage, change no longer occurs by the elimination of maladapted individual members of the population but by means of the adaptation of tools, traditions, and, more generally, collective life processes to the demands by the natural environment.

From an economy of occupations to an economy of production: On the dominance of society-internal laws of development. Change-over from hunting/gathering practices to farming, higher population densities, rapidly changing natural environments (loss of forest), and the emergence of written forms of communication co-emerge, mutually amplifying further development of practices and control. Increasing division of labor leads to increasing stratification of collective life, emergence of city-country distinctions, and the formation of activities.

Analytic Step 5: Restructuring process

Activity theory now is recognized in the form an emblematic triangle that provides a structural perspective of human forms of activity (Engeström, 1987). It has emerged from another triangle that characterizes the typical way in which animals relate to their environment. What Engeström did not provide was a description of the mechanism by means of which specifically human activities, i.e., their way of relating to the social and material environment, could have arisen from the typical animal form.

Cultural-historical activity theory is particularly amenable to an interdisciplinary approach because of its fundamental assumption in the real material conditions as important moments in activity and cognition. Thus, in their reconstruction of a probably evolutionary path that led to the condition for the specifically human psyche to emerge, scientific evidence of the natural evolution are the material grounds against which explanatory schemes have to be tested (see Step 1). Because it describes evolution in terms of the emergence of qualitatively new functions from quantitative changes within the organism and in its environment, it lends itself to the catastrophe theoretic analysis, which also is, according to its inventor and developer, a means of providing analogies and metaphors for the emergence of structures in culture.

Making Connections: Morphogenesis, Catastrophe Theory, and Diachronic Biology

In the explanations of background to and method of a cultural-historical activity theoretic position on the relationship of evolutionary and societal-historical processes, I emphasize the Marxist, dialectical materialist grounding that Vygotsky and his successors have chosen. In the West and especially in the US, this may, though quite unjustified, trigger (political) defense mechanisms. In this section, I show the connections that can easily be established with theoretical developments in mathematical catastrophe theory, morphogenesis, and theoretical biology. The generality of catastrophe theory in providing a descriptive account of the emergence of structures has had applications not only in the natural sciences for describing such

phenomena as phase transitions but has been extended to the social sciences generally and to the emergence of symbolic orders such as behaviors, metaphors, archetypes, myths, and classification systems and classification (e.g., Roth, 2004).

Catastrophe theory (e.g., Thom, 1989) is a mathematical approach to study dynamical systems that exhibit quantitative and qualitative change. Here, the term catastrophe does not mean something catastrophic happens but rather that there is a qualitative change in the dynamical system described. The theory is based on two fundamental mathematical concepts: (a) the concept of a function and (b) the concept of dynamical system. Dynamical systems, normally described in terms of continuous functions will undergo qualitative changes when an associated function goes through a singularity. The most widely used catastrophe is the one that represents trajectories as occurring on the surface of a cusp (Figure 2). This surface is the result of a potential that takes the form $V(x,u,v) = x^4/4 + ux^2/2 + vx$, which has as its derivative the function $V_x(x,u,v) = x^3 + ux + v$.

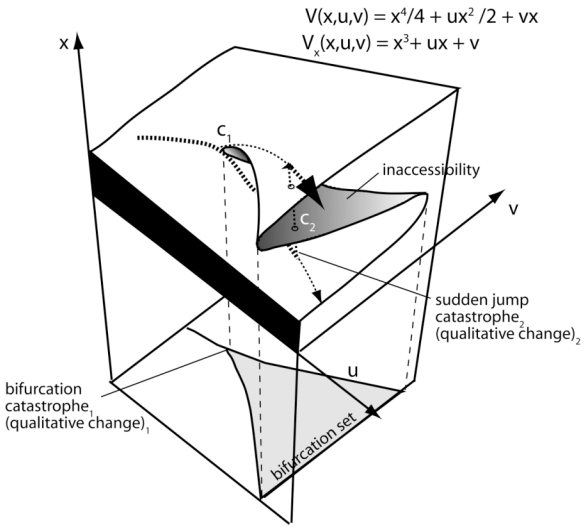

Figure 2. The cusp catastrophe allows for two qualitative changes (catastrophes), one when the single surface changes into two surfaces with an increase in u at c_1 and the other when the system suddenly shifts from the lower to the upper plane at c_2.

There are two singularities. The first one is at $u = 0$, where the system with one stable equilibrium (to the left of c_1) changes into the region with two stable equilibriums in the fold region described by the projection of the "bifurcation set." In this bifurcation set, the system may undergo a qualitative change from being on the lower plane to switching to the higher plane or vice versa, a transition typical for a phase change in physical chemistry, a sudden behavior change (peace, war), or a switch of favoring one decision over another. This change is the consequence of a slightest disturbance in the environment (the proverbial butterfly in China that changes the weather in North America). Outside of the bifurcation set defined by a particular set of u,v combinations, the system cannot undergo a qualitative change but remains in one or the other state.

It should be immediately evident that the five-step method Holzkamp articulates for the elaboration of a dialectical materialist account is structurally commensurable with a catastrophe theoretic account. First, the system moves along a trajectory where the variables on the control plane change in a quantitative manner ($u < 0$, left of branching point). Here, the preparation of the conditions upon which the qualitative change and the quantitative change has its equivalent in $u \square 0$. In the second step of Holzkamp, the conditions emerge for a qualitatively new function, which has its equivalent in the singularity where $u = 0$ and the potential therefore is $V = x^4/4 + v$. It is here that a qualitative change occurs, when the space of possible states now includes two states rather than previously one. The "negation" in the Holzkamp method has its equivalent in the negation of u from negative values to positive values. With increasing u, the system still changes in a quantitative manner. But at some point c_2, a (small) disturbance or change in the environmental condition can lead the system to jump to the upper plane, which corresponds to the second qualitative change in the Holzkamp model. As long as the combination of values for u, v is such that they lie within the bifurcation set, both states are possible. The system can now develop to go through a similar process but based on the new system-sustaining function. In essence, therefore, the catastrophe theoretic function, which describes the generation of qualitative different states and the sudden shifts from one to another state in the presence of two possible states is a suitable metaphor for describing the morphogenesis of new functions in the Holzkamp method and model. In fact, René Thom himself, biologists, and (cognitive) developmental psychologists have used catastrophe theory to provide a model for the emergence of qualitatively new properties and (cognitive) functions.

Every branch of cellular specialization is defined by a stable process and leads to a stabilized and regular spatiotemporal behavior. This leading and stable character in the evolution of tissue corresponds to Waddington's idea of a chreode. Waddington hypothesized—now confirmed experimentally (Gilbert 2000)—that some

environmental factors might be strong enough to push a cell, during its evolution, from one chreode into another. The differentiation of an undifferentiated tissue into different cellular specialization can be described, when it is regular and stable, by a morphological field. Thom (1981) describes this field as an "archetype." Catastrophe theory allows interpreting the field as a leading field (the "epigenetic landscape" in Waddington's terms), leading to homoeostatic states, where the field regulates the conflict between stable (homeorhetic) metabolic processes, that is, between the chreodes. Homeorhesis is the process equivalent of homeostatics.

Waddington felt that a shortcoming of traditional biology was that it could not describe the processes of how the genotype became a phenotype, which is the same question Leont'ev/Holzkamp addressed in their stage 3 to stage 4 transition, where a merely present function among function becomes the for the organism dominant function. Canalization is the property of developmental pathways to produce standard phenotypes despite mild environmental perturbations. Waddington used the concept of *competence,* which he defined as the ability to respond to an inducing signal. It was achieved actively and could be selected for. This is what parallels development at Level 1 in the Leont'ev/ Holzkamp model. *Genetic assimilation* is the process by which a phenotypic response to the environment becomes, through the process of selection, taken over by the genotype so that it becomes independent of the original environmental inducer. There are two aspects of genetic assimilation: the environment induces phenotypic variation and embryological inducers can come to mediate the environmental stimuli. A parallel to Waddington can be found in Holzkamp's description of the development of simple organisms: "In the subsequent phylogenetic development within this functional plane those parts of the activity evolve from the orienting activities (which initially consist only in the form of change of position of the organism as a whole) *that are shifted towards the inside and to part systems of the organism*" (p. 87, original emphasis).

Catastrophe theory has been proposed as a description for the stagewise cognitive development (van der Maas & Molenaar, 1992). There are seven flags that can be used to match mathematical aspects in catastrophe theory and expressions of cognitive development. First, modality and inaccessibility of states (Figure 2) corresponds to bimodal score distributions on developmental tests (population expression). Further evidence for the presence of two states in the same individual comes from psycholinguistics, where children have been observed to express concepts simultaneously at different developmental levels when they gesture and when they speak (Church & Goldin-Meadow, 1986). Second, sudden jumps correspond to spurts in the development. In the psycholinguistic literature, children have been shown to be ready for instruction when their gestural and verbal expressions differ, that is, when these indicate two developmental stages (Perry, Church, & Goldin-Meadow, 1988). Teaching then would correspond to the external influence that shifts the previously dominant mode (as expressed verbally) to the new mode, generally expressed by gestural means. Development subsequently proceeds in the new mode. Third, hysteresis, which are cyclical dynamics involving jumps back and forth from the upper to the lower plane (Figure 2) correspond to regressions in cognitive development. Fourth, the concept of divergence corresponds to the possibility of the developmental trajectory to follow one of two planes that emerge at the singularity; such changes are observed in psycholinguistics, for example, when strategy changes on developmental tasks are gradual. Thus, rather than moving along further on the lower developmental level (stage 3 of Holzkamp's model), development immediately shifts to and continues on the upper level (see Figure 2). Fifth, divergence of linear response corresponds to the validity of training studies and, sixth, critical slowing down to psychometric tests of conservation. These two constitute observable instabilities due to perturbations of the system. Finally, anomalous variance corresponds to second order transitions and oscillations in the responses of individuals in the transition between cognitive developmental stages.

Catastrophe theory also has been used to describe developments at the phylogenetic level to articulate how, during a first developmental shift, a generalized *Homo sapiens* gave rise to *Homo sapiens sapiens* and *Homo sapiens neanderthalensis* and other contemporary, allopatric hominds (Weaver, 1980). It is suggested that "the mutation of a developmental regulator gene to accelerate and amplify robusticity in [Neanderthal] infants" (p. 408) may have constituted the point of the first qualitative change (catastrophe). This regulator mechanism, which does not require any changes in the adult reproductive system, "supports the widely accepted position of *Homo sapiens neanderthalensis* as a viable subspecies (or member of the modern species)" (p. 408). The two co-existed for a while, with little interbreeding until, eventually the latter died out and the former became the dominant lineage upon which evolution selected. Cultural behavior, though not the initiator of differentiation, forces the second qualitative change (catastrophe). Thus, the exploitation of large herd fauna and larger social

groupings may have reduced the stress on infants through stable and regular access to high-energy foods, childcare, and possibly tailored clothing. As a consequence, smaller, more graceful anatomies and metabolically less expensive morphologies might become advantageous. Significant climatic changes forced high-latitude hominins, such as *Homo neanderthalensis*, "to respond . . . behaviourally, culturally and even physiologically and morphologically in order to survive" (Elton, 2008, p. 384).

Coda

Cultural-historical activity theory has experienced rapid expansion over the past 20 years in the social sciences as shown by the exponential growing references to some of its key works (Roth & Lee, 2007). Though little attended to, it has been built as a social psychological theory in which the basic categories of consciousness, activity, and personality are consistent with the biological evolution of the species. As shown here, cultural-historical activity theory provides a description in which each psychological characteristic has its precedence in evolution. It is therefore a social theory entirely commensurable with those sciences that attempt to construct an understanding of the biological and cultural-historical antecedents of individuals and collectives *in a non-reductionist* manner. That is, cultural-historical activity theory focuses on the emergence and development of systems, of which the organism is a constitutive part, rather than the relationships of individual external variables, which, as the theory presupposes, *cannot have inner connections*. The mechanism for evolution and development include quantitative and qualitative changes, which can be, as shown, suitably modeled using catastrophe theory, which already has found applications in the explication of developmental changes both at the phylogenetic, transitional (i.e., anthropogenetic), cultural-historical, and ontogenetic levels.

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