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DEVELOPMENT, MOVEMENT AND AGENCY: BREAKING AWAY INTO MYCORRHIZAE ACTIVITIES

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INTRODUCTION

Development is a classic focus of Vygotskian cultural-historical research. On the other hand, development is curiously absent in many recent ethnographic and interactionist approaches to the study of human practices. Partly this split may be due to the normative and vertical bias commonly associated with the notion of development. But if we keep development out of our studies of work and other collaborative practices, we will have little to offer in dialogues with practitioners and users who are trying to make their lives better.

Development needs to be re-introduced as a central category in studies of human practice. To overcome its paternalistic and determinist biases, development needs to be radically re-conceptualized as *breaking away.* I will argue that the notions of agency and movement, based on Vygotsky's idea of *double stimulation,* can significantly help us to achieve such a re-conceptualization. I will also argue that as work practices are moving toward increasingly networked, hybrid and weakly bounded forms of organization, toward what I call *mycorrhizae* activities oriented at *runaway objects,* opportunities emerge for the formation of radically new forms of agency and movement.

Basically this paper is a first attempt at weaving together two distinct conceptual endeavours, namely reconceptualization of human development on the one hand and transformation of work practices on the other hand. The challenge is schematically depicted in Figure 1.

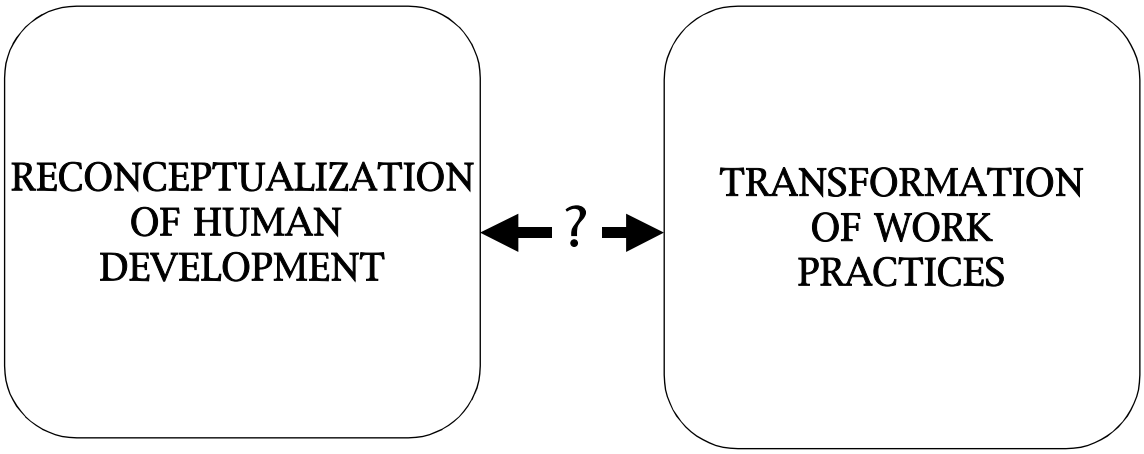

Figure 1. The challenge of the paper

I will begin by discussing the transition from notions of causality to notions of agency in the explanatory frameworks of human and social sciences. I will then examine change going on in the world of work. This leads me to propose a framework for analyzing historically distinctive forms of agency and patterns of movement in work activities. To connect this framework to the concept of development, I will present Vygotsky's idea of double stimulation and illustrate its practical meaning with the example of student cheating. As a first step toward reconceptualizing development, I will put forward Cussins' theory fo cognitive trails. The second step is a tentative formulation of the idea of breaking away. Finally, I will concretize the notion of development as breaking away with the help of an example from field of health care.

FROM CAUSALITY TO AGENCY

Eskola (1999, p. 107; see also Ghoshal, 2005) points out that the traditional notion of causality still dominates empirical studies in psychology and social sciences.

"The first idea is that the phenomenon that is being explained is determined by certain factors, not directly but through the mediation of certain mechanisms. This means we must first decide which are the dependent variables that represent the

phenomenon we want to explain and which are the independent variables from which we will try to find our explanation. We then go on to examine whether there are any correlations between those two categories of variables. If such correlations exist, then it is assumed that they reflect some sort of universal laws, psychological, social, or biological. The laws exert their influence through mediating mechanisms, which are represented by intervening variables."

Maxwell (2004) calls the traditional notion of causality the 'regularity' approach. It holds that we cannot directly observe causation, only the regularities in the relationships between events. The regularity approach necessarily entails a variable-oriented view of research. Causation is understood as a systematic relationship between variables rather than a causal process. In contrast to variable-based research, process-oriented research believes that causation can actually be observed and reconstructed as a real sequence of events. It uses historical methods and narrative evidence, as well as close observation and recording of unfolding chains of events.

But how does one observe and reconstruct chains of events among human beings? What kind of interpretive lenses do we need for that? Eskola (1999, p. 111) suggests that the answer lies in three facets: (1) the structure and development of the activity in which the actors are involved and its meaning to the different actors, (2) the laws and rules that actors take into account in this activity, and (3) the logics on the basis of which they do so. Eskola presents the basic explanatory schemes of traditional variable oriented research on the one hand and of 'realistic research in human action' on the other hand as depicted in Figure 2.

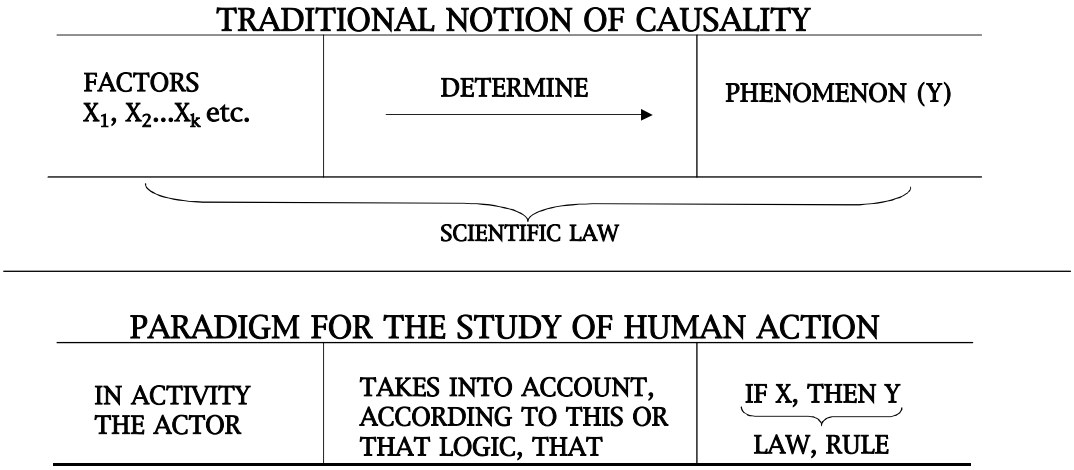

Figure 2. Traditional notion of causality and an alternative realist paradigm for the study of human action (Eskola, 1999, p. 108 and 111)

Eskola's realistic paradigm focuses on the fact that humans do not merely react as physical objects; they act based upon their activities, interpretations and logics. For the sake of simplicity, we may call the lower part of Figure 2 the *interpretive layer* of causality.

But there is more to causality in human contexts. Human beings not only interpret, they also face contradictions between multiple motives embedded in and engendered by their historically evolving communities and objects. This is the layer that makes humans look irrational and unpredictable (see Engeström, 1989). This adds another layer to human causality. I call it the *contradictory layer* (Figure 3).

INTERPRETIVE LAYER	IN ACTIVITY THE ACTOR	TAKES INTO ACCOUNT, ACCORDING TO THIS OR THAT LOGIC, THAT	IF X, THEN Y LAW, RULE
CONTRADICTORY LAYER	AS PARTICIPANT IN COLLECTIVE ACTIVITIES	IS DRIVEN BY CONTRADICTORY MOTIVES	SEARCHING RESOLUTION BY OFTEN UNPREDICTABLE ACTIONS

Figure 3. Two layers of causality in human action

What is still missing in Figure 3 is the human potential for agency, for intentional collective and individual actions aimed at transforming the activity. Thus, I complete the picture by adding an *agentive layer* (Figure 4).

INTERPRETIVE LAYER	IN ACTIVITY THE ACTOR	TAKES INTO ACCOUNT, ACCORDING TO THIS OR THAT LOGIC, THAT	IF X, THEN Y ⏟ LAW, RULE
CONTRADICTORY LAYER	AS PARTICIPANT IN COLLECTIVE ACTIVITIES	IS DRIVEN BY CONTRADICTORY MOTIVES	SEARCHING RESOLUTION BY OFTEN UNPREDICTABLE ACTIONS
AGENTIVE LAYER	AS POTENTIAL INDIVIDUAL AND COLLECTIVE AGENT	TAKES INTENTIONAL TRANSFORMATIVE ACTIONS	INVENTING AND USING ARTIFACTS TO CONTROL THE ACTION FROM THE OUTSIDE

Figure 4. Three layers of causality in human action

Davydov and his colleagues (2003, p. 63) defined agency as "the ability to construct and transform independently one's own life activity." Vygotsky's saw agency as originating in the use of external artifacts to reach a redefinition of a situation. This view corresponds to the third, agentive layer of Figure 4 (I will return to Vygotsky's ideas shortly). Here I only want to point out that Vygotsky's description of an experiment reported by Kurt Lewin beautifully captures all the three layers of Figure 4 in a simplified form.

"In experiments involving meaningless situations, Lewin found that the subject searches for some point of support that is external to him and that he defines his own behavior through this external support. In one set of experiments, for example, the experimenter left the subject and did not return, but observed him from a separate room. Generally, the subject waited for 10-20 minutes. Then, not understanding what he should do, he remained in a state of oscillation, confusion and indecisiveness for some time. Nearly all the adults searched for some external point of support. For example, one subject defined his actions in terms of the striking of the clock. Looking at the clock, he thought: 'When the hand moves to the vertical position, I will leave.' The subject transformed the situation in this way, establishing that he would wait until 2:30 and then leave. When the time came, the action occurred automatically. By changing the psychological field, the subject created a new situation for himself in this field. He transformed the meaningless situation into one that had a clear meaning." (Vygotsky, 1987a, p. 356)

In other words, the subject initially interprets the situation as an experiment in which one must follow the rules of the experimenter (interpretive layer in Figure 4). When nothing happens, a contradiction emerges between those expected rules and one's quest for meaning; there is a period of confusion, which could lead to unpredictable and 'irrational' actions (contradictory layer in Figure 4). However, by using an external cultural artifact such as the clock, the subject is able to transform the situation and take agentive action (agentive layer in

Figure 4). Notice that agentive action in its rudimentary forms may look like non-action, or mere resistance – such as leaving the room in the experiment. It is nonetheless a radically different action from that of, say, passive waiting or 'irrational' making of noise.

Now it is time to connect the general idea of agency to the concrete history of work and organizations.

THE CHANGING LANDSCAPE OF WORK

Many recent attempts to analyze historical change in work organizations (e.g., Powell, 1990) have condensed the current landscape into three major forms: hierarchy, market, and network. In this view, organizations in capitalist society have been built either along the principles of centralized hierarchy (for example large vertically integrated corporations and big bureaucracies) or along the principles of the market (typically more agile companies seeking to exploit new opportunities). Hierarchies are strong in securing standardization needed in traditional mass production, but they are limited by their rigidity. Market organizations are strong in their flexibility, but they are limited by their excessive internal and external competitiveness which tends to exclude collaboration and reciprocity.

In a simplified form, we might characterize the nature of agency in hierarchies with the imperative 'Control and command' for the management, and with the imperative 'Resist and defend' for the workers. In an ideal market organization, this dualism melts into one overriding imperative: 'Take advantage and maximize gain'.

Powell and many others point out that these two classic forms of organizing work in capitalism are increasingly being challenged or even replaced by various forms of networks in which different organizations or organizational units seek new innovations by means of collaboration across traditional boundaries. In network organizations, the imperative would be: 'Connect and reciprocate'.

The rate of alliance and partnership formation in work organizations has exploded in recent years. Firms no longer compete as individual companies, they compete as rapidly changing constellations of companies that cooperate to succeed. Across virtually all sectors of the economy, alliances have reshaped the interactions of companies. While partnerships and alliances are clearly spearheads toward the future,

they are also full of tensions and thus extremely difficult to sustain and manage (Spekman, Isabella & MacAvoy, 2000).

Partnership and alliance formation typically takes place in multi-organizational fields (Scott & al., 2000). In activity-theoretical terms, these may be called distributed multi-activity fields or terrains, bound together by partially shared, often elusive or emergent large-scale objects. The mastery and/or cultivation of such 'runaway objects' urgently requires new forms of distributed and coordinated agency.

My research groups have been particularly interested in what we call *negotiated knotworking* as an emerging way of organizing work (Engeström, Engeström & Vähäaho, 1999, Engeström, in press). In knotworking, collaboration between the partners is of vital importance, yet takes shape without strong prederminded rules or central authority.

The concept of network is somewhat problematic as a framework for understanding knotworking. A network is commonly understood as a relatively stable web of links or connections between organizational units, often materially anchored in shared information systems. Knotworking, on the other hand, is a much more elusive and improvised phenomenon. The notion of network organization also tends to be depicted as a positive, reciprocal and innovative alternative to hierarchy. However, detailed critical studies of networked organizational arrangements reveal that the dominants features are often outsourcing and fragmentation of work (Marchington, Grimshaw, Rubery & Willmott, 2005).

Knotworking is similar to the 'latent organizations' described by Starkey, Barnatt and Tempest (2000, p. 300) in that it "persists through time as a form of organization that is periodically made manifest in particular projects," remaining dormant until market or user demand presents an opportinity or necessity for the organization to reanimate itself as an active production system. However, Starkey, Barnatt and Tempest (2000, p. 300) argue that latent organizations "come to exist when a central broker reconstitutes the same creatively unique set of agent partners on a recurring project basis." This is clearly not the case in the knotworking settings we have analyzed. In these settings, the center just does not hold.

The Open Source movement in software production (e.g., DiBona, Ockman & Stone, 1999) has been used as an example of new forms of community-based work and knowledge creation that go beyond the

limits of bounded firm-based models (Lee & Cole, 2003; see also Weber, 2004). According to Lee and Cole (2003), the key to the 'knowledge expansion' witnessed in the Linux kernel development is, besides its openness and non-proprietary nature, the norm of critique.

"In the Linux development community we observe a peer review process as a structured approach to generating criticism of existing versions, evaluating these criticisms, and eliminating 'error,' while retaining those solutions that cann ot be falsified." (Lee & Cole, 2003, p. 639)

Lee and Cole (2003, p. 641) report that between 1995 and 2000, they found 2605 people in the Linux community "development team" which adds features and fixes bugs. Over the same period, they found 1562 people on the "bug reporting team" which reports, documents or characterizes bugs. In addition, the authors found that 49% of the "bug reporting team" also performed tasks of the "development team," while 29% of the "development team" performed tasks of the "bug reporting team". The sheer size, openness and fluctuation across boundaries of this community makes the use of the term 'team' somewhat ludicrous.

Authors like Howard Rheingold (2002) have began to prophesize 'smart mobs' as radically new forms of organization made possible by mobile technologies. Initial conditions of such 'swarm' or 'amoeba' organizations were nicely captured by Rafael in an essay where he discusses the overthrowing of President Estrada in the Philippines in 2001.

"Bypassing the complex of broadcasting media, cell phone users themselves became broadcasters, receiving and transmitting both news and gossip and often confounding the two. Indeed, one could imagine each user becoming a broadcasting station unto him- or herself, a node in a wider network of communication that the state could not possibly even begin to monitor, much less control. Hence, once the call was made for people to mass at Edsa, cell phone users readily forwarded messages they received, even as they followed what was asked of them.
Cell phones then were invested not only with the power to surpass crowded conditions and congested surroundings brought about by the state's inability to order everyday life. They were also seen to bring a new kind of crowd about, one that was thoroughly conscious of itself as a movement headed towards a common goal." (Rafael, 2003)

Clearly such a 'smart mob' has no single, permanent center. Mobile technologies make it possible that each participant is potentially a momentary center. Rafael's example underlines the importance of a shared goal. But the emphasis on goal also implies the problem. Since goals are relatively short-lived, also 'smart mobs' seem to be very temporary organizational forms.

However, there are amoeba-like collective activities which are not limited to the pursuit of short-term goals. Two quite resilient examples are the activities of birding (e.g., Obmascik, 2004) and skateboarding (e.g., Borden, 2001). These might be also called 'wildfire activities' as they have the peculiar capacity to disappear or die in a given location and suddenly reappear and develop vigorously in a quite different location, or in the same location after a lengthy dormant period. While participants in these activities commonly use mobile technologies to communicate with one another and to broadcast information about their objects (rare birds, good skating spots), these activities are much older than mobile phones and the Internet. Birding has a history of several hundred years, and skateboarding dates back at least to the early 1970s. Two additional features need to mentioned. Both birding and skateboarding are peculiar combinations of leisure, work, sport, and art. And they both have consistently defied attempts at full commercialization, offering ample opportunities for enterpreneurship but not becoming themselves dominated by commercial motives.

Why would strongly use-value oriented, mobile and dispersed activity patterns such as skateboarding and birding be relevant for the world of work? A partial answer may be found in the current contradictions of capitalism. As Froud, Johal and Williams (2002) show, financialization, the dominance of stock markets and 'shareholder value,' makes work increasingly oriented at very abstract and disappointing objects – 'coupons' that promise wealth divorced from actual production of goods and services. In such a landscape, "the only safe forecast is that the gap between expectation and outcome will drive corporate management towards ever more restructuring in financialized economies" (Froud, Johal & Williams, 2002, p. 140).

> "There will be more mergers and acquisitions, divestments, rightsizing, outsourcing, buy outs and buy ins... The inability (often impossibility) of meeting market expectation will also lead to financial engineering involving share buy backs, tax dodges, sale and leaseback, pension fund contribution holidays and such like which start from the cynical premise that the market is easily impressed by earnings." (Froud, Johal & Williams, 2002, p. 140)

All this means that large portions of population find it increasingly difficult to find meaning and motivation in the financialized spheres of work. There is breeding ground for alternatives.

AGENCY AND MOVEMENT IN THE NEW LANDSCAPE

What might be the nature of distributed agency in knotworking and amoeba-like organizations? What are the basic patterns of movement in such a landscape?[1]

I have previously put forward and used the concepts of coordination, cooperation and communication as a scheme that describes the interactional dimension of transitions in work (Engeström, Brown, Christopher & Gregory, 1991, Engeström, 1992). When each individual practitioner is focused on his or her own object or fragment of the object, they are commonly held together by externally imposed or tradition-based coordination. In industrial organizations, teams emerged as units for cooperative solving of problems. However, teams run into troubles and find their limits when faced with objects which require questioning the division of labor, rules, and boundaries of the team and the wider organization – in short, reflective communication.

So it seems that reflective communication is one aspect of the distributed agency required in knotworking. But it is only the interactional aspect. I will now sketch a more complete framework for analysis and development of agency in and for a landscape of knotworking. The framework is condensed in Table 1.

In the first column of Table 1, mainly the notion of 'runaway object' requires further elaboration at this point. The notion is related to the concept of 'runaway world', coinded by Giddens (1991, 2000). Claudio Ciborra (2002, p. 98) characterizes the phenomenon as follows.

"We experience control in the age of globalization as more limited than ever. We are creating new global phenomena (global warming and greenhouse effects, nuclear threats, global production processes, and so on) that we are able to master only in part. Although information infrastructures appear to be important instruments for governing global phenomena, they possess ambiguities which make their eventual outcome difficult to determine. Consequently, they may serve to curb our control capabilities just as much as they enhance them."

Runaway objects typically have the potential to escalate and expand up to a global scale of influence. They are objects that are poorly under anybody's control and have far-reaching unexpected side effects. Actor-network theorists (Law, 1991) point out that such objects are often

[1] The importance of movement for an activity-theoretical analysis of development was stressed by Davydov and Zinchenko (1981) who put forward the concept of 'living movement' as foundational starting point for a developmentally oriented psychology. Space does not allow a thorough discussion of this concept in this paper.

monsters: they seem to have a life of their own that threatens our security and safety in many ways. They are contested objects that generate opposition and controversy. They can also be powerfully emancipatory objects that open up radically new possibilities of development and wellbeing, as exemplified by the Linux operating system.

Contrary to mega-projects (Altshuler & Luberoff, 2003, Flyvbjerg, Bruzelius & Rothengatter, 2003), most runaway objects do not start out as big and risky things. More commonly, they begin as small problems or marginal innovations, which makes their runaway potential difficult to predict and utilize. They often remain dormant, invisible, or unseen for lengthy periods of time, until they break out in the form of acute crises or breakthroughs (e.g., Vickers, 2001).

Table 1. Framework for conceptualizing distributed agency and movement[2]

NATURE OF OBJECT	LOCUS OF AGENCY	MODE OF INTERACTION	ENERGIZING FORCE	MOVEMENT IN SPACE
Personal object	Individual actor	Coordination	Want	Peripheral participation, gradual movement toward competent center
Problematic object	Team	Cooperation	Will	Focal involvement, vertical improvement
Runaway object	Knots in mycorrhizae	Reflective communication	Improvisation and persistence	Expansive swarming engagement; multi-directional pulsation

[2] Table 1 and the three layers of learning activity proposed by Davydov, Slobodchikov & Tsukerman (2003, p. 72) have interesting commonalities, and also important differences.

In the second column of Table 1, the most demanding concept is 'mycorrhizae'. I use it much in the same general sense in which Deleuze and Guattari (1987) proposed the concept of 'rhizome'. They wanted to highlight the importance of horizontal and multidirectional connections in human lives, in contrast to the dominant vertical, tree-like images of hiearchy. Originally a biological concept, rhizome refers to a horizontal underground stem, such as found in many ferns, where only the leaves may stick up into the air. As such, I find the implications of 'rhizome' too limited.

I am more interested in the invisible organic texture underneath visible fungi. Such a formation is called 'mycorrhizae' (see Allen, 1991, Sharma & Johri, 2002). It is a symbiotic association between a fungus and the roots or rhizoids of a plant. Fungi are not able to ingest their food like animals do, nor can they manufacture their own food the way plants do. Instead, fungi feed by absorption of nutrients from the environment around them. They accomplish this by growing through and within the substrate on which they are feeding. This filamentous growth means that the fungus is in intimate contact with its surroundings; it has a very large surface area compared to its volume. Most plants rely on a symbiotic fungus to aid them in acquiring water and nutrients from the soil. The specialized roots which the plants grow and the fungus which inhabits them are together known as mycorrhizae, or 'fungal roots'. The fungus, with its large surface area, is able to soak up water and nutrients over a large area and provide them to the plant. In return, the plant provides energy-rich sugars manufactured through photosynthesis.

The visible mushrooms are reproductive structures. Even these structures are sometimes quite large, but the invisible body of the fungus, mycorrhizae, can be truly amazing. When molecular techniques were used, one Michigan fungus (*Armillaria bulbosa*) which grew in tree roots and soil and had a body constructed of tubular filaments was found to extend over an area of 37 acres and to have the weight of 110 tons, equivalent to a blue whale. An even larger fungal clone of *Armillaria ostoyae,* reported earlier in the state of Washington, covered over 1500 acres. Each clone began from the germination of a single spore over a thousand years ago. Although they probably have fragmented and are no longer continuous bodies, such organisms give us cause to think about what constitutes an individual.

Mycorrhizae are difficult if not impossible to bound and close, yet not indefinite or elusive. They are very hard to kill, but also vulnerable.

They may lie dormant for lengthy periods of drought or cold, then generate again vibrant visible mushrooms when the conditions are right. They are made up of heterogeous participants working symbiotically, thriving on mutually beneficial or also exploitative partnerships with plants and other organisms.

As I see it, knotworking eventually requires a mycorrhizae -like formation as its medium or base. Such a formation typically does not have strictly defined criteria of membership. But its members can be identified by their activism. The 2605 'development team' members and 1562 'bug reporting team' members of the Linux mycorrhizae mentioned by Lee and Cole (2003) were identified on the basis of their publicly available contributions to the development and perfection of the object, the Linux operating system. It is very likely that mycorrhizae include quite a variety of members, ranging from grassroots activists or clients or victims to certified professionals, researchers, enterpreneurs, and spokespersons.

A mycorrhizae formation is simultaneously a living, expanding process (or bundle of developing connections) *and* a relatively durable, stabilized structure; both a mental landscape or 'mindscape' (Zerubavel, 1997) and a material infrastructure. In this, it resembles the 'cognitive trails' of Cussins (1992) and the 'flow architecture' described by Knorr-Cetina (2003, p. 8) as "a reflexive form of coordination that is flat (non-hiearchical) in character while at the same time being based on a comprehensive summary view of things – the reflected and projected global context and transaction system."

I have thus far mentioned Open Source software communities, skateboarding and birding as examples of mycorrhizae-like activities. In the final section of this paper, I will also elaborate on Peer-to-Peer (P2P)networks and new patterns of health care as possible examples. An important common denominator of all these activities is their strong object and use-value orientation, coupled with resistance to thorough commercialization. This is sometimes characterized as 'the gift economy' of Open Source communities (Bergquist, 2003).

The model of an activity system (Engeström, 1987, p. 78) is a functioning tool for the analysis of individuals and teams. But does it have any use when we step into the fluid world of mycorrhizae? The answer is that horizontal and invisible mycorrhizae do not eliminate visible, erect, bounded and institutionalized activity systems. As I pointed out above, mycorrhizae depend on plants and generate

mushrooms, both visible, vertical, and more or less durable. Knorr-Cetina (2003, p. 18) points out that the mycorrhizae-like formation of global financial markets is crucially dependent on institutionalized, stable 'bridgehead centers'. Without these relatively stable and well-bounded 'plants' and 'mushrooms', the knotworking mycorrhizae will not take shape. Careful analyses of the structures and dynamics of the activity systems involved are more important than ever before.

[HERE ADD A FOOTNOTE on the vertical: Eric Raymond'snotion of moving from cathedral to bazaar with Open Source is misguided in three respects: (1) vertical structures are important in Open Source, too (e.g., the role of Linus Torvalds; see Weber), (2) cathedral may be an impressively robust vertical structure, but the making of cathedrals originally looked more like mycorrhizae (Turnbull), (3) bazaar may be a flat horizontal network, but it is based on exchange and profit while Open Source is based on production and use value.]

The 'energizing force' characterized in the fourth column of Table 1 refers to the quality of the effort and intentionality of the subject. By 'want' I refer to the experience of lack or desire, similar to the 'want structures' discussed by Knorr-Cetina (1997; see also Davydov's [1999] discussion of 'desire'). By 'will' I refer to voluntary actions, planned in advance and realized by means of cultural signs and tools (Vygotsky, 1997) – I will discuss them in the next section.

The notions of improvisation and persistence imply the dual dynamics of swift situational concerted action and pursuit of a repeatedly reconfigured long-term perspective in knotworking. Improvisation has attaracted the attention of organizational researches seeking models for swift trust and weakly scripted but well-focused collaborative problem solving in Jazz and other forms of improvised collective performance (REFERENCES). Persistence refers to patient dwelling in the object over long periods of time, alternating between intense action and more detached observation or even partial withdrawal. In includes pausing, backing up, regrouping and finding detours or new openings in the face of obstacles. Interestingly, Whorf's (1956) classic description of 'preparation' in Hopi culture displays some crucial features of persistence.

"A characteristic of Hopi behavior is the emphasis on preparation. This includes announcing and getting ready for events well beforehand, elaborate precautions to insure persistence of desired conditions, and stress on good will as the preparer of right results." (Whorf, 1956, p. 148)

"To the Hopi, for whom time is not motion but a 'getting later' of everything that has ever been done, unvarying repetition is not wasted but accumulated. It is storing up an invisible change that holds over into later events." (Whorf, 1956, p. 151)

The 'movement in space' (the fifth column of Table 1) refers to dominant patterns and directions of physical, discursive and cognitive motion in historically different organizational frameworks of work. 'Peripheral participation' refers to novices moving gradually toward a perceived comptent center of an activity or community of practice (Lave & Wenger, 1991). 'Focal involvement and vertical improvement' refer to intense closure around a shared problematic object, often organizationally channeled into a movement of ascending along a predetermined vertical pipeline of specialized expertise. 'Expansive swarming engagement' and 'multi-directional pulsation' refer to star-like patterns of movement where the participants disperse outward to pursue their various trails and to expand the scope of the mycorrhizae, but also return and come together in various ways to contribute to the forging of the runaway object. The notion of swarming is borrowed from the study of distributed collaboration patterns among social insects, such as ants and bees (Bonabeau, Dorigo & Theraulaz, 1999). Models from the insect worlds are simulated to build systems of artificial intelligence. Interestingly enough, mycorrhizae behave in ways somewhat similar to the social insects: when one of the filaments contacts a food supply, the entire fungal colony mobilizes and reallocates resources to exploit the new food. Unfortunately students of swarm intelligence have thus far done little to observe and analyze humans in their everyday work settings and activities.

The concepts of this framework are far from finished and stabilized. They are first approximations, meant to open up a field for further debate, theoretical work and experimentation in activity fields with complex runaway objects, seeking to build collaboration in knot-like ways, beyond the models of stable and well bounded institutions and teams.

Moving horizontally across the last layer in Table 1, the agency called for in knotworking may be summarized as *persistent communicative engagement with runaway objects in knots and mycorrhizae.* This is a pretty challenging, if not a monstrous string of words. Perhaps that is unavoidable.

Now it is time to swing back to Vygotsky's theoretical and methodological framework.

VYGOTSKY'S IDEA OF DOUBLE STIMULATION

In his quest for a new psychology based on cultural mediation of higher mental functions, Vygotsky was very conscious of the need to build a methodology that would correspond to the character of the theory.

"This methodology [study of reactive responses based on the S-R formula], which easily establishes the response movements of the subject, becomes completely impotent, however, when the basic problem is the study of those means and devices that the subject used to organize his behavior in concrete forms most adequate for each given task. In directing our attention to the study of specifically these (external and internal) means of behavior, we must conduct a radical review of the methodology of the psychological experiment itself." (Vygotsky, 1999, p. 59)

The methodology Vygotsky, Leont'ev and Luria developed has been characterized by different names. Vygotsky (e.g., 1997b, p. 68, 1997c, p. 85-89, 1999, p. 57-59) used at least the names 'experimental-genetic method', 'instrumental method', 'historical-genetic method', and 'method of double stimulation', somewhat interchangeably. In this paper, I will use the 'method of double stimulation'.

As van der Veer and Valsiner (1991, p. 169) put it, in double stimulation experiments, "the subject is put in a structured situation where a problem exists (...) and the subject is provided with active guidance towards the construction of a new means to the end of a solution to the problem." Vygotsky himself described the methodology as follows.

"The task facing the child in the experimental context is, as a rule, beyond his present capabilities and cannot be solved by existing skills. In such cases a neutral object is placed near the child, and frequently we are able to observe how the neutral stimulus is drawn into the situation and takes on the function of a sign. Thus, *the child actively incorporates these neutral objects into the task of problem solving.* We might say that when difficulties arise, neutral stimuli take on the function of a sign and from that point on the operation's structure assumes an essentially different character." (Vygotsky, 1978, p. 74; italics added)

"By using this approach, we do not limit ourselves to the usual method of offering the subject simple stimuli to which we expect a direct response. Rather, we simultaneously offer a *second series of stimuli* that have a special function. In this way, we are able to study the *process of accomplishing a task by the aid of specific auxiliary means;* thus we are also able to discover the inner structure and development of higher psychological processes.
The method of double stimulation elicits manifestations of the crucial processes in the behavior of people of all ages. Tying a knot as a reminder, in both children and adults, is but one example of a pervasive regulatory principle of human behavior, that of *signification,* wherein people create temporary links and give significance to

previously neutral stimuli in the context of their problem-solving efforts. We regard our method as important because it helps to *objectify* inner psychological processes…" (Vygotsky, 1978, p. 74-75)

It is important to note that the second stimuli, the mediating means, were not necessarily given to the subjects in any ready-made form.

"In experimental studies, we do not necessarily have to present to the subject a prepared external means with which we might solve the proposed problem. The main design of our experiment will not suffer in any way if instead of giving the child prepared external means, we will wait while he spontaneously applies the auxiliary device and involves some auxiliary system of symbols in the operation. (…) In not giving the child a ready symbol, we could trace the way all the essential mechanisms of the complex symbolic activity of the child develop during the spontaneous expanding of the devices he used." (Vygotsky, 1999, p. 60)

van der Veer and Valsiner (1991, p. 399) point out the fundamental challenge this methodology poses to the experimenter who wants to control the experimental situation.

"The notion of 'experimental method' is set up by Vygotsky in a methodological framework where the traditional norm of the experimenter's maximum control over what happens in the experiment is retained as a special case, rather than the modal one. The human subject always 'imports' into an experimental setting a set of 'stimulus-means' (psychological instruments) in the form of signs that the experimenter cannot control externally in any rigid way. Hence the experimental setting becomes a context of investigation where the experimenter can manipulate its structure in order to trigger (but not 'produce') the subject's *construction* of new psychological phenomena."

In other words, the subject's agency steps into the picture. To fully appreciate the radical potential of the methodology of double stimulation, we need to reconstruct Vygotsky's more general conception of intentionality and agency. Vygotsky described this artifact-mediated nature of intentional action as follows.

"The person, using the power of things or stimuli, controls his own behavior through them, grouping them, putting them together, sorting them. In other words, the great uniqueness of the will consists of man having no power over his own behavior other than the power that things have over his behavior. But man subjects to himself the power of things over behavior, makes them serve his own purposes and controls that power as he wants. He changes the environment with the external activity and in this way affects his own behavior, subjecting it to his own authority." (Vygotsky, 1997b, p. 212)

Vygotsky (1997b, p. 213) pointed out that voluntary action has two phases or 'two apparatus'. The first one is the design phase in which the mediating artifact or "the closure part of the voluntary process" is,

often painstakingly, constructed. The second one is the execution phase or "actuating apparatus" which typically looks quite easy and almost automatic, much like a conditioned reflex.

Classic examples of culturally mediated intentionality include devices we construct and use to wake up early in the morning. Vygotsky's examples of voluntary action are mostly focused on individual actors. This must not be interpreted as neglect of collective intentionality. According to Vygotsky's famous principle, higher psychological functions appear twice, first interpsychologically, in collaborative action, and later intrapsychologically, internalized by the individual.

"V. K. Arsen'ev, a well-known researcher of the Ussuriysk region, tells how in an Udeg village in which he stopped during the journey, the local inhabitants asked him, on his return to Vladivostok, to tell the Russian authorities that the merchant Li Tanku was oppressing them. The next day, the inhabitants came out to accompany the traveler to the outskirts. A gray-haired old man came fromthe crowd, says Arsen'ev, and gave him the claw of a lynx and told him to put it in his pocket so that he would not forget their petition about Li Tanku. The man himself introduced an artificial stimulus into the situation, actively affecting the processes of remembering. Affecting the memory of another person, we note in passing, is essentially the same as affecting one's own memory." (Vygotsky, 1997b, p. 50-51)

Vygotsky's colleague A. N. Leont'ev (1932) focused on the social origins of intentional action. He pointed out that signals given by foremen, the rhythmic sounds of a drum, and working songs gave collective work the necessary direction and continuance. The interpsychological origins of voluntary action – and collective intentionality - would thus be found in rudimentary uses of shared external signals, prompts, as well as in reminders, plans, maps, etc.

CHEATING AS DOUBLE STIMULATION

We see the radical potential of double stimulation and mediated intentionality every day in educational practice. Cheating in schools is an enlightening example (e.g., Diekhoff & al., 1996, Higbee & Thomas, 2002, Magnus, Polterovich, Danilow & Savvateev, 2002). As one might expect, current research and literature on cheating is completely dominated by moralizing about the evil effects of cheating and attempts to design means to catch the culprits. Few authors (e.g., Cizek, 1999) even mention the possibility that the intense high-stakes testing of memorized knowledge in schools might have something to do with the apparent increase of cheating.

But what does a student actually do when she constructs a cheating slip while preparing for an exam? The exam questions and the texts one must master are the 'first stimuli', or the object, for the student. The cheating device, for example a paper slip, is the 'second stimulus', or the mediating tool. The cheating slip is typically a small piece of paper that can be hidden away from the teacher's eyes and on which one writes what one considers the most essential information about a topic one expects to be included in the exam questions. Since the slip is small, there cannot be too much text. To create a good cheating slip, the student must carefully select the most relevant and useful aspects of the topic and represent them in an economic and accessible way on the slip. Thus, the construction of a cheating slip is truly what Vygotsky described as creating an external auxiliary means for mastering an object.

The construction, contents and use of the cheating slip bring into light and objectify the inner psychological process of preparing for the test. If we get access to the construction, contents and use of cheating slips we learn much more about students' learning than merely by reading and grading their exam answers. That is why I occasionally ask my students to prepare cheating slips and to cheat in my exam, then at the end of the exam I collect their slips and the actual answers.

Cheating is an important form of student agency. By creating and using a cheating slip, the student controls his or her own behavior with the help of a tool he or she made. The hard part is the construction of a good cheating slip – the design phase or the 'closure part' of the agentic action. When asked, students often report that the execution part is surprisingly easy. If the slip has been well prepared, it is often enough that the student merely glances at it – the details seem to follow from memory as if a floodgate had been opened. This is the phenomenon of instantaneous recollection or reconstruction of a complex meaningful pattern with the help of a good 'advance organizer' (Ausubel, Novak & Hanesian, 1978, Ausubel, 2000), 'orientation basis' (Haenen, 1995, Talyzina, 1981), or 'germ cell model' (Davydov, 1990). In other words, learning to cheat well is extremely valuable.

At the same time, cheating is contestation of the given activity of school-going. By constructing and using a cheating slip, the student takes as risk but also creates a new mediating tool for the mastery of the entire testing situation, which is really the core of traditional schooling. This goes far beyond merely quantitatively enlarging or 'amplifying' one's memory. Good cheating is a way to beat the system,

to be more clever than the given activity. Long ago John Holt (1964) gave a vivid picture of the beginnings of this type of agency when he described how elementary school kids learn to calculate the risk: When the teacher asks a question to which you don't know the answer, it is reasonably safe to raise you hand if most of the other kids also raise their hand. You look good and the probability of getting caught is low. Agency is by definition testing and going beyond the limits of what is required and allowed. Students are themselves making double-stimulation experiments in these situations.

What do double stimulation and cheating have to do with development? Development may be tentatively defined as formation of qualitatively new 'functional systems', relatively stable patterns of conduct, within and between individuals or collective activity systems. Most psychological theories depict development essentially as progression from a limited toward a broader and more inclusive mastery over the environment and the self. As such, development is a positive process. It may entail problems and contradictions, but overall it is a benign process of achievement. Furthermore, developmental theories are heavily saturated by conceptions of vertical progression through more or less predetermined stages or phases.

While these affirmative and vertical aspects are surely important, exclusive focus on them makes developmental theory unable to deal with processes where something unexpected is created and subjects change their lives without adhering to the preconceived courses of acceptable progress and improvement.

I am currently analyzing an extensive corpus of detailed accounts of cheating in crucial exams, reported by 268 Italian university students presently studying to become kindergarten and elementary school teachers. Most of the students describe their cheating in the national high school final exam, which they characterize as an impossible test of memorizing excessive amounts of literature. In such an impossible and crucially important situation, carefully prepared cheating becomes much more than a memory-enhancing technique (see Figures 5 and 6).

Figure 5. A cheating belt and cheating slips that are inserted in the pockets of the belt

Figure 6. Another cheating belt with cheating slips

The students describe their actions of cheating as a major struggle with their conscience, their fear, and their values. Almost without exception,

they conclude that daring to prepare their elaborate cheating tools, or the second stimuli was a personal breakthrough into self-confidence and pride through the realization that what they did was not wrong – what was wrong was the system of education strangled by exams and assessments. This is all the more interesting as many of the students mention in passing that they actually did not need to use their cheating slips in the exam situation – it was sufficient that they had prepared them, both in terms of careful selection and presentation of knowledge and in terms of at least equally careful construction of the physical artifacts, typically with the assistance of mothers, fathers and other relatives.

This pride, collective self-confidence and critical awareness is, if not a relatively stable qualitatively new 'functional system', at least an impressive embryo of one. For me, it qualifies as an example of development, or at least a developmental step. Yet it is not publicly acknowledge as desirable development. To the contrary, it effectively udermines the public ideology and operational logic of educational institutions.

In this view, rejection, undermining or destruction of the existing dominant pattern of activity is an important aspect of development. I will now explore this emerging concept of development in some detail.

DEVELOPMENT AS BLAZING COGNITIVE TRAILS

Vygotsky's idea of double stimulation puts agency in the center of development: voluntary action "probably distinguishes man from the animals which stand closest to him to a greater extent than his more developed intellect" (Vygotsky, 1999, p. 64-65). How does voluntary action, or agency, do its developmental work? One way to look at this is Adrian Cussins' (1992, 1993) theory of cognitive trails. It shares with activity theory an emphasis on living movement as source of development.

Cussins' theory is an account of embodied cognition where the basic metaphor is that of a person moving in a territory. The key concepts are perspective-dependence (PD) and stabilization. Imagine a person standing somewhere in the middle of a city. The person's ability to find his or her way to any desired location regardless of the person's initial position is called perspective-independence. In such case, the PD ratio is high - close to 1. The PD ratio is close to zero when the person is

completely unable to find his or her way to any desired location in the territory.

People learn to move around in a territory by moving around in the territory. In so doing, they make cognitive trails.

"Trails are both person-made and world-made, and what makes persons and worlds. Trails are in the environment, certainly, but they are also *cognitive* objects. A trail isn't just an indentation in a physical surface, but a *marking* of the environment; a signposting for coordinating sensation and movement, an experiential line of force. Hence the marking is both experiential and environmental. " (Cussins, 1992, p. 673-674)

"Each trail occurs over time, and is a manipulation or a trial or an avoidance or capture or simply a movement. It is entirely context-dependent [...]. Yet a trail is not transitory (although a tracking of a trail is): the environmental marking persists and thereby the ability to navigate through the feature-domain is enhanced." (Cussins, 1992, p. 674)

As multiple trails are marked, some trails intersect. Intersections are landmarks. A territory is structured by means of a network of landmarks. Such structuring means increasing the PD ratio.

Along with the PD ratio, there is another dimension that characterizes the development of cognitive trails, namely stabilization. Stabilization may also be characterized as blackboxing.

"Stabilization is a process which takes some phenomenon that is in flux, and draws a line (or builds a box) around the phenomenon, so that the phenomenon can enter cognition (and the world) in a single act of reference [...]." (Cussins, 1992, p. 677)

"There comes a time when it is best to stabilize a network of trails so that the space is treated cognitively (functions) as a given unit (an object!), and then build higher-order feature-spaces [...]." (Cussins, 1992, p. 679)

"One familiar and important way in which stabilization is achieved is by drawing a linguistic blackbox around a feature-space: the imposition of linguistic structure on experiential structure. [...] A region of feature-space starts to function as an object as it is dominated by a network of trails and stabilized by a name." (Cussins, 1992, p. 679-680)

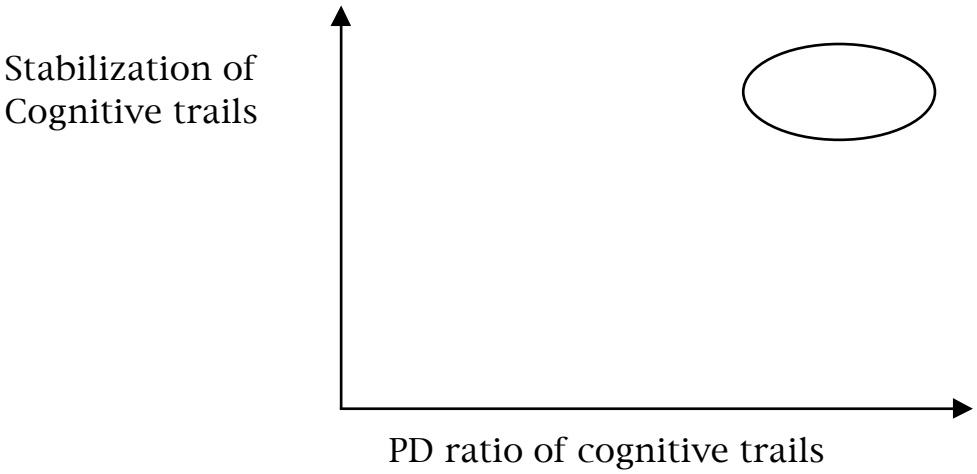

Figure 7. Generality as high PD ratio and high stabilization (Cussins, 1992, p. 683)

In Figure 7, the point of maximum generality is depicted with the help of an oval. This is where stabilized objects, concepts and explicit propositions emerge.

Cussins depicts cognition as "appropriate spiraling" in the two-dimensional terrain depicted above. He calls this movement “virtuous representational activity.”

“The course of a cognitive phenomenon (a dynamic, representational activity) may be plotted on a graph whose axes are the PD ratio of the cognitive trails and the degree of stabilization of the cognitive trails. Let us suppose that an activity starts out with low PD ratio and low stabilization. As the field starts to become structured – the creatures start to find their way around a landscape (as the theorist would say) – PD ratio will increase. A network of cognitive trails is temporarily established, and this provides for the possibility of stabilization. Both stabilization and PD ratio continue to increase, until the work concentrates almost entirely on the stabilization of trails that are in place. However, once a network of trails is tightly stabilized it becomes less flexible, and as the nature of the field of activity changes over time, PD ratio will start to decrease as stabilization increases. Further improvement in way-finding will then require that a destabilized region of cognitive trails be established for a period of time in order to allow PD ratio to increase again. In other words, *virtuous* representational activity is the effective trade-off of the relative merits and demerits of PD ratio and stabilization. Virtuous activity may itself be represented as a figure, a shape, in the two-dimensional space of the PD ratio/stabilization graph. It is not hard to see that the virtuous form of representational activity has the shape of a spiral.” (Figure 8; Cussins, 1993, p. 249-250)

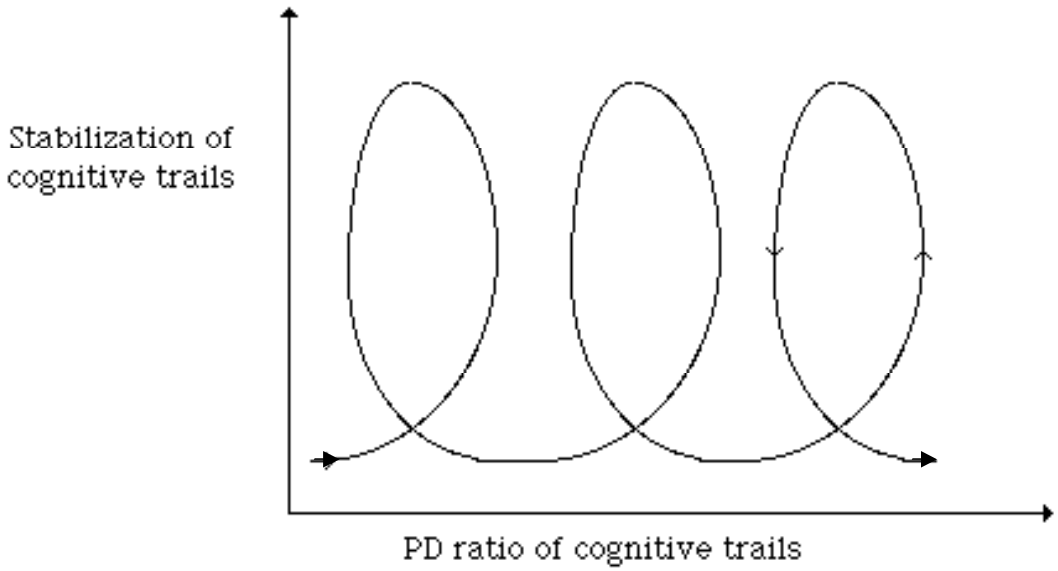

Figure 8. The spiral of virtuous representational activity (Cussins, 1993, p. 250)

Cussins' theory of cognitive trails depicts change as construction and maintenance of multiple intersecting trails across an unexplored field or terrain, gradually leading to a stable conceptualization of the terrain, and subsequently again to destabilization. The terrain may be understood as a zone of proximal development for the actors who enter it. The terrain, or the zone, is both material and mental. Importantly, the theory of cognitive trails has no built-in linear directionality, closure or finalism in it. The trails take multiple directions, there is no untouchable predetermined goal, and the contents of the emerging concept are open.

Some change efforts die while some others evolve into long, sustained transformations which seem to energize themselves. To grasp this phenomenon, activity theorists have looked into dialectical oscillations within developmental transformations. Vygotsky and Leont'ev pointed out a foundational oscillation between internalization of given cultural meanings and externalization of novel ideas or solutions.[3] This is echoed in Tomasello's (1999) description of cultural learning as

[3] Another important developmental oscillation is that between socially oriented and object-oriented activity, presented by El'konin (1977) as the explanatory principle behind shifts in leading activity in the development of children and adolescents. Space does not permit me to discuss this oscillation more fully here.

oscillation between lengthy periods of imitation and intense phases of innovation that lead to externalized, artifact-supported new patterns of action. I prefer to connect this oscillation to the idea of expansive cycles of learning and development (Figure 9).

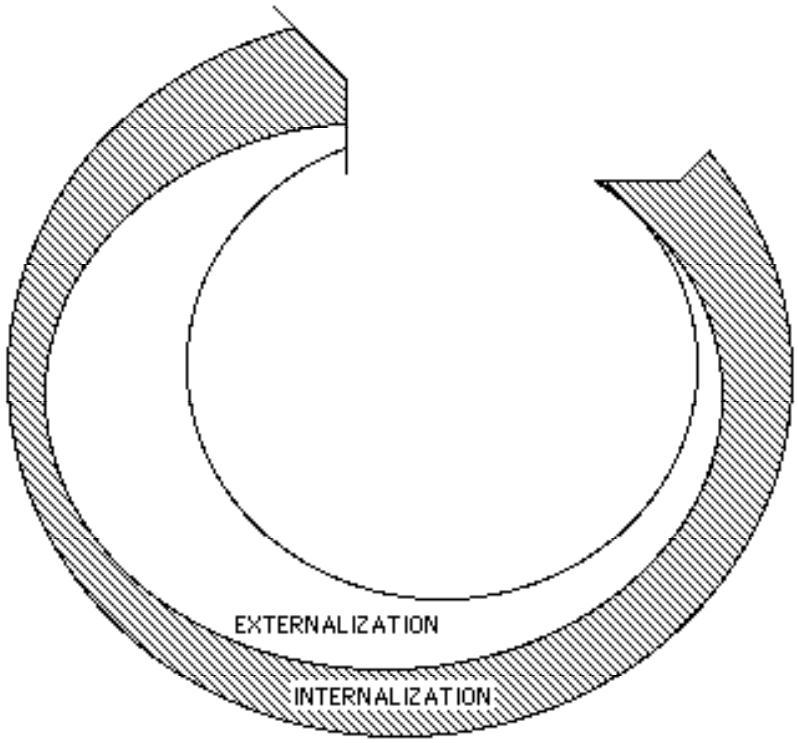

Figure 9. Oscillation of internalization and externalization in expansive cycles (Engeström, 1999, p. 34)

The expansive cycle depicted in Figure 9 begins with an almost exclusive emphasis on internalization, for example in the sense of socializing and training the novices to become competent members of the activity as it is routinely carried out. Creative externalization occurs first in the form of discrete individual deviations and mundane innovations. As the disruptions and contradictions of the activity become more demanding, internalization increasingly takes the form of defense on the one hand and critical self-reflection on the other hand. Externalization, search for novel solutions, increases and reaches its peak when a new model and germ-cell concept for the activity is designed and implemented. As the new model is stabilized, internalization of its inherent ways and means again becomes the dominant form of learning and development.

It is not too hard to see the similarities between this account and the spiral of virtuous representational activity of Cussins presented above. In fact, Cussins proposes another, complementary oscillation, namely that between stabilization and destabilization. It is closely related, while not identical, to both internalization/externalization and imitation/innovation.

Several interesting attempts have been made to capture the specificity of the actions by means of which human beings construct new meanings and change their own patterns of activity. These include the notions of scaffolding (Davis & Miyake, 2004), bridging (Granott, Fischer & Parziale, 2002), and blending (Fauconnier & Turner, 2003). There is room for all of these specific mechanisms within the general conceptual framework outlined above.

However, there is a crucial mechanism that precedes or at least is complementary to such constructive actions as those listed above. I call this mechanism *breaking away* (Engeström, 1996).

DEVELOPMENT AS BREAKING AWAY

What the theory of cognitive trails fails to discuss is the fact that there are no empty terrains to begin with. They are already inhabited by objects, actors and activities, and the networks those have established are often very stable and resistant. In this light, the crucial question is: What makes change possible in the first place?

This is where activity theory builds on the concept of contradictions. No terrain of activity, no matter how stable and resistant, is free on inner contradictions. Contradictions are not the same as problems or conflicts. Contradictions are historically accumulating structural tensions within and between activity systems. An activity system is constantly working through tensions and contradictions within and between its elements. Contradictions manifest themselves in persistently recurring disturbances and eventually as ‘double binds,’ situations experienced as impossible.

The primary contradiction of activities in capitalism is that between the use value and exchange value of commodities. This primary contradiction pervades all elements of our activity systems. The school-going activity of students may serve as an illustration. The primary contradiction, the dual nature of use value and exchange value, can be

found by focusing on any of the elements of the student's activity. A student works on textbooks. But textbooks are not utilized only for learning useful knowledge - they are also, and often primarily, studied in order to get grades, to maximize the exchange value of the student as a marketable product.

Activities are open systems. When an activity system adopts a new element from the outside (for example, a new technology or a new object), it often leads to an aggravated secondary contradiction where some old element (for example, the rules or the division of labor) collides with the new one. Such contradictions generate disturbances and conflicts but also innovative attempts to change the activity, making the zone of proximal development an invisible battleground. The stiff rules lagging behind and thwarting possibilities opened up by advanced new instruments are a common example. A typical secondary contradiction in the activity of school-going may be, for instance, triggered by the introduction of computers and Internet into the students' work. Internet opens up a huge range of interesting and entertaining objects that potentially jeopardize the school's control over students' attention and effort in classrooms, leading to what is called E-cheating (McMurtry, 2001).

Contradictions are not just inevitable features of activity. They are "the principle of its self-movement and (...) the form in which the development is cast" (Ilyenkov, 1977, p. 330). This means that new qualitative stages and forms of activity emerge as solutions to the contradictions of the preceding stage of form. This in turn takes place in the form of 'invisible breakthroughs', innovations from below.

"In reality it always happens that a phenomenon which later becomes universal originally emerges as an individual, particular, specific phenomenon, as an exception from the rule. It cannot actually emerge in any other way. Otherwise history would have a rather mysterious form.
Thus, any new improvement of labour, every new mode of man's action in production, before becoming generally accepted and recognised, first emerge as a certain deviation from previously accepted and codified norms. Having emerged as an *individual exception* from the rule in the labour of one or several men, the new form is then taken over by others, becoming in time a new *universal norm.* If the new norm did not originally appear in this exact manner, it would never become a really universal form, but would exist merely in fantasy, in wishful thinking." (Ilyenkov, 1982, p. 83-84)

But for a contradiction to become effective as source of development, specific agentive actions are needed. Recall Vygotsky's description of Kurt Lewin's experiment on so called meaningless situations. The

subjects were put in a contradictory situation, oscillating between the expected rules of the experiment and one's own quest for meaning. This contradiction was resolved by constructing a second stimulus, a mediating instrument (such as the clock) for breaking away from the impossible situation. The same happens with cheating. Students are put in a contradictory situation, oscillating between the rules of obedient school-going and their own quest for meaning. Again, the contradiction is expansively resolved by constructing a new mediating instrument, the cheating slip or a whole belt of cheating slips, which enables the student to break away from the closed impossible situation.

Breaking away may now be tentatively defined as resolving or escaping a contradictory situation by means of constructing mediating artifacts that enable the subjects to master their own actions in a qualitatively new way. As such, this definition seems very benign: there is no direct indication of rejection and destruction. However, when you break away, you also break something: a constraining rule, a limiting boundary or constraining relationship. Actions of breaking away typically involve an under-explored aspect of emotional tension, resistance, pain, loss, and insecurity (e.g., Viorst, 1986).

In Cussins' terminology, breaking away would correspond to opening up a destabilized region of new cognitive trails. This will lead to a new round of stabilization. In other words, breaking away is both movement *out* of something and *into* something else. The film *Breaking Away,* directed by Peter Yates (1979), offers an example. Four working class boys have finished their high school and feel stuck in the home town. One of them develops a passion for competitive bicycling, and the bicycle eventually becomes the new mediating artifact, the 'second stimulus' for the boys in their attempt to show that they can be as good or better than college kids with wealthy parents. In the film, the boys struggle to move *out* of the confines of their life activity in working class homes, working class part of the town, and working class jobs. The protagonist succeeds. At the end, he moves *into* the life activity of a university student. In this transition, there is something depressingly predetermined and unsurprising: the movement is upward along the social ladder, from one pre-established position to another one. The working class object of 'making a living' is replaced with the equally familiar middle-class object of 'making a career'. The positions, institutions, objects and motives available seem to be given and unchangable – some individuals just move between them (for studies of this type, see London, 1989, Willis, 1977; for recent more dialectically

oriented work, see Perret-Clermont, Pontecorvo, Resnick, Zittoun & Burge, 2004).

This is an impoverished version of breaking away. A richer view of breaking away focuses not only on individuals moving (or remaining stuck) but also on objects and institutions facing contradictions, undergoing transformations, and being destroyed and created. From an activity-theoretical point of view, the generation and transformation of expanded objects is the key (Engeström, Puonti & Seppänen, 2003, Engeström & Blackler, 2005).

In some collective work activities, the emerging historically possible breaking away entails moving *into* the construction of runaway objects, knotworking and mycorrhizae-like organizing. In other words, at present it is particularly exciting to study attempts to break away from traditional hierarchical and market forms of work organization into emerging forms of knotworking in mycorrhizae-like activities.

BREAKING AWAY INTO MYCORRHIZAE ACTIVITIES

The most obvious examples of mycorrhizae-like activities at the moment are the Open Source communities in software development and the Peer-to-Peer (P2P) networks in cultural production and exchange.

> "What do music file exchanges like KaZaA and Gnutella, collaborative news networks like Slashdot and Kuro5hin and open source operating systems like Linux have in common? They are all forms of digital culture that are networked in technology, are P2P in organization and are collaborative in principle. Although they may seem to be on the fringes of the digital scene, their impact on existing cultural practices may well turn out to be disproportionate to their apparent position; indeed, their implications for how we define certain practices, including the practice of citizenship, and how we participate in cultural production are potentially transformative. These systems might be seen as part of a larger participatory turn whereby the users generate the content, evident in such diverse activities as fan fiction production, computer gaming and club culture. Although the notion of 'participatory culture' is not without its complexities, even at its simplest level of meaning, the concept signals a blurring of the boundaries between the categories of production and consumption and a subversion of established hierarchies of cultural value and authority." (Uricchio, 2004, p. 86; see also Vaidhyanathan, 2004, Subramanian & Goodman, 2005)

The other important area where mycorrhizae-like organizing has become manifest is grassroots political activism.

"On the one hand, grassroots activists have developed highly advanced forms of computer-mediated alternative and tactical media, including Indymedia, culture jamming, hacktivism, and electronic civil disobedience. These practices have facilitated the emergence of globally coordinated transnational counterpublics while providing creative mechanisms for flexibly intervening within dominant communication circuits. On the other hand, activists have appropriated the Internet into their everyday routines, largely through e-mail lists and Web sites, favoring the rise of highly flexible and decentralized network forms. At the same time, the network has also emerged as a broader cultural ideal, as digital technologies generate new political values and vocabularies, which are often directly inscribed into organizational and technological network architectures, suggesting a powerful dialectic among technology, norm, and form, mediated by human practice. Finally, activists are building a new digital media culture through the practice of informational utopics, involving experimentation with new technologies and the projection of utopian ideals regarding open participation and horizontal collaboration onto emerging forms of networked space." (Juris, 2005, p. 204-205; see also Hardt & Negri, 2005)

Alternative utopias have the tendency of evaporating or being integrated into existing forms of production and power. Uricchio (2004, p. 89) points out that "corporations are increasingly aware of the power of praticipatory culture and are incporporating elements of P2P culture in their own marketing." Weber (2004, p. 234) adds that "as open source software becomes increasingly mainstream in corporate applications, people have started companies to customize and service the software, and these companies have to make money, follow corporate law, and otherwise interface with conventional economic and legal systems." This brings up the difficult dilemma of *livelihood:* "it is not at all clear how communities and networks will provide for their members" (Uricchio, 2004, p. 89). The dilemma may take the form: sell out or starve.

Another dilemma in the present literature is the relationship between the new organizational forms and *technology.* The analyses mentioned above tacitly or openly tend to make the emergence and existence of mycorrhizae-like organizational patterns entirely dependent on, even generated by, digital technologies.

Steven Weber's discussion of possibilities of open source models in primary care medicine is an instructive example of the two dilemmas.

"Consider, for example, the structure of medical knowledge in a common family practice type setting, which is interestingly parallel to the structure of knowledge for in-house software development. My doctor in Berkeley has a hard problem to solve. I present myself to her with an atypical sinus infection, low-grade fever, aching muscles, and a family history of heart disease. The bad news is that I represent to her a highly customized configuration and a finely grained problem. The good news is

that there almost certainly is a similarly configured patient presenting somewhere else at the same time. At the very least, other doctors are solving pieces of my problem in other settings.

The second piece of bad news, though, is that she will find it extremely difficult to access that distributed knowledge and thus will most likely have to figure out my problem without much help. In fact, doctors have very cumbersome means of upgrading the common medical knowledge that they draw on to support their work..." (Weber, 2004, p. 268)

Weber argues that medical doctors would benefit enormously from a capacity to share their solutions online. He asks whether much of what has been considered tacit knowledge in medical practice may actually become representable digitally when bandwith increases. He concludes that "a positive answer would make certain aspects of medical practice an obvious place to experiment with open source style knowledge production" (Weber, 2004, p. 269).

Weber's example implies that the *livelihood dilemma* may be approached by extending open source models to domains of practice which already have a stable, well insitutionalized economic basis, whether in the public or in the private sphere. An obvious prerequisite is that there are pressing contradictions in the existing practices that may be resolved by means of introducting the new models. Weber's example also implies that all this will be possible when the technology allows it – when there is enough bandwith for smooth digitizing and sharing of previously tacit medical knowledge. This leaves us prisoners of the *technology dilemma.* Over the past two decades, medical practioners have heard time and again the technological promises of unified and user-friendly information systems that make the sharing and using of medical records a pleasure. Promises of bandwith revolution just don't cut the ice anymore.

From the point of view of activity theory, Weber's example has a fundamental weakness. It is not based on a careful consideration of the *object.*

In an open source software community such as Linux, the object is a concrete product, an operating system that keeps evolving as the developers and users contribute to its improvement. The object is at the same time distributed and unified: everyone can have it and tinker with it on his or her desktop, but it is also one and the same basic system for all. The object is at the same time a product and a project: it does useful work for users, yet it is unfinished, full of challenges and continuously developed further. And it is truly a runaway object: it is a source of

pride in that it is conquering the world by being better and cheaper than its commercial competitors. These features give the object unusual holding power.

What would be the characteristics of the object of shared knowledge production in primary care medicine as described by Weber? For an individual practioner, such as Weber's own doctor in Berkeley, the immediate object would be the 'atypical sinus infection' of the patient. To find out about similar cases does not in fact seem to be such a pressing problem for medical practitioners. In primary care, most such cases are not very urgent, so the doctor has time to find the needed information from literature, from various databases, and from peers. Often additional time actually solves the patient's problem or makes its symptoms clearer. If the doctor has reason to suspect something serious, she refers the patient to a hospital specialist. It is difficult to see what in this case could become an object comparable to the Linux operating system for the doctor.

Of course there are primary care medical practitioners who see health and suffering at large as their object. Many of these pratictioners devote periods of their lives to working with international aid organizations in developing countries or catastrophe areas, often as volunteers without much financial gain. Theirs is a runaway object with strong holding power. It is at the same time distributed and unified: the health and suffering of the poor is a global fact, yet very local and personal when one gets close to it. It is at the same time a product and a project: the health situation may be improved in one area, but the next one is waiting. Very probably among these practitioners, we would find knotworking and mycorrhizae-like formations which extend beyond the professional boundaries of medicine, to other relief workers, local activists, etc. Probably in those formations we would also find active uses of technologies of digital networking. But these formations are certainly not dependent on radically increased bandwith. In fact, it is not an activity of 'shared knowledge production' as Weber fashionably sees it. It is an activity of fighting illness and suffering.

Another possible way to build a strong object in primary care medicine is to focus on what is truly unique to primary care. Historically, primary health care has evolved into a screening mechanism charged with identifying and referring forward potentially serious cases which need specialized care. This has led to a dilemma. The tools and rules of the practice support early identification of biomedically serious

diseases and speedy treatment of non-serious routine medical problems. What is left in the shadow is a diffuse but evidently growing portion of primary care patients experienced by doctors as difficult, demanding or complex (e.g., Rogers, Hassell & Nicolaas, 2001). These patients are not difficult in the traditional sense of the biomedical 'seriousness' or diagnostic difficulty of their illness – and thus they are not commonly referred to specialist hospital care. Often, though not always, they have a history of very frequent consultations, or what may be labeled as 'excessive use' of primary care services.

Some authors argue that these patients are difficult in their attitudes and relations to physicians, so called 'heartsink' cases (O'Dowd, 1988). Using the frequency of consultations as their criterion, Gill and Sharpe (1999) conducted a careful literature review of relevant studies and found little evidence for the 'heartsink' stereotype. Instead, they found that this heterogenous group of patients have high rates of physical disease, psychiatric illness and social difficulties. Patients with both physical and psychiatric disorders – medical-psychiatric comorbidity – were much more common among frequent consulters than among normal attenders. One prototype is a combination of chronic physical disease (e.g., type 2 diabetes) and various other more or less chronic conditions, including psychiatric disorders and problems of unhealthy lifestyle.

Both traditional specialty-oriented medical thinking and neoliberalist market-oriented reforms in health care tend to marginalize and exclude this poorly understood but increasingly important group of patients, turning them into 'rubbish' that practitioners try to avoid and get rid of (Engeström & Blackler, 2005). On the other hand, many payment schemes may actually push these patients to multiple parallel strands of poorly coordinated specialist care when a continuous relationship with a general practitioner in primary care would actually be the best solution for the patient.

In any case, the triple phenomenon of increasing chronic illness, increasing life expectancy and increasing comorbidity is a virtual economic time bomb in industrialized countries (Georgeson & al., 2005, Thrall, 2005). In their careful study, Starfield and her colleagues (2005) found a very high salience of comorbidity, or multimorbidity, in the care of elderly American patients. While the central role of primary care physicians in the care of chronic conditions is increasingly recognized in principle, Starfield & al. found that specialists in fact played a major role in the care of many common conditions.

"Most comorbid conditions receiving care from specialists are extremely common. And there may be legitimate questions about the need for specialist care. Because specialists are more likely than generalists to suspect serious abnormalities, they are more likely to do extensive and unnecessary procedures. [...] Inappropriate use of specialists could contribute to explaining why costs are higher in areas with a greater number of specialists, even though there is no improvement in outcomes among the elderly." (Starfield & al., 2005, p. 221)

In other words, there is a real and growing set of contradictions in primary care medicine, centered around the emerging object of patients with multiple, chronic illnesses (comorbidity, multimorbidity) which tend to be either marginalized as nuisance or pushed to fragmented and expensive specialist care. This emerging object requires new forms of knotworking and mycorrhizae-like patterns of organization.

"Consultations with specialists directly (rather than through the patient) may be more efficient overall and more convenient for the patient. Trials of teleconsultations or specialist outreach sessions (in general practitioner offices) as alternatives to referrals show promise. Similarly, a simple intervention of consisting of giving primary care physicians cameras and direct access to specialists resulted in a 25% reduction in dermatologist visits by patients. Various attempts to reduce unnecessary specialist visits through better mechanisms of information transfer (such as integrated electronic medical records) have had modest success, and there have been trials (particularly involving patients with specific diseases, such as diabetes) in which consultants do not seethe patient but provide education, support, and strategic planning to the primary care physician." (Starfield & al, 2005, p. 221)

The emerging runaway object might be tentatively characterized as negotiated care trajectories for multiple chronic illnesses. This object is both distributed and unified in that each patient is locally specific and different, yet a representative of the general challenge of comorbidity. It is both a product and a project in that each well coordinated care trajectory represents a concrete result, yet the trajectory needs continuous monitoring and reconfiguring. Importantly, the 'end users', the patients themselves, are central producers of their own care trajectories.[4] Again, digital networking technologies are important in the formation of these forms of knotworking and mycorrhizae, as

[4] The users' productive role is obvious in the construction of services with long life cycles, such as care trajectories for chronic illnesses. It is all the more odd that even recent literature of the changing roles of users (including users of health care) largely neglects this realm and focuses restrictively on users as consumers of technological products (e.g., Oudshoorn & Pinch, 2003).

Starfield & al. point out in the excerpt quoted above. But they are tools, not the object.[5]

My research group is currently working with the practitioners of a municipal primary care clinic near Helsinki, Finland, to analyze and support their attempts at breaking away *from* mass production oriented work, *into* rudimentary forms of knotworking and mycorrhizae-building around complex care trajectories, typically with multiple chronic conditions and frequent consultations. After a physician or a nurse identifies a potential problematic patient case, we interview the patient and his or her primary physician as well as other professionals involved in the care of this patient, including social workers.

We ask the patient to list all the clinics and caregivers involved in his or her care and construct a simple graphic map of the caregivers together with the patient. We also ask the primary physician and the patient to construct together a simple graphic representation of the patient's care trajectory (a timeline of health-related life events, consultations, diagnoses, treatments). These are the initial secondary stimuli, or mediating artifacts, with which the practitioners and the patient will begin to reorganize the care.

The initial artifacts are used as starting points for one or more knotworking sessions aimed at analysis and redesign of the care trajectory. There are four varieties of such sessions; (a) discussion between the physician and his or her colleague (either another physician or a nurse), (b) regular meeting of the primary care team that typically consists of two to four physicians, a nurse and two assistant nurses, (c) family meeting between the patient, the patient's significant family member(s), the primary physician and other professionals immediately involved in the care of the patient, (d) network meeting between all parties involved in the care, including professionals from remote sites such as specialist physicians from relevant hospital clinics.

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[5] A important juncture of this development will be the integration of telecare into the work of primary care practitioners. As May, Finch, Mair and Mort (2005) point out, there is an ongoing shift from telemedicine to telecare, a technological framework for the domestic management of chronic illness which regards patients as experts in their own illness and self-care. Paradoxically, *both* monitoring at distance by telecare *and* new forms of home delivery may become important aspects of the future general practitioner's mycorrhizae-like work context (Jerant, von Friedrichs-Fitzwater & Moore, 2005).

When a family meeting or a network meeting is used, a further mediating artifact is constructed if possible, namely a care agreement. This is a written and signed informal agreement between the different caregiver parties and the patient that singles out the patient's main medical diagnoses, personal concerns and ongoing treatments, as well as the responsibilities and division of labor between the parties (see Engeström, Engeström & Kerosuo, 2003).

Clearly such small-scale steps toward negotiated knotworking in the care of patients with multiple chronic illnesses or conditions is not a radical breakthrough away from mass production and into a mycorrhizae-like organization of work. It is more like blazing relatively isolated cognitive trails into a new territory, the obstacles and existing structures of which are still poorly known.

Then again, if we look at the history of the Open Source movement, it also began as isolated small-scale paths into a poorly charted territory. Perhaps the big difference is in the visibility, accessibility and cumulation of the product.

How can the results of knotworking with patient care trajectories be made visible, accessible and cumulative? One possible avenue will be to turn transformations from fragmented to negotiated patient trajectories into a Web repository of richly documented narratives in which the voices of the patient, the professionals and the researchers are heard. Such an open repository of documented health-care stories can be updated whenever new events in care trajectories occur and the different parties feel the need to keep the stories alive. Perhaps the repository itself can eventually become a collective second stimulus for concerted efforts to break away into mycorrhizae activities in health care.

KNOTWORKING AS BREAKING AWAY?

If we examine participants' accounts of episodes of knotworking in Open Source communities, Peer-to-Peer networks, skateboarding, or birding, we will find strong indications of repeated experiencing of breaking away. [GET EXAMPLES FOR EVIDENCE!]

-Open source is 'copyleft'; peer-to-peer is 'disruptive technology'; 'skateboarding is (not) a crime' - testing the limits of what is legal

-Birders break away from their physical and social routines to go after birds

-Liberated action (Zinchenko); the psychology of experiencing; flow

-These are frequent 'mini-breakways' that happen time and again. Can breaking away become a dominant mode of activity - a way of life?

CONCLUSION

At the beginning of this paper, I set out to weave together two conceptual domains, human development and transformation of work practices. The integration of these two domains is not simply a matter of finding common elements or shared issues. I have tried to show that, from an activity-theretical point of view, both domains must themselves be radically reconfigured in the process of their integration.

Connecting threads between the domains may be constructed step by step, as we identify conceptual resources within one domain that may carry over new explanatory potential to the other domain. This kind of weaving is a delicate job, and here I have only generated a first crude sketch for it. One might say that instead of weaving, I have only done some initial stiching. The intermediate result of this attempt may be summarized with the help of Figure 10.

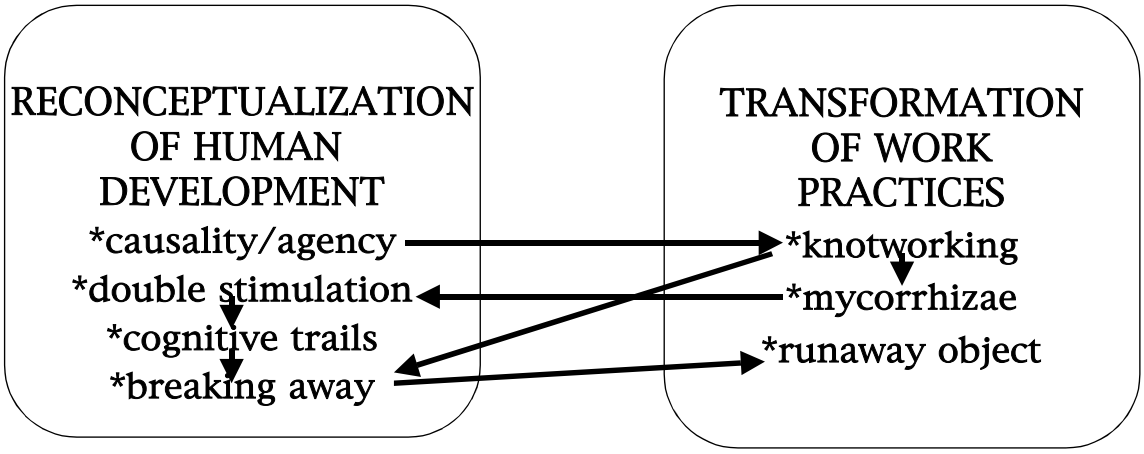

Figure 10. Summary of connecting threads

The picture that emerges is tentative, a working hypothesis that may guide, or at least challenge and provoke, further empirical and theoretical studies.

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