

Cognitive Grounding of Activity Modalities

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Abstract

In this paper, we assume that the social reality and the communal meaning about this reality are reflected in each other. In object-related activity two kinds of congruent elements are constructed – objectivated elements oriented internally towards the human mind and objectified elements oriented externally towards the social reality. We propose that the mutual construction of mind and social reality proceeds along certain dimensions called activity modalities. Previously, the “objectification side” of these modalities has been grounded in the practice of developing large telecom systems. The purpose of this paper is to ground the “objectivation side” of the modalities. We claim that the “ontological categories” in the conceptual structure proposed by Jackendoff are compatible with the activity modalities. Thus, the contribution of this paper is a reinforced grounding of activity modalities as basic dimensions for coordinating human activity.

Keywords: cognition, congruence of mind – social reality, activity modalities, communal meaning, ontological categories, Jackendoff’s theory of meaning

1 Introduction

The subject matter of this paper is the construction of communal meaning in order to coordinate human activity aiming at fulfilling social needs¹. The motivation for concentrating on operational aspects of meaning comes from observations in the development practice at Ericsson, a major supplier of telecom equipments worldwide. A key issue in this practice turned out to be controversies about how to define the coordination of large, extraordinary complex projects developing the 3rd generation of mobile telecom systems (Taxén, 2003). The experiences indicated that consensus might be achieved without difficulty at generic levels. However, as the level of detail increases, disagreements begin to surface (cf. Bititci & Muir, 1997). This becomes particularly troublesome when the meaning of coordination items such as requirements, deliveries, functions, etc., has to be concretised enough to be implementable in information systems (ISs) providing support for coordination.

Whatever position is taken towards the nature of meaning, it is clear that two realms are involved – the human mind and the social reality. Meaning has of course been extensively treated in the literature (see e.g. Smircich, 1983; Giddens, 1984; Boland, 1985; Bruner, 1990; Walsham, 1993; Weick, 1995; Hirschheim et al., 1996). In general, these contributions have focused on investigating the nature and influence of meaning. Fewer contributions have, however, suggested procedures to actively *construct* communal meaning, that is, considered meaning as a constructible element in the same sense as, for example, software modules or user interfaces in IS design. Thus, we seek to advance the discourse on meaning beyond the analytical to a position where meaning is regarded as something that needs to be actively “developed”. This calls for an operationalization of meaning, i.e., defining meaning by

¹ In the literature, connotations like “shared” or “distributed” are used to express commonality of meaning. However, as Boland (1996) and Walsham (2005) have noted, these terms are problematic. Thus, we prefer “communal” to express trans-individual aspects of meaning.

elements that can be manipulated, measured or observed in practice in order to influence that practice.

In general, theoretical inquiries into meaning are either focused on the micro / individual level or the macro / social level. Not surprisingly, such inquiries are weak on covering both levels. An example is found in Structuration Theory, where structures are defined on the micro level as “existing only as memory traces” (Giddens, 1984, p. 377). A corresponding example comes from Gärdenfors, who theorizes about the nature of conceptual structures as mediating between linguistic and associative, neural network structures in the brain. He states that “meanings are not in the head of a single individual, but they *emerge* from the conceptual structures in the heads of the language users together with the linguistic power structure.” (Gärdenfors, 2000, p. 202, italics in original). Neither “memory traces” nor “linguistic power structures” appear to be very precise terms in articulating the “opposite” perspective.

An alternative point of departure is to focus on the dialectical interaction between humans and their social reality. This line of inquiry, which has long roots in philosophy, considers the subjective and objective as mutually constituting each other. In the praxis philosophy, which traces back to the writings of early Marx and Engels, this dialectic is formulated as follows:

“Human praxis [is] the arena for the metamorphosis of the objective into the subjective and of the subjective into the objective.” (Kosík, 1976, p. 71).

The dialectical perspective has been further developed by numerous scholars, perhaps most prominently by Giddens (1984). His central notion of the “duality of structure” indicates that structures are both enabling and constraining human action. Further inquiries along this line have been made by, for example, Orlikowski (1992, 2000, 2002), Sewell (1992) and Rose & Scheepers (2001). However, with the exception of Rose & Scheepers, these contributions provide little guidance of how to operationalize the dialectical perspective into recipes or guidelines for intervening in practice.

Discussions of the mental versus the social are usually framed in terms of subjective-objective, internal-external and the like. However, as noted in the literature (e.g. Zinchenko, 2001) this separation is problematic. While it is commonly accepted that the ontogenetic development of the mind is grounded in activity, the nature of this development is disputed. For example, subjective elements are by necessity intangible and confined to the individual mind, yet these elements influence the interaction with the social and material, that is, something located outside the individual. Terms like internal, subjective and mental suggest that object-related external action does not possess any mind-related aspects, something which appears to be strange (ibid., p. 138). Another difficulty is the transition from tangible, external elements into intangible, internal elements and the other way around. What is the nature of this transition and how does it work? What cognitive mechanisms are at play in this transition?

These and other difficulties have prompted alternative stances that seek to eliminate the opposition between the internal and external (e.g. Vygotsky, 1978; Leont'ev, 1978; Bedny & Meistner, 1997; Ray, 1999; Stetsenko, 1999; Zinchenko, 2001; Callaos & Callaos, 2002). The essence of these positions is to hypothesise a *congruence* between the internal and external. The mental, or subjective, is considered as objective at the same time – without regard to whether it appears in its external or internal form, whether it is observable or not: “Suppose

that mind, just like culture, does not have its own enclosed territory, but is situated instead at the borders between own and not-own.” (Zinchenko, 2001, p. 139).

In this paper we will proceed along this line of argumentation. We assume that two kinds of communal, persistent and, in some sense, congruent elements are constructed in object-related human activity: internally oriented *objectivated* elements and externally oriented *objectified* elements (Kosik, 1976). From this point of view, the gist of communal meaning consists of these two types of elements together with the process in which they are constructed. Taxén (2004; 2005) has suggested that this process proceeds along certain dimensions called *activity modalities* – spatialization, temporalization, stabilization, transition and contextualization. Examples of concrete manifestations of the modalities are business processes (temporalization), product structures (spatialization), and business rules (stabilization). The modalities were derived from observations in the development practice at Ericsson, where interdependencies between them were found crucial for managing the coordination of development projects (Taxén, 2003). Thus, we may say that the “objectification” aspect of the meaning construction process is provisionary grounded in the Ericsson practice.

The purpose of this paper is to investigate a corresponding grounding of the “objectivation” aspect. Thus, we seek to ground the activity modalities in the human cognitive system, that is, in the constraining and enabling “biological substrate” as constituted through the phylogenetic evolution of humankind. One way to “get access” to the structure of the cognitive system is via the structure of language. Language is clearly grounded in both mind and social reality. If, indeed, the activity modalities are fundamental, these should be manifested also in language. On the surface, this is quite self-evident since we can talk about spatial, temporal, stabilizing, etc., aspects of activity. In order to approach the underlying structures in the mind, we depart from the theory of meaning proposed by Jackendoff (1983, 1990). In particular, we draw on his notion of “conceptual structure” as a level of mental representation where linguistic, sensory and motor information are compatible. In this structure, basic conceptual constituents are provided by “ontological categories” such as [THING], [EVENT], etc. These fundamental categories of cognition are assumed to have emerged during the phylogenetic evolution of humankind.

There might be other theories providing similar or different ways to achieve the same objective, for example, via cognitive semantics (Lakoff, 1987; Gärdenfors, 2000). However, at the present state of theorizing, this has to be postponed to future research efforts. In summary, our instruments for grounding the activity modalities in the cognitive constitution of humans are objectified manifestations of activity in the Ericsson development practice, the congruence between objectivated and objectified forms of activity and the theory of Jackendoff. This is illustrated in Figure 1:

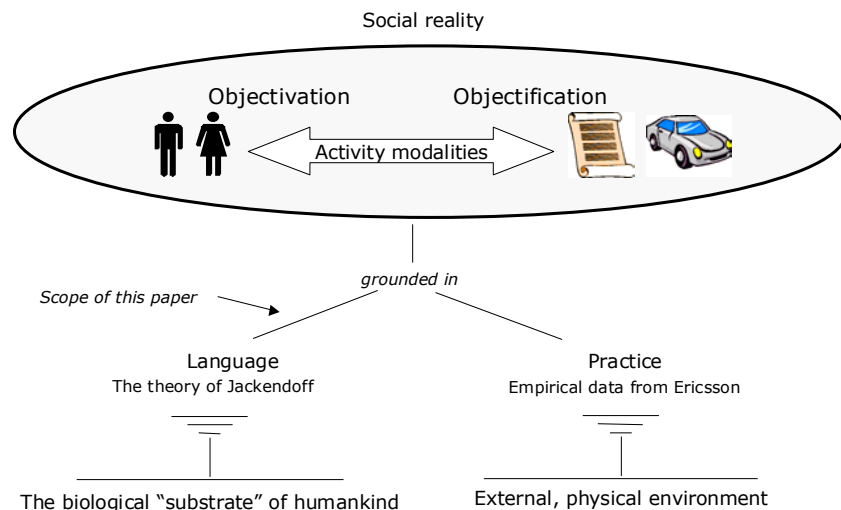


Figure 1: The context of the paper

The outline of the paper is as follows. In the next section, we sketch Jackendoff’s theory. Next, we provide a description of the activity modalities and their relations to the ontological categories. In the discussion section we consider the nature of the objectivation – objectification process and suggest that it can be seen as a structuration process as conceived by Giddens (1984). We also provide some additional arguments for the cognitive and neurophysiological grounding of activity modalities. Furthermore, we discuss implications for material versus communicative acts and IS development (ISD). The contribution of the paper should be seen as a step towards grounding the activity modalities as fundamental modes of coordinating human activity. The ultimate consequence of this venture is the articulation of a practice-based theory, which may inform the operational construction of communal meaning concerning coordination in concrete, practical settings.

2 The Constitution of Mind

In this section, we recapitulate the main features of the theory of meaning proposed by Jackendoff (1983). His knowledge interest is two-fold:

- What is the nature of meaning such that we can talk about what we perceive and what we do?
- What does the grammatical structure of natural language reveal about the nature of perception and cognition?

According to Jackendoff, these two questions cannot be separated. He suggests that there is a single level of mental representation where linguistic, sensory and motor information are compatible: the *conceptual structure* (ibid., p. 17). Unless there is such a level, it would be impossible to use language to report sensory input. We could not speak about what we see, hear, touch, smell, etc. Likewise, linguistic information must be compatible at some level with information conveyed to the motor system. For example, an utterance like “Please close that window!” presumes an interaction of visual, linguistic and motor information.

Jackendoff suggests that the conceptual structures attainable by human beings are characterized by a finite set of conceptual well-formedness rules that are universal and innate (ibid., p. 17). In order to explore the properties of these rules, two issues need to be addressed:

What is the nature of the information that language conveys, and what is the information about? The first is concerned with sense or intension – the second with reference or extension.

These questions are approached from a discussion about what we see when we perceive something. From ambiguous figures like the famous Wittgensteinian “duck-rabbit” in Figure 2, it is clear that the brain overlays such figures with an organization that is not present in any physical sense.



Figure 2: Duck-rabbit (Wittgenstein, 1953)

There is no reason why this mechanism should be confined only to the vision modality. Thus, the world as we perceive and experience it is “unavoidably influenced by the nature of the unconscious processes for organizing environmental input. One cannot perceive the ‘real world as it is’” (ibid., p. 26). It follows that it is necessary to distinguish between the source of the environmental input and the world as experienced. Jackendoff calls the former the *real world* and the latter the *projected world*. We have conscious access only to the projected world – the world as unconsciously organized by the mind. We can talk about things only insofar they have achieved mental representation through these processes of organization. Hence, “information conveyed by language must be about the projected world” (ibid., p. 29). The information in the conceptual structure is the single level of mental representation onto which and from which all peripheral information is mapped. In this perspective, meaning is apprehended as the connection of sensory inputs to entities in the projected world.

In order to analytically distinguish the real world from the projected one, Jackendoff introduces a meta-language. References to the projected world are surrounded by # #. Entities in the conceptual structure, which give rise to the projected world, are designated in CAPITALS. Real-world entities have no particular marking. However, in this paper we will surround real-world entities by * *. Moreover, the notion of different worlds may appear odd, since all phenomena discussed are parts of the same world. Therefore, in the following we will refer to the different worlds of Jackendoff as “realms”.

To illustrate this, consider again Figure 2. By interacting with other people in an English speaking society, two entities in the conceptual structure are formed in the mind: RABBIT and DUCK. The real-world electromagnetic radiation from the illustration may be labelled *duck-rabbit*. This physical input on the retina is processed by the nervous system and mapped to either RABBIT or DUCK in the conceptual structure. From this structure, either the entity #rabbit# or #duck# may be projected into awareness but not both simultaneously. Thus, the same real-world input may give rise to different experiences in the projected realm. If, for example, #duck# is projected, this entity may be transformed via correspondence rules to the linguistic and motor systems, resulting in the utterance “That is a duck!”, possibly accompanied with a pointing gesture.

Consequently, the sense of the linguistic expression consists of expressions of the conceptual structure. The reference of the expression takes place in the projected realm, not the real-world. This view has far-reaching consequences. The traditional view of truth and reference as

relations between statements and facts in the real-realm cannot be upheld, since the direct connection between language and this realm does not exist.

The single level of mental representation provided by the conceptual structure indicates that “semantic structures could be simply a subset of conceptual structures – just those conceptual structures that happen to be verbally expressible” (ibid., p. 19). Thus, the study of semantics and grammar of natural language should give evidence for the organization of the conceptual structure and the conceptual well-formedness rules. This is discussed in the following section.

2.1 Ontological categories

An obvious feature of the projected realm is that it includes #things# that have some kind of spatial and temporal integrity. These #things# are projected from a corresponding mental representation in the conceptual structure. Jackendoff calls a unitary piece of mental representation a *conceptual constituent* (ibid., p. 42). These are surrounded in the Jackendoff formalism with square brackets []. Thus, in order to account for the fact that humans perceive #things#, a corresponding conceptual constituent [THING] must have been established in the conceptual structure.

Utterances like “I have read that book” relate linguistic and visual information. Such utterances are examples of what has been coined *pragmatic anaphora* (ibid., p. 48). It turns out that there is a set of grammatically different classes of pragmatic anaphora, which can be identified by different types of grammatical phrases. The utterance above is clearly about [THING]s, and the part “that book” can be identified as a noun phrase (NP). However, an utterance like “Your book is there (pointing)” is about a [PLACE], which is recognized by a prepositional phrase (PP). [PLACE] and [THING] are clearly of separate kinds. Such different types of basic categories are called *ontological categories*. Through an elaborate linguistic discussion, Jackendoff identifies a set of such categories, which combine to perform meaning functions. The categories, which are of prime interest for our purposes, are as follows:

- [THING]
- [PLACE]
- [PATH]
- [EVENT]
- [STATE]
- [PROPERTY]
- [DIRECTION]
- [ACTION]

The semantic structure of a sentence is built from a hierarchical composition of the conceptual constituents, each belonging to an ontological category. These categories are realized by syntactically mapping them according to well-formedness rules to phrasal categories such as sentences (S), noun phrases (NP), verb phrases (VP), adjective phrases (AP), adverbial phrases (AdvP) and prepositional phrases (PP). For example, the sentence “John walked into the room” is mapped between syntactical and conceptual structures as follows:

- Syntactic: [_S [_{NP} John] [_{VP} walked [_{PP} into [_{NP} the room]]]].
- Conceptual: [_{Event} GO ([_{Thing} John], [_{Path} TO [_{Place} IN [_{Thing} the room]])]].

In this way, Jackendoff tries to establish a connection between the lexical categories and phrases used in different, ordinary languages and the conceptual structure common to all humans.

In later works, Jackendoff includes *thematic roles* as part of the conceptual structure (Jackendoff, 1990). A thematic role can be then seen as a relationship that ties a term with an event or a state, establishing a semantic relationship between a predicate (e.g. a verb) and an argument (e.g. the noun phrases) of a sentence. Examples of thematic roles are:

- [AGENT] (the instigator of an action)
- [ACTOR] (the willfull instigator of an action)
- [GOAL] (what the action is directed towards)

Jackendoff also discusses categorization as an essential aspect of cognition. Categorization refers to the ability to judge that a particular thing is or is not an instance of a specific category (Jackendoff, 1983, p. 77). The ability to categorize is indispensable for using previous experiences to guide the interpretation of new experiences. In order to discuss matters concerning categories and instances, Jackendoff refers to the thing being categorized as [TOKEN] and the category as a [TYPE]. The latter is the information that is created and stored when an organism learns a category.

In summary, cognition emerges from a level of mental representation where language and sensory modalities are compatible. This level, which is called the conceptual structure, contains major ontological categories such as [THING], [PLACE], [DIRECTION], [EVENT], etc. These categories characterize the distinctions among major classes of #entities# that we act as though the #world# contains. The total set of ontological categories “must be universal: it constitutes one basic dimension along which humans can organize their experience, and hence it cannot be learned” (Jackendoff, 1983, p. 56).

3 The Constitution of Activity

In order to relate ontological categories and activity modalities we depart from the Russian Theory of Activity (AT) (e.g. Bedny & Meistner, 1997; Engeström, 1999; Bedny et al., 2000). A fundamental principle in AT is the unity of mind and activity, where the concept of activity (*deyatel'nost'* in Russian) has quite a specific meaning. The activity is motivated by social needs. These are met by goal-oriented, coordinated actions directed towards an object in order to produce an outcome. Each action is realized by motor and mental acts, called operations. Thus, in AT activity, action and operations are distinct, albeit dialectically interrelated, concepts.

A famous example illustrating the difference between activity and actions is given by Leont'ev (1981) where he considers the role of the beater in the activity of hunting. The motive of the activity is to get food. However, the action of the beater actually drives the quarry away. This action is meaningful only from a social perspective. The object of the activity is the quarry and the goal-oriented actions of individual actors, whether beater or hunter, are coordinated in order to achieve the outcome – a brought-down quarry.

The principles of AT has been guiding the elaboration of the Activity Domain Theory (ADT) suggested by Taxén (2003; 2004; 2005). The purpose of this theory is to inform the coordination of actions within and between activities. The main construct in ADT is the *activity domain*, which can be conceived of as an activity where coordination is the motive. The object of the activity is made up from meaningful elements that enable coordination. For example, a particular element **rule** in the real-realm develops through interaction into an element RULE in the conceptual structure, from which #rule# is projected into awareness. Subsequent actions may modify the physical element **rule** in order to improve the goal-oriented coordination of actions.

Thus, manifesting a certain coordination element in an activity domain has two facets: one internally oriented towards the mind and one externally oriented towards the domain. These two facets are called *objectification* and *objectivation* respectively (Kosík, 1976). Objectification refers to the enactment of **entities** in the real-realm while objectivation refers to the enactment of associated ENTITIES in the conceptual structure, which are subsequently projected into #entities# in the projected realm. Moreover, enactment process is considered to be dialectical in nature:

“The external world is constructed inside, that is, in a phenomenal, symbolical field-space, however narrow, flat or limited it may be. The internal world is constructed outside. Of course, these two processes of world construction do not go separately. They are synergic [...]. Such synergy, as it were, provides for two oppositely directed processes: subjective becomes objective and objective becomes subjective.” (Zinchenko, 2001, p. 142)

In ADT, it is hypothesized that the objectification – objectivation proceeds along certain dimensions called *activity modalities*. These were derived from observations in the Ericsson development practice (Taxén, 2003). We posit that the modalities – spatialization, temporalization, stabilization, transition and contextualization – express fundamental modes of coordination developed during the phylogenetic evolution of the human race. In other words, we assume that humans have innate propensity to construct the coordination of actions along these modalities.

The systemic and dynamic relations between the modalities constitute the activity. By this, we mean that manifestations of all modalities are needed in order to coordinate human activity. For example, three major elements in product developing organizations are product structures, process models and business rules. These elements can be seen as manifestations of spatialization, temporalization and stabilization respectively. However, they are often treated as independent in the sense that separate organizational functions are responsible for their development and maintenance, something that may cause considerable problems in coordinating development tasks.

3.1 Relating Ontological Categories and Activity Modalities

First, it can be noted that basic concepts in AT have ontological category counterparts: “action” - [ACTION], “goal” - [GOAL], “actor” - [ACTOR]. The role of agents is represented by a binary function CAUSE that have the structure

$$[_{\text{Event}} \text{CAUSE} ([_{\text{Thing}} x], [_{\text{Event}} y])].$$

This means that the agent is not necessarily acting willfully as in the example “The wind blow the paper away”. The case of an intentional actor is seen as a special case of [AGENT].

Spatialization

The spatialization modality concerns the spatial construction of the domain. In order to carry out actions, the actors need to know what kind of #things# are relevant in the domain with respect to its motive. Spatialization manifests a communal meaning of these #things#, how they are characterized, how they are related to each other, and in what state or condition they are. In ISD, examples of spatial elements are object-oriented models, information models, and data models. Spatialization can be associated to the conceptual structure as follows:

- [THING]s are related to other [THING]s.
- [THING]s have [PROPERTIES].
- [THING]s have [STATE]s.
- [DIRECTION]s provide orientation.

Temporalization

The temporalization modality concerns the temporal constructions of the domain. Temporalization manifests a communal meaning of how actions should be coordinated. In ISD, examples of temporal elements are process models, interaction diagrams, and use cases. Temporalization can be associated to the conceptual structure as [EVENT]s which changes [STATE]s or [PROPERTIES] of [THING]s. It can be noted that spatialization and temporalization are interdependent, something that is often ignored in business and enterprise modelling efforts (cf. Parsons, 1996).

Stabilization

Stabilization manifests a communal meaning of elements such as, for example, norms, values, habits, routines, and rules. Together, these elements constitute an ideology, that is, a wide-ranging system of belief or thought. Stabilization enables a habitual performance of actions. Some elements of the ideology may be common to several domains, but in general, these vary between domains according to their motives. In ISD, examples of stabilizing elements are naming conventions, business rules, and standards. The ability to categorize is central to achieve stabilization. Stabilization affects [TYPE]s and [TOKEN]s in the conceptual structure and is constantly adjusted in interaction with the environment:

A processing model of cognition must include an active component that continually seeks to adjust and reorganize conceptual structure in an effort to maximize overall stability (Jackendoff, 1983, p. 149).

Contextualization

Contextualization concerns the construction of a context in which actions are meaningful. Contextualization implies at least two things: framing and context dependency of meaning. Framing is mainly determined by the motive of the activity, that is, what needs it fulfils. Only those things that are relevant for this purpose become meaningful in the context. This means

that different PROPERTIES can be associated with the same THING depending on the context (cf. Parsons, 1996).

Contextuality is inextricably related to the classification of THINGS into categories or TYPES. Our visual system simplifies a visual scene into foreground and background. Certain #things# are attended in the foreground while other *things* remain unattended in the background (Jackendoff, 1983, p. 42). Thus, a capability to contextualize appears to be innate. In ISD, examples of contextual elements are increments in incremental development methods, projects, teams, etc.

There seem to be no direct correspondence in the conceptual structure to contextualization. However, the notion of SEMANTIC FIELD is used to describe a set of lexemes that are related in some way. For example, a SEMANTIC FIELD concerning air travel would include reservation, flight, travel, buy, price, cost, fare, rates, meal, plane, etc. This can be apprehended as a list of relevant THINGS in an activity domain with the motive of providing air travel services.

Transition

Transition manifests a capability of actors in one domain to interact with actors in other domains. The outcome of one domain may be the prerequisite of other domains. Since stabilization brings about different domain ideologies, the outcome may be characterized differently. Transitional elements provide a mapping and translation between the ideologies. In ISD, examples of transitional elements are contracts between users and developers, interface specifications between modules, and translation between different languages in system descriptions and manuals.

It appears that there is no direct correspondence to transition in the conceptual structure. However, at a minimum the transition between domains implies a mapping between [TYPE] categories in different domains. For example, the category DOG in English is mapped to the category HUND in Deutsch.

4 Discussion

The inquiry of congruence between mind and society has proceeded from the assumption that the structure of language reveals something about deeper, innate abilities to make sense of the world through all sensory modalities. Jackendoff argues that there are elementary, ontological categories which all humans share in the conceptual structure. We claim that at least some of these categories are compatible with the activity modalities. Thus, we have tried to articulate general proposals of congruence as expressed, for example, by Mingers:

As living systems, we have a closed (autopoietic) organization but are interactively open to our environment. The nature and limitations of such interactions are determined primarily by our own physical structure (structure-determined) rather than by the environment. [It] is the structure that determines what can or cannot be a stimulus for the organism – organisms without eyes or the equivalent cannot be triggered by light. (Mingers, 2001, p. 119)

In order to discuss implications, we will make use of an example provided by Goldkuhl for analysing the alleged distinction between communicative versus material acts (Goldkuhl, 2001, p. 4): (1) A communicative act of a woman asking her husband to bring in some

firewood: “Would you please bring some firewood. I think it is cold in here”. (2) A communicative act of the husband accepting the request. (3) A material act of chopping wood performed by the husband. (4) A material act of the husband bringing the firewood to the wife. (5) A communicative act of the wife thanking the husband for bringing the firewood. (6) A material act of the wife making a fire in the fireplace.

This example can be described as follows. The entire situation is an activity, motivated by the need to get warm. This is evident from the statement “I think it is cold in here”. The object of the activity is the firewood, and the action is the whole sequence of acts leading to the intended goal – a lit fire. The husband needs to know where the firewood is located, he must place the firewood on the chopping block, and he must know where the fireplace is, and so on. These spatial relationships are manifestations of spatialization. Temporalization is manifested in the order in which the acts are carried out. Manifestation of stabilization are found in rules and norms for how to chop firewood such as spreading the legs in order not to get hurt by the axe, what size the logs should have, etc. Contextualization is manifested in the motive of the activity – to get warm. This determines the context in which the communicative and material acts are meaningful. Transition becomes significant if, for example, there is no firewood to begin with. In this case, another activity with the motive of producing firewood must be engaged. The actions in this activity include other material and communicative acts, which are most likely irrelevant for the husband. However, if the firewood producing activity refers to firewood as “kindling” or “logs”, there is a need to make sure that the husband and firewood producer means the same thing.

As been pointed out earlier, the distinction between activity and action is fundamental in Activity Theory. It is through the motive of the activity that actions become meaningful. To illustrate this we may modify the example slightly. Suppose that the communicative act (1) is changed to “Would you please bring some firewood?” and the material act (6) is removed. Then, the same action (sequence of acts) could have different possible goals such as warming the room (the original goal), storing some firewood for further use, making the husband to do some exercise because the woman think he is too fat, and so on. Moreover, the chopping of firewood requires a tool – an axe. However, the axe can be used in other activities with quite different motives such as killing somebody. Thus, the meaning of actions can be understood only in relation to the organising principle of the activity, the motive. As a consequence, the activity should be regarded as the main unit of analysis in socio-technical approaches. This is in line with other workpractice based approaches (e.g. Goldkuhl & Röstlinger, 2003; Alter, 2006).

4.1 The nature of the objectivation – objectification process

In order to clarify the nature of the objectivation – objectification process, we will draw on a discussion of structures by Sewell (1992). His point of departure is structure as defined by Giddens (1984):

Structure: Rules and resources, recursively implicated in the reproduction of social systems. Structures exist only as memory traces, the organic basis of human knowledgeability, and as instantiated in action.” (Giddens, 1984, p. 377)

Giddens use the term “virtual” to characterize structures, indicating that these are lodged in the human brain. Thus, both rules and resources are regarded as virtual, something that Sewell challenges. For example, an axe is certainly a resource in the action of producing firewood. It

seems hard to characterize such resources “virtual”, since material things have an actual existence exist outside the head.

At first glance, rules may appear to have only virtual existence since we learn rules of action in a particular culture. However, also rules have an actual existence as codified in texts, oral expressions and so on. Because of this ambiguity, Sewell suggests to use “schemas” rather than “rules” to denote that which make up structures. Through an elaborate discussion, Sewell concludes that schemas, and thus structures, have a virtual existence. What amounts to as resources is a “consequence of the schemas that inform their use.” (Sewell, 1992, p. 11). Human resources are the products of schemas (ibid., p. 11).

Resources in the sense discussed here, exist only as far as their use in a particular activity are informed by schemas in the brains of actors. For example, the axe is not a resource for chopping firewood to someone who has never used an axe. Likewise, the axe is not a resource in an activity where there is no need chop firewood. Moreover, the axe may appear as different kinds of resources in different activities. For examples, in an activity of fighting enemies, the axe may be a weapon resource. Consequently, an artefact becomes a tool only when it is recognized as a tool:

“A tool is any object perceived by an agent (or agents) as a tool within an unfolding situation, and used as a mediator between him/herself and the environment. More specifically, a tool is an object ascribed with a meaning of usefulness, in the sense that it can be used to achieve some purpose (whether the agent is aware of it or not).” (Susi, 2006, p. 175)

Orlikowski has demonstrated the validity of this analysis in several studies of the use of technology in organizations (Orlikowski, 1992: 2000). Technology is “socially constructed by actors through the different meanings they attach to it and the various features they emphasize and use.” (Orlikowski, 1992, p. 406). What users do with technology should be seen as *enactment* rather than appropriation:

Technology structures are thus not external or independent of human agency; they are not “out there,” embodied in technologies simply waiting to be appropriated. Rather they are virtual, emerging from people’s repeated and situated interaction with particular technologies.” (Orlikowski, 2000, p. 407)

Structuration conceived in this way goes well with the notions of objectivation and objectification. The objectivation – objectification process might be considered as a structuration process in which internally oriented objectivation elements (schemas) are manifested simultaneously with congruent manifestations of externally oriented objectified elements (resources). Thus, the internal and external are not two distinct realms; they should rather be apprehended as two facets of the same, underlying structuration process.

Concerning the commonality of meaning, Jackendoff asserts that meaning construction is taking place in the individual mind. Thus, meaning is inherently subjective in the sense that the conceptual structure is unique for each individual. How is it then possible to achieve a communal meaning? One answer is that the processes by which we construct the projected world are the same in each of us; they are part of our genetic inheritance as human beings (Jackendoff, 1983, p. 30).

Moreover, actions carried out by individuals impact physical elements in the *real-realm* that can be perceived and in turn become meaningful for other individuals. If the consequences of actions are meaningful in relation to the goals of the actions, then the construction of a communal meaning enabling coordination is possible. In other words, the goal of an action works like a beacon towards which individual acts are directed and aligned.

4.2 Activity modalities

On a superficial level, it is obvious that social realities are shaped in accordance with the measure of humankind and the physical prerequisites given. For example, we do not find entrances to houses that are 1 x 1 meter or forks that have a length of 2 meters other than in amusement parks. In the same manner, social realities are abundant with meaningful artefacts such as maps, calendars, rules, cultures, dictionaries, etc., that can be associated with spatialization, temporalization, stabilization, contextualization and transition.

In order to move closer to the biological constitution of humankind, we have grounded our arguments in the structure of language and its connections to the conceptual structure as suggested by Jackendoff. This argumentation is strengthened by other findings indicating that cognition is derived from some kind of mental structure where sensory modalities are integrated (Chen, 2003). For example, Freeman states that

“[It is] understandable that evolution has provided multimodal sensory convergence in order to perform space-time integration on the multi-sensory percept, a Gestalt, not on its components prior to their assembly.” (Freeman, 2004, p. 525)

Concerning spatialization, “there is consensus among cognitive scientists that intraconceptual relations within object concepts are in essence spatial.” (Chen, 2003, p. 965). As an example, Chen refers to the idea of image-schemas of Lakoff (1987). Such schemas – “paths,” “up-down,” “front-back,” “part-whole,” “centre-periphery” and the like – are considered to be “among the most fundamental carriers of meaning” (Gärdenfors, 2000, p. 162). Image-schemas are used to map metaphorically spatial structures of physical space into a conceptual space. Thus, conceptualization of an object concept involves a process of “spatialization” (Chen, 2003, p. 965).

Moreover, it appears that the brain is structured to distinguish between temporal and spatial information. Psychological experiments indicate that “there are different retrieval patterns between object and event concepts. The differences in the retrieval pattern, specifically, in the rate of production, reflect significant differences in the underlying mental organizations and cognitive processes.” (Chen, 2003, p. 966). This is also supported by neurophysiological findings:

“Indeed, there are a broad range of behavioural, neuropsychological, and electrophysiological findings that support a dissociation between object knowledge in temporal cortex and action knowledge in parieto-frontal cortex.” (Plaut, 2002, p. 631)

This means that there exist, in addition to the linguistic arguments, neurophysiological and cognitive indications that sensory modalities are integrated into spatialization and

temporalization as basic modes of action. Thus, at least some of the activity modalities are grounded in research closer to the “biological substrate” of the brain.

4.3 Material versus communicative acts

In his communicative action theory, Habermas (1984) makes a fundamental distinction between communicative versus material actions (Goldkuhl, 2001). A similar distinction can be found in the Vygotsky (1978) who argues that human action is mediated by signs (called psychological tools) and material tools. Material tools are externally oriented and lead to changes in objects, while psychological tools are means of internal activity and internally oriented.

It is clear that the consequences of material and communicative acts are different. “Giving a rudder command is not the same as turning the wheel.” (Bødker & Andersen, 2005, p. 366). However, the fundamental distinction between these types of acts has been challenged (e.g. Leiman, 1999; Goldkuhl, 2001; Bødker & Andersen, 2005). Goldkuhl, for example, discusses instrumentality in actions. He separates between means-instrumentality, in which the whole action is seen as an instrument to achieve a goal. As part of means-instrumentality, he considers tool-instrumentality, by which is meant the use of tools in material acts. Goldkuhl argues that also communicative acts can be seen as means- and tool-instrumental. Thus, both types of acts should be regarded as instrumental in relation to the goal of the action.

This stance is reinforced by the positions taken in this paper. Both material and communicative acts are related to the real-realm. In order to become meaningful, these acts must be associated with some physical stimuli. Communicative acts are material in the sense that the signifier / sign vehicle is physical. The spoken word depends on acoustic waves forms in the air; the written text depends on distinguishable patterns on some substrate, and so on. The same is of course valid for material acts. An axe must be recognised as such through visible and / or tactile stimuli. Thus, both material and communicative acts have a common basis in the sense that perceptions associated with the acts must be rendered meaningful by the individual actors. The implication of this stance is that mediators of actions, regardless of their material or semiotic nature, should be seen as complementary in relation to the activity. Mediators can be any artefact, for instance, instruments, signs, symbols, procedures, machines, methods, laws, forms of work organization (Kuutti, 1996, p. 26). This is in line with Lemke who states that:

“Semiotic formations [...] are essential elements in the material dynamics of human communities, and this material-semiotic coupling is reciprocal. There cannot be two systems here, changing according to separate laws, relatively independent of one another. There can be only one unitary ecosocial system, material and semiotic, with a single unified dynamics, described under two aspects, by two different sorts of culture-specific discourses.” (Lemke, 1993, p. 4).

4.4 Implications for IS development

In general, implications for ISD of this contribution underlines trends already present in the ISD discourse such as participatory design, evolutionary development, and communicative approaches towards ISD (Iivari & Lyytinen, 1998). However, some specific implications for ISD can be identified. The prime one is the view of communal meaning as a *constructible*

element. Engineering processes, methods and guidelines may be devised in order to enable the construction of communal meaning alongside with the development of the IS and systems. A successful example is the anatomy-based approach at Ericsson (Taxén & Lilliesköld, 2005); Taxén, 2006). In this approach, a simple illustration on one page – the anatomy – signifies the communal meaning of the most relevant functional dependencies in the system. The anatomy is used as an instrument for planning and controlling the development.

A more profound consequence of the focus on constructible communal meaning is that the notion of ISD needs to be reconstructed. The IS should be considered as a resource in the sense described above, that is, an element in the objectivation - objectification process. The target of the construction task is the *entire activity* in which the IS makes sense as a resource. Accordingly, IS development could be rephrased as *activity* development. This goes beyond approaches where the context of the IS is merely considered or taken into account in ISD (e.g. Dahlbom & Mathiassen, 1993).

Examples of such construction tasks are the activity domains constructed for coordinating development projects at Ericsson. These domain constructions were performed according to a particular strategy that passes through three phases: the mathetic, consolidation and pragmatic ones (Taxén, 2003; 2005b). The terms mathetic and pragmatic comes from Halliday (1975), who distinguishes between pragmatic and mathetic functions of language. Mathetic functions concerns the construction of communal meanings, while pragmatic functions involve coordination of actions when a communal meaning is established.

A further consequence for ISD is to focus the attention to the activity modalities and their interdependencies. If human cognition is fundamentally structured along the activity modalities, ISs should be designed accordingly. However, most established modelling techniques used for ISD do not support this. For example, dynamic association of attributes with objects depending on the context is not possible in the Unified Modelling Language (UML, Jacobson et al., 1992). An example of a modelling technique that takes contextualization into account has been suggested by Parsons (1996).

Usually, models used in ISD are regarded as representing “reality” (e.g. Milton & Kazmierczak, 2004). ISD is seen as a process where successive modelling transformations result in a closer and more “correct” correspondence between models and the “real” system. The position of Jackendoff refutes this understanding of models. Models are part of the real-realm like any other phenomena that can be perceived and experienced in the projected realm. We do not have direct access to the **real system**, only indirectly through the entity *#real system#* in the projected realm. The representation of the *#real system#* by the *#model#* takes place in the projected world. This is why we can conceive of the **real system** through a *#model#* before it exist in the real-realm.

The practical consequence of this position is that ISD should be apprehended as a succession of transformations between *#entities#* in the projected world that are constantly corrected by sensory impression from the **entities** in the real-realm. Models are no less “real” than the final, running system and should be regarded primarily as resources for actions to reach the intended goals.

4.5 Limitations

The concept of activity modalities is still being developed. In this contribution, we seek to ground these modalities in the theory of meaning suggested by Jackendoff. Further work is needed to explore this line of grounding more thoroughly. However, we have provided some provisional arguments for claiming that activity modalities are congruent with the biological constitution of humans.

The issues treated in this paper – meaning, action, activity, external versus internal, etc., – are never-ending topics in the scientific and philosophical discourse. Consequently, alleged implications should be treated with care. The theory of Jackendoff has been challenged (e.g. Bunn, 2000; Gärdenfors, 2000). The linguistic based derivation of the ontological categories is open for the same kind of critique as the universal grammar proposed by Chomsky (Chomsky, 1965).

Moreover, it can be argued that the proposed congruence between the mental and social realms is a correspondence theory, that is, a theory claiming that the truth or falsity of a statement is determined only by how accurately it describes (i.e., corresponds with) that world. A number of issues can certainly be raised with such theories. However, by grounding the analysis in the theory of Jackendoff, our point of departure is rather the opposite. The only way we can relate to our environments is by making sense of physical stimuli accessible within the limits given by our biological constitution. Ideas about the constitution of the world are always interpretations, and we simply do not have access to the “world as such” in an absolute sense.

Finally, there may be other theories that support or refute the idea of activity modalities. However, the empirical grounding of the modalities implies that coordination can be operationalized according to these modalities, regardless of the particular way the modalities are cognized by the mind. Thus, the relevance of considering the activity modalities in practice remains.

5 Conclusions

In this contribution, we have inquired into the cognitive grounding of activity modalities through the theory of meaning proposed by Jackendoff. In previous contributions, these modalities have been grounded in the development practice of Ericsson. The contribution of this paper should be seen as a step towards grounding activity modalities as fundamental modes of coordinating human activity. We argue that spatialization, temporalization, stabilization, contextualization and transition can be traced both to the individual mind and social reality. Thus, it is possible to reconcile the individual micro level and social macro level through the activity modalities. The ultimate consequence of this venture is the articulation of a practice-based theory, which may inform the operational construction of communal meaning concerning coordination in concrete, practical settings.

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