

Artefacts as Mediators of Distributed Social Cognition: A Case Study

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Abstract

Traditionally, cognition has been regarded as the outcome of internal cognitive processes manipulating mental representations. More recently, however, it has become clear that cognition cannot be separated from the social and material environment in which people live and act, and that in many cases cognition is distributed among individuals and environmental properties. One important aspect has turned out to be artefacts and their use, and there is growing interest in understanding how tool use affects cognition. However, even with this increased awareness of the role of artefacts, the focus has mainly been on the cognitive processes and representations of individuals, while the social role of artefacts has received less attention. An ethnographically inspired field study, observing a hospital's children admission unit, was conducted to investigate the way individual and collaborative work are affected by the use of artefacts within a given social context. The results indicate that the use of artefacts is closely coupled to the social environment, that to some degree social interactions are transformed into more indirect, individual processes, and that artefacts are crucial for high-level processes such as memory and coordination.

Introduction

Most work in cognitive science has for a long time been based on a general consensus that cognition is best described and analysed in terms of *internal*, often symbolic, representations and computational processes manipulating them. Thus, cognition has been considered to take place largely within the individual mind, with a focus on mental representations and processes, while the environment largely has been reduced to inputs and outputs (e.g., Pylyshyn, 1990). However, since the mid-1980s there has been a growing awareness that individuals are socially and culturally situated and that the environment needs to be considered in order to understand cognition (Clancey, 1997; Clark, 1997; Hendriks-Jansen, 1996; Hutchins, 1995; Suchman, 1987). Humans are, for instance, very proficient in using environmental properties as cognitive aids (Clark, 1997; Kirsh, 1995, 1996), and there is growing interest in finding out how artefacts/tools affect cognition (e.g., Preston, 1998). The terms artefact, tool, and tool use are not

particularly well defined, even though there are numerous definitions, resulting from differing focuses in different areas (see, e.g., Gibson & Ingold, 1993; Neuman & Bekerman, 2000; Preston, 1998). In this paper, artefact and tool are used, in accordance with much of the literature, more or less interchangeably.

Despite an increasing interest in cognition and artefacts (see, e.g., Norman, 1993), there is so far a limited understanding of the way artefacts affect the individual within a social context. The present paper aims to contribute to the understanding of the way people are affected by artefacts, and the role artefacts can have in a certain social context. A field study was conducted in a Swedish hospital, at the children's admission, where artefacts (as it turned out) constitute an important part of work tasks. The results indicate that artefacts play an important role in the social context, in a manner different from their role when considered in relation to an individual.

The next section elaborates in some more detail work on situated, distributed and social cognition that constitutes the background for the work of the present paper. Then methods, analysis, and results are described, followed by a discussion.

Situated, Distributed, and Social Cognition

Situated cognition has become an influential approach in many different areas, such as artificial intelligence (e.g., Brooks, 1999), cognitive anthropology (Hutchins, 1995), cognitive psychology (e.g., Barsalou, 1999), and developmental psychology (e.g., Thelen & Smith, 1994). Although there is not yet any universally accepted notion or definition of 'situatedness' (cf. Clancey, 1997; Wilson, 2003; Ziemke, 2002), generally speaking there is an agreement that cognition is a continuous process (e.g., perception-action-loops) with changing boundaries, and that cognition is more than what takes place within the individual mind (e.g., Clark & Chalmers, 1998; Clark, 1999; Susi et al., 2003). The context in which human activities take place is equally important. Hence, there is a growing interest in understanding the role of scaffolds or 'wideware', i.e., external structures such as artefacts, in cognition (e.g., Clark, A., 1997, 1999, 2003; Hutchins, 1995). In itself an

artefact may not be much, but coupled with human cognitive abilities artefacts can become powerful tools, and it has been argued that they extend cognitive abilities such that 'thinking' cannot be reduced to internal cognitive processing (Chalmers & Clark, 1998). Hence, the use of scaffolds or (cognitive) artefacts amplifies cognition. However, it has been pointed out that artefacts actually do not amplify cognition as such (Cole & Griffin, 1980; Hutchins, 1995). Even though a tool may appear to amplify cognition, it is really a coordination of different cognitive processes, which can be aided by using appropriate tools, but no cognitive ability, or process, has been amplified. Other considerations on the topic of artefacts and cognition concern, for instance, that tool use extends the body and a person's body schema (Bateson, 1972; Berti & Frassinettis, 2000; Maravita et al. 2001; Maravita & Iriki, 2004). We are also spatial beings, and, subsequently, all actions are taken in relation to the environment (Kirsh, 1995). People continuously organise and reorganise, for instance, their work environments to reduce the cognitive effort needed.

For a long time tool use and technology were degraded to 'by-products' of cognitive evolution (Saito, 1996), but with increased knowledge it has become clear that artefacts and their use have a considerable effect on cognitive processes. This issue received much attention already by Vygotsky and his followers (see, e.g., Gal'perin, 1969; Haenen, 1996; Vygotsky, 1978, 1981). However, in order to understand this relation further research is needed concerning questions such as what makes an object become a tool, and the development of tool use behaviour (Preston, 1998).

The fact that artefacts, for a long time, have received relatively little attention in cognitive science is somewhat surprising. Nowadays they are commonly described as the "the other major form of cognitive mediation between individual and world" (Preston, 1998, p. 514), besides language, but obviously language has always played a much more central role in cognitive science. Artefacts also played a crucial role, as controlling behaviour from the outside, in the cultural-historical school in psychology, in particular the work of Vygotsky (1978, 1981), but with the advent of cognitive science attention, for the abovementioned reasons, for a long time shifted towards internal, individual processes and representations.

Recent work on *distributed cognition* (Hutchins, 1995) has in some sense rediscovered the integral role that artefacts play in both individual and collaborative cognitive processes that are distributed over people and the material resources they use. This view takes an interest in the way information is represented, transformed, and propagated in the material and social environment. That way, cognitive processes can be described in terms of functional relationships between brains, other people, and external objects. The role of artefacts as mediators of social cognition, however, is far from being fully understood. The present paper considers cognition from a situated and distributed perspective, i.e., it views high-level cognition as resulting from a close interplay between brain, body, and

the social and material environment in which humans live and act.

Like most of cognitive science, research in *social cognition* has traditionally focused on individual cognitive processes involving social information, such as attention, perception, and memory, and the internal representations they generate or manipulate (e.g., Augoustinos & Walker, 1995; Fiske & Taylor, 1984; Gilbert, Fiske & Lindzey, 1998). Hence, few studies have taken a situated perspective (Semin & Smith, 2002). However, people are also *socially* situated, which means, one the hand, social interaction between individuals, and, on the other hand, that cognition is situated within a wider social and cultural context (Lave, 1988; Wertsch, 1993; Semin & Smith, 2002). Hence, besides interactional aspects, cognition is also affected by (cultural) artefacts (Levine & Resnick, 1993). Due to the fact that they constitute part of a culture's intellectual history, their use actually turns even seemingly individual activities into a social process as artefacts are affected by social aspects (Resnick, 1993). As pointed out by Hutchins (1995, p. xiv), "human cognition is not just influenced by culture and society, but ... is in a very fundamental sense a cultural and social process".

Case study

Most research on cognition and artefacts has to a large extent focused on the individual (e.g., Norman, 1991, 1993) while contextual and environmental aspects largely have been disregarded, with some notable exceptions (e.g. Hutchins, 1995). Subsequently there is a limited understanding as to how artefacts affect the individual within a social context. Further research is needed that considers both social interactions and tool use to gain further understanding of the relation between artefacts, individual, and social cognition. Accordingly, the underlying question for the present study was '*how does tool use affect individual cognitive processes within a social context?*'? The term 'artefacts' in this case refers to objects that are significant for everyday work tasks, while 'cognitive processes' here refer to high-level processes such as attention, memory, and coordination.

Method and Setting

In order to investigate the above questions, a field study was conducted at the children's admission in a Swedish hospital. Such work places are indeed highly *social* work places: well functioning daily work requires well-organised cooperation between the members of the staff, as well as between different wards. The work tasks at the children's admission are individual in the sense that most work is carried out individually. For example, parents and children arriving at the admission would usually first meet an administrator who registers their arrival, then a nurse who, for example, might draw a blood sample, and eventually a doctor. At the same time though, all these individual activities are, of course, socially situated and have a strong coupling to the social and environmental context.

In the children's admission, we chose (a part of) the central office (which functions as a communication, coordination, and administrative centre), as the setting for the study. The office has three units: a reception, an administrative unit, and a unit where all incoming phone calls are handled. The study was limited to the *administrative unit* (see Figure 1), since it is a central place for much of the daily activities, and nurses frequently visit this unit. There are always three to four nurses working at the same time, and the study focused mainly on their work. However, other people also visit the administrative unit during the day, e.g., doctors who come by to collect patient records. The main part of the nurses' work consists of taking care of patients that have an appointment, as well as urgent cases that appear during the day. They also handle administrative tasks, phone counselling, and patient-related tasks, e.g. drawing blood samples. Each member of the staff is responsible for certain tasks, but must also be aware of the others' tasks and responsibilities in order to coordinate their work. On an overall level, the daily routine consists of registering patients on their arrival, and getting each patient's medical record from the archive. Patients that are expected during the day are listed on a patient list. A nurse carries out an initial examination (weight, etc.), and if the patient has a doctor's appointment, he or she is shown into a consultation room. In cases where some kind of a sample needs to be drawn or collected, the doctor notifies a nurse.

The study was inspired by *cognitive ethnography* (Hollan et al. (2000), with observations (moderate participation; DeWalt & DeWalt, 2002), video recordings, and interviews. The combination of such techniques provides a means for gaining insight into the interactions between people and their use of artefacts, and subsequently cognitive processes. The staff was informed that the office was the subject of a study, and the time when it was to take place. Initial interviews were conducted to gain information about the staff, their work tasks, and the setup of the office. Observations were made during two days, and when necessary, questions were asked during the observation. During the observations the office was also videotaped. When all material had been analysed, another interview took place to verify that, e.g., work tasks had been correctly understood.

Analysis and Results

The videotaped material (three hours in total) and notes taken during the observations were analysed from the perspective of the staff's work tasks and activities, and the function of artefacts used in relation to the identified activities.

A highly social work setting, such as the observed children's admission, requires well functioning cooperation, interaction, communication, shared knowledge about routines, others' tasks, etc. In this particular setting the staff uses various artefacts with varying functions, which requires an additional interpersonal understanding of their different functions. In the present study a number of artefacts turned out to be crucial with respect to processes such as

coordination of the ongoing work. However, due to space limitations, only a few artefacts are discussed here in some detail.

Most activities in the administrative unit take place around a small table, on which various items are kept and placed (cf. Figure 1). The structure of the office unit also provides structure to the work tasks since the artefacts draw attention to what is going on and what needs to be done.

Patient's record One of the most important artefacts in this particular setting is the patient's medical record. Basically, it is a folder containing a collection of documents with information about a patient. All the documents are sorted in a specific manner in order to reduce the effort of finding the right information (a document out of its proper placement causes disturbances in the work-flow), and when a patient visits the children's admission new information is added. The patient record has several functions, besides the obvious one of storing information about patients. Clearly, no single person could keep all the information in the head, and there is no need to either, as the patient record provides an external memory (on some rare occasion a patient's medical record has been displaced, which caused serious problems). As different people handle the patient record, more information is added to it, and its contents (the representations) become transformed. Commonly, patients do not meet the same nurses and/or doctors each time they come to the children's admission, but information concerning the patient is transferred between staff members through the patient record, which functions as a 'communicator' between different people. That way the contents of a patient's record transform intrapersonal knowledge to interpersonal knowledge shared by several people. The patient records also contribute to an overall coordination of work processes since, depending on where a patient record is placed, it causes different people to take different actions. Placed in the reception's tray, it triggers a nurse to take the patient record into the administrative unit, while placed in a tray labelled with a doctor's name it informs the doctor that a patient is waiting, etc.

The patient list Another highly crucial artefact is the *patient list* placed on the wall above the small table (cf. Figure 1) (another list is in the reception, but that was not included in the study). The list actually consists of nine smaller lists (together referred to as the patient list), each corresponding to a consultation room (each doctor uses the same consultation room throughout the day). Thus the list tells, not only who is coming when, but also in which room the patient will be received and by whom. The list also contains information about each patient and the measures to be taken. The list is computer-generated, and during the day the nurses make additional markings by hand. The markings consist of symbols that are typically understood only by the staff. For instance, a certain symbol next to a name on the list means that the patient is waiting in the consultation room (which the list concerns), another symbol means that a doctor has been delayed, and yet another one means that the patient has left the admission. All markings are made in red

so that they are highly visible and easy to perceive. During the observation it became clear that the nurses had no difficulties in understanding the added markings, and hence

placed on a shelf under the small table (cf. Figure 1). Trays belonging to doctors who are not on duty are placed somewhere else (top shelf to the left of the small table, cf.

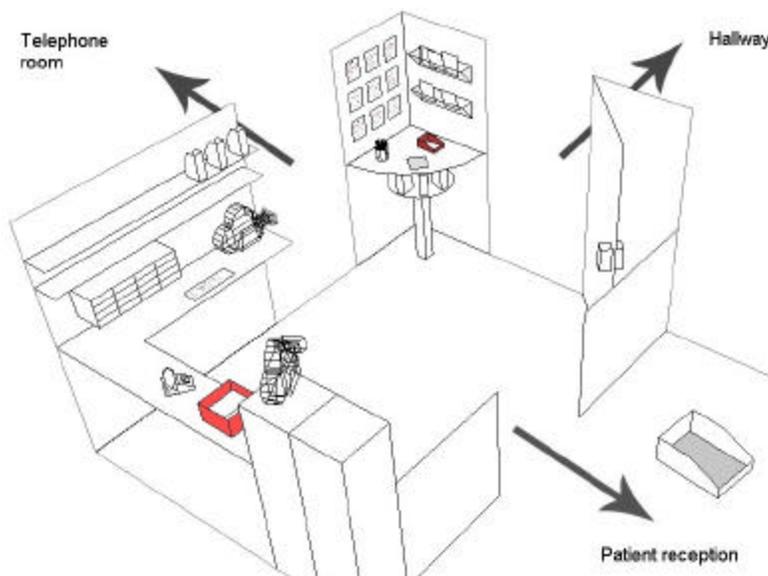


Figure 1. The observed administrative unit. In the upper corner is the small table with a tray (follow-up instructions), and with labelled trays on the shelf below. On the left wall above the table is the patient list(s). On the bench to the lower left is the (orange) tray for filled in sample documents. The cameras indicate the two placements of the (one) camera during the observation.

the list provides a means for communication and coordination between people, even when they do not interact directly.

Another function of the list is that it provides a (shared) external memory, providing everyone with the same necessary information. No one needs to memorise the information, as it is 'there' all the time, visible to those who need it, as they need it. As symbols are added to the list, the information becomes transformed and it is propagated from one individual to another when needed. The list also provides an overview and a visualisation of the consultation rooms, and each doctor only needs to pay attention to that part of the list that is related to their room, which in turn delimits the amount of information that needs to be attended to.

Paper trays There are a number of trays¹ in the office, each with its own function(s) and assigned meaning. As patients are registered on their arrival, their medical records are withdrawn and placed in a paper tray in the reception. A patient's record in the tray is a signal to the nurses that a patient has arrived. The patient records are brought by the nurses to the administrative unit, and, eventually, they are placed in trays labelled with the name of the doctor that the patient is going to see. Usually there are four to five doctors working at the same time, and their (labelled) trays are

placed on a shelf under the small table (cf. Figure 1). During the day each doctor collects the patient records that are placed in their tray. When a sample needs to be drawn or collected, the doctor notifies it by leaving follow-up instructions in a blue tray (to the right on the small table in Figure 1). When a nurse has performed the procedure, a filled-in document concerning the sample is placed in an orange tray (on the bench to the lower left in Figure 1). Thus, the spatial arrangement of the trays (and other artefacts) contributes greatly to structuring the ongoing work.

Besides containing documents, the trays have several other functions. For instance, rather than having to keep each ongoing process of the work place in memory, the trays, and their contents, provide information about what is going on and matters that need to be taken care of, thereby providing an external memory. The trays also serve as a means of indirect communication between individuals. The nurses, for instance, do not have to tell a doctor, in person, that a patient is waiting. Instead that information is mediated through the contents of the labelled tray. That way each person can attend his or her own individual work tasks, while at the same time, on an overall level, the indirect communication contributes to a well-functioning operation. The trays also limit the amount of information that needs to be considered. A doctor, for instance, only needs to pay attention to *one* labelled tray (or *one* part of the patient list).

Other artefacts There are also a number of other artefacts, equally important but taken for granted to the extent that they become 'invisible' (Gauvain, 2001). One such artefact

¹ The items containing documents that are discussed in this paragraph are not all paper trays in the real sense of the word, but are here, for simplicity sake, collected under the label of 'trays'.

that should be mentioned here is the small table (Figure 1), which plays a crucial role in the organisation of the daily work. Such a common artefact might seem trivial to discuss, but in this case it is an important part of the spatial arrangement that contributes to the overall structure of work tasks (cf. Kirsh, 1995). People know that it is the place where things that are used or needed often, are kept, and that it is a place for important information. Thus it provides, e.g., an external memory, and people often take a glance at the table before leaving the room, to see if they left anything there as they entered the room (as is often done), or if there is something they need to take care of. The table is also used as a message board, where people leave notes for others.

Discussion

The question guiding our study was “how does tool use affect individual cognitive processes within a social context?”. One perspective of interest in the present analysis is the ecological perspective (Gibson, 1986), since an artefact’s function is closely related to its appearance (affordance). However, due to space limitations that discussion has been left out in this paper.

Obviously, a two-day study has its limitations, and can only provide a rough understanding of the complexities of a work setting, artefacts, the relations between individuals and social contexts, etc. Nevertheless, despite possible shortcomings, this study is an important step in what we consider an important research direction. Even limited studies can provide valuable insights, and this particular study illustrates some aspects of the relation between artefacts, individuals, and social context.

On a general level, the study shows the importance of the artefacts used in this particular setting, and the way they contribute to a well-functioning operation where much of the activities are coordinated in an implicit manner. It can also be argued that just how powerful artefacts are becomes evident only when considered within the social context in which they are used. Some artefacts, such as a patient list, only make sense to and are understood by those who use them (cf. Levine & Moreland, 1993). As it turned out, it is not only the way an artefact is used that is important for cognition, but also *where* it is used (cf. Kirsh, 1995). The environmental structure and spatial arrangements partly determine the function and the meaning of an artefact. For instance, the labelled trays have different meanings depending on where (on which shelf) they are placed, and patient records trigger different activities depending on where they are placed (cf. also Clark, H., 2003). Artefacts also provide a scaffold for different cognitive processes depending on *who* the user is, i.e., the user’s role in the overall social arrangement. Artefacts play an important role as organisers: the state of an artefact (e.g., a tray that is empty, or not) helps the individuals to organise their work, and on the social level they contribute to coordination, cooperation and structure. Some artefacts make information available and visible, and contribute to the propagation of information between people and artefacts.

As discussed by Hollan et al. (2000), the activities of a group cannot be fully understood from the individual’s

perspective, rather the functional relationships of people and artefacts need to be considered. Thus, individual actions cannot be explained without considering what others are doing, the interpersonal codes, knowledge, and shared understanding of the functions of all the artefacts they use (e.g., Leont’ev, 1978; Thompson & Fine, 1999). Another important aspect is the way artefacts transform individual processes into social processes, and vice versa. For instance, when a nurse adds a marking to the patient list the information becomes part of a social activity and individual knowledge becomes shared knowledge (in a sense propagated ‘on demand’ only). Likewise, social or shared activities may become individual activities, e.g., when the nurse attends to information added by others.

To summarise, the artefacts analysed in this study function as mediators of distributed social cognition, i.e., they constitute or facilitate shared memory, coordination, communication, and sharing of information. Many artefacts have the same, or similar, functions, which however vary depending on *who* is using them, *where* (spatially) they are used, their functional coupling to other artefacts, and the social context. As illustrated in this paper, artefacts in many cases transform social interactions into individual processes, but at the same time they also mediate the indirect interaction of these processes, and thus maintain their social nature (cf. Susi & Ziemke, 2001).

This study has illustrated that, in order to understand artefacts and their role in individual and social cognitive processes, we need to consider artefacts, individuals, the social context, and their functional interrelations. Much of the work addressing these issues, including this paper, has been presented in the form of examples, anecdotal evidence, case studies, etc. Future work will have to further address the development of a more systematic, principled understanding of the role that artefacts play in distributed social cognitive processes.

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