

Primary Metaphors Describe Standard Meanings of Topological Arrangements

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ABSTRACT

Primary metaphors are basic mental representations that arise from repeatedly experiencing the co-occurrence of physical properties and abstract judgements. At the example of ethnographic studies several spatial/topological primary metaphors are reviewed and their usefulness for designing ubicomp systems is discussed along with some caveats that concern the application of these metaphors to predict human behaviour.

Author Keywords

Image schemas, primary metaphors, meaning of space

PRIMARY METAPHORS

Primary metaphors provide a notation to describe standard meanings of standard topological arrangements of objects. Examples include MORE IS UP – LESS IS DOWN, IMPORTANT IS CENTRAL, and CONSIDERED IS NEAR.

The term ‘primary metaphor’ was coined by Joseph Grady [1]. According to Grady, primary metaphors arise from frequently repeated co-occurrences of concrete sensorimotor experiences and more abstract subjective experiences or judgements. For example, in many contexts, the abstract concept of quantity is connected to physical vertical extension. The vertical level of a liquid in a container correlates with the quantity of the liquid; the amount of paper in a pile correlates with the vertical extension of the pile, and so on. These repeatedly occurring connections between the physical domain and the abstract domain are automatically learned during the first years of life. Through repetition over a variety of contexts, these connections eventually become generalised and are also used in thinking beyond concrete physical situations. As a result, for example, verticality has become connected with quantities of all sorts– including non-physical quantities, as indicated by expressions like *The inflation is rising* or *The gross domestic product is at an all time low*. Thus, the metaphor MORE IS UP – LESS IS DOWN has formed in mind.

Other correlations in experience form other primary metaphors. For instance, when carrying heavy objects, the sensory judgment of an object’s mass is correlated with affective states associated with exertion. With repeated

experience, the domains of exertion/difficulty and heaviness become mentally connected forming the primary metaphor DIFFICULT IS HEAVY. The metaphor is instantiated in language, for example, when moaning about *the burden of work we have to do*. Similarly, intimacy co-occurs with physical closeness forming the metaphor INTIMACY IS CLOSENESS instantiated in expressions like *I am very close to George* that are also valid when George is currently not physically close.

The experience of space and topological arrangements is a subgroup of these physical sensorimotor experiences that are involved in primary metaphors (others may be the force dynamics of moving objects or object attributes like texture or brightness). Many primary metaphors involve space image schemas, i.e. mental representations of standard topological arrangements of objects (irrespective of the shape, colour or size of these objects). Among these are CENTER-PERIPHERY, CONTACT, FRONT-BACK, LEFT-RIGHT, NEAR-FAR, PATH, and UP-DOWN. Containment schemas form another relevant group, including IN-OUT, CONTAINER and SURFACE [3, 4].

Image schemas and primary metaphors are assumed to be processed subconsciously by the human mind. They get instantiated in behaviour, imagination, language and, of course, user interfaces. The primary metaphor MORE IS UP – LESS IS DOWN, apart from being instantiated in language, can also be instantiated visually in charts, e.g. showing the development of share prices of a company. In user interfaces, instances of MORE IS UP – LESS IS DOWN can be found in a vertical slider controlling the volume of speakers, a single-lever water tap or a spin box. Previous studies have shown that people use primary metaphors when selecting gestures or tangible objects for representing abstract concepts [5, 6, 12] and that user interfaces instantiating primary metaphors are more usable than those that violate primary metaphors [3]. Due to their groundedness in basic experiences, primary metaphors are also assumed to be universal across cultures. Indeed, primary metaphors seem to be consistently used in many (unrelated) languages with only few variation in detail [10, 11, 13].

Primary metaphors may act as a formal notation able to describe the possible meaning of spatial arrangements. Ubicomp systems could use this knowledge to make sense of and predict human behaviour as well as to select the right

reaction, e.g. to present the right information at the right time at the right place to the user.

EXAMPLE METAPHORS FROM EMPIRICAL WORK

In the following we report on several uses of space that confirm a number of topological primary metaphors. The examples are taken from ethnographic studies of (1) the work practices of nurses in an intensive care unit (ICU), (2) older people preparing for and taking their medication at home, (3) student work groups preparing for exams and exercises, and (4) families and flatmates using refrigerators. While the latter two studies were conducted with a specific focus on meaningful spatial activities, the former two studies originally had a different focus but also revealed interesting examples of spatial uses of primary metaphor.

IMPORTANT IS CENTRAL

The metaphor **IMPORTANT IS CENTRAL** highlights that items that are important for a task are likely to be in the focus of our attention, our field of vision or reaching space. The metaphor is also instantiated in expressions like *What is central here?* or *Some issues tend to get pushed aside and forgotten*.

When observing student work groups, for example, four to five people might sit around a relatively small table that provides not enough space to hold all objects needed. Then objects would spread out to other surfaces, e.g. nearby tables or the floor area near where people sit. It turned out that items on these peripheral surfaces were less frequently used than the items in the centre (focus of attention), indicating their lesser importance to the task at hand.

Sometimes items that have a default location in the periphery are only moved to the centre of attention when needed, e.g. pills are normally kept outside of sight in cupboards and will only be moved to the kitchen top when needed; books are kept in the periphery of the working space, but will be retrieved to the centre of attention when their content needs to be consulted.

Perishable items in the fridge are more important to monitor and frequently used items tend to be more important in cooking. Both types of items are often put in more central (and more accessible) parts of the fridge than durable and less often needed items, which move into the periphery, i.e. the back of shelves or the door compartments. If, for some reason, items accidentally move into more peripheral regions, they will get disregarded and are in danger of going to waste.

By monitoring the location of things, a ubicomp system might infer which items are important in a particular activity. It may notify users when important items are in danger moving outside the focus of attention. When users are in need of important information, the system could proactively project the information to the centre of attention and, once not needed any more, could move the information out of the attention space.

CONSIDERED IS NEAR

As being **NEAR** often means 'being within reach', **NEAR** objects can be seized, grasped, inspected, and manipulated. The correlation of physical distance with mental access of physical objects gets metaphorically extended to abstract domains, for example in *My companion put it to me that an initiative must now be taken. For the Kaszubes and Poles of Danzig, Poland was a distant idea only*.

In the work group studies we saw that objects that are not task-relevant (any more) tend to be placed further away from the person (independent of their focus of attention) and people are more likely to interact with nearby things, e.g. when a notebook computer is closer to a person than when further away. In multi-user settings, there is another entailment of this metaphor: items may also be considered more, because they belong to that person. In the work groups the belongings of a person will be grouped **NEAR** them, and the person is also more likely to work with these. Personal items, however, can also be brought **NEAR** someone else's space to get considered by the other person.

Some **NEAR-FAR** situations are ambiguous to interpret in their details. For example, if someone leans back in his chair he becomes removed from an on-going activity. The spontaneous detachment, however, could serve different purposes, making it for a ubicomp system difficult to predict any consequences. The person could move away to stop considering the on-going task altogether or to only temporarily detach from the details of the task to think something over on a more global or abstract level. Indeed, construal level theory predicts that increasing physical distance tends to entail more abstract reasoning [14].

In the medication studies we have seen that patients place their pills near to a plate or a glass of water that is also used during a meal to make sure they are reminded at the right moment to take these pills.

SIMILAR IS NEAR

Similar things in the natural and built environment tend to occur close together in space: be it the same type of trees, rocks, insects, linguistic dialects, or buildings within quarters of a city. People with similar interests and values tend to meet in the same spaces. Artefacts like tools in toolboxes and crockery in cupboards are ordered in a way that reflects the similarities and differences between them. The correlation of similarity and proximity is so ubiquitous that physical closeness stands in for similarity and distance for difference. This is also expressed in language, for example *A and B are close, but they are by no means identical. There's a long way between Paul Newman and Woody Allen*.

In our studies we have seen that books are close to other books, pens close to other pens, medication close to other medication and stored close to other private things (in contrast to more public items), etc. Dissimilar objects tended to be separated. The drugs and the medicine of older

couples are often stored separately. The husband's medicine is stored in a different place than the wife's medicine to minimise the danger of taking the wrong medication (pointing out an interesting connection to the CONSIDERED IS NEAR metaphor). Most often, the separation is made even stronger by additionally keeping the medication in different CONTAINERS (e.g. cupboards, drawers, even different rooms).

RECENT/CURRENT IS UP and IMPORTANT IS UP

Kirsh in his analysis of the use of space in offices [8] already pointed out, that piles of paper act as last-in-first-out (LIFO) storage keeping the most recent and current items on top of the pile. This could also be seen when analysing student work groups. On piles as on any surface the items that were on the top are the most recent. Similarly, they also were the first things to be removed. As the most frequently moved documents also tend to be most needed documents in a specific activity, the upper items in a pile are also often the most important ones.

Sometimes there is no time for a pile to grow, but piles are instantly created, e.g. when moving a stack of books from a rucksack to a table. In this case, the LIFO and IMPORTANT IS UP principles do not hold immediately, as the most important items may be hidden within the pile. But important items then are drawn out of the pile and over time, the pile naturally evolves into a LIFO storage.

As a prioritisation of items sometimes does not come naturally, people also actively invoke the IMPORTANT IS UP mapping. In the refrigerator study, for example, some people deliberately put items that neared their end date on the top shelf of the fridge to prioritize their usage.

BEING ACTIVE IS BEING OPEN / OUT OF THE CONTAINER

Normally, the content of a CONTAINER is visible, accessible, and therefore usable only when the CONTAINER is open. In the refrigerator study, items that were in a crisper, drawers or other closed containers provided by the fridge were less often used than items that were stored on the open shelves in the fridge.

In analysing student work groups we found that an open pencil case reliably signals on-going work activity (as the pens are still being potentially used), while a closed pencil case signals that the owner has finished her activity and is about to leave.

People taking their medication often prepare the drugs for a whole day or week by taking them OUT of their packaging and sorting these into more accessible CONTAINERS like tablet dispensers. They also prepare their next instance of tablet taking by taking the tablets OUT of the dispenser and placing these in a visible location to remember taking the drug.

UNRESOLVED IS UP – FINISHED IS DOWN

In language there are expressions that instantiate the metaphor UNRESOLVED IS UP – FINISHED IS DOWN: *I'd like to raise some questions. Let's bring it up for discussion. The matter is settled.* An example from the ICU study illustrates the deliberate use of this metaphor. In the ICU, drugs are stored in a cupboard in baskets that each carry a label on a metal plate with the name of the drug and a barcode on it. On each basket there is a second metal plate that is removable. On the inside doors of the cupboard two horizontal rails are mounted – one above the other. When the nurses order new drugs, they remove one label from the basket and hang it on to the upper rail. The drug delivery service then scans the barcodes of all the labels on the upper rail and the order is formally placed in the hospital management software. When the drugs are delivered, the courier removes the label from the upper rail and puts it on to the lower rail, thereby visibly setting the status of the order to “finished”. The nurses then, after checking the delivery, remove the label from the rail. Note that the physical representation of the order status is actually not necessary, because the status can also be accessed in the hospital management software.

DISCUSSION AND CAVEATS

The empirical analysis of the four domains has shown that primary metaphors could be a useful tool to describe standard meanings of standard topological relations between objects as well as between objects and users.

Many of these primary metaphors, are instantiated unintentionally, partly guided by the constraints of the human body or the physical environment. The strong hypothesis of primary metaphor is that people always and subconsciously take into account and act on the meaning of topological relations within the context of their activities. Thus, ubicomp systems able to analyse the topological relations between objects (and people) can infer via primary metaphor what these mean to people. Based on this enhanced contextual knowledge, these systems could draw better and more meaningful inferences, have richer representation of human users, and could subsequently deliver better and more useful responses. They could, for example, influence behaviour by pointing out items that are in the wrong place, by presenting additional information in a meaningful topological relation to other information or even by repositioning items in the working space of users. A danger of such systems is that they are used to the detriment of the user by making personal information public, by building rich user profiles under disguise, or by grabbing users' attention unsolicitedly to deliver advertising (see [2] for a more thorough discussion of ‘dark patterns’).

However, instances of primary metaphors may also be deliberately created by people, as the last ICU example shows. If a computer senses such status visualisations, these could be used as a welcome means of unobtrusive input to context-aware ubicomp systems.

Note that there are higher-order uses of space that can make use of primary metaphors. Kirsh [8], for example, discusses the notion of ‘entry points’ to office work that help people to start or resume their work, e.g. after an interruption. On a lower level, entry points share many features of primary metaphors and can make their descriptions more concrete, e.g. UNRESOLVED IS UP, BEING ACTIVE IS OPEN or CONSIDERED IS NEAR.

However, not every use of space needs to be motivated by primary metaphors. Apart from ostensibly random arrangements, other exceptions are possible:

Kirsh’s investigations into the meaning of space show that how we use space may be dependent on task and context and not be universal. An analysis of the minutiae of playing Tetris, for example, shows that experienced players develop strategies of using space that are highly adapted to the specific rules and constraints of the game [9]. Indeed, the domain-specific meaning of space can be also be pre-built into the environment [7], cf. the standard layout of car interface elements or of kitchen furniture. People would expect to find the accelerator pedal on the right and knives, forks and spoons in a drawer beneath the kitchen working surface. Although primary metaphors may be involved, there are many domain-specific conventions about spatial arrangements and their meaning that need to be differentiated by a system.

Spatial arrangements could also emerge for purely physical reasons. For example, moving objects to make space to add other objects changes the existing spatial arrangements. If someone joins a workgroup, this often initiates a reorganisation of many objects on the table. Similarly, if some unusually large item enters the fridge, this initiates a reorganisation of the content of the fridge. But as these events are breaking the usual ‘routines’ (e.g. stocking the fridge with drinks for a party), larger spatial reorganisations indicate unusual events that a ubicomp system should not interpret in terms of primary metaphors.

Thus, as not every topological instance can be meaningfully interpreted in terms of a primary metaphor, ubicomp systems need to allow for different interpretations of space. It will be a task for future research to determine the amount of spatial arrangements that can be described by universal primary metaphors at all and how reliable primary-metaphor interpretations are in different domains. Even if primary metaphors turn out to motivate only a small fraction of how we use space, it may still be worthwhile considering their use in the design of context-aware systems.

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