Image Schemas as Tool for Exploring the Design Space of Data Physicalisations

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Abstract
Data physicalisation is a promising approach to encourage engagement with data and provide a memorable experience. Unfortunately, current data physicalisations do not live up to their potential, using generic presentation strategies and materials, remaining inactive, and primarily addressing the visual sense. These problems could be addressed through the use of image schemas, which already have been shown to improve the design of user interfaces. Image schema theory could support the design of more active, multimodal, intuitive, and innovative data physicalisations. In this paper we present the first attempt to investigate this approach by analysing which image schemas are instantiated in current data physicalisations. Based on our findings, we provide a model that organises image schema groups in terms of their potential for designing data physicalisations.

Keywords [1]
Image schemas, data physicalisation, analysis

1. Introduction

Image schemas are mental representations of recurrent sensorimotor experiences of our environment [42, 47]. These mental building blocks support structuring our experiences and understanding the surrounding world [7, 48, 68]. In Human-Computer Interaction (HCI), image schema theory has been applied to the design of different types of interfaces and interaction methods, and has been shown to support the design of more intuitive, innovative and inclusive interfaces and interactions [30, 35].

The field of data physicalisation explores the physical representation of abstract data through artefacts. This approach to represent data goes beyond visualisation, and promises to enhance user engagement with data and to provide the opportunity for a more memorable data experience [55, 65]. In order to investigate the actual state of data physicalisation and to establish a design space, numerous analyses with different intents have been carried out (categorisation: [11, 41, 59, 72], bridging disciplines: [3, 13, 24], supporting designers or providing design guidelines: [16, 24, 59, 60, 62], for inspiration: [70]).These attempts have shown that actual data physicalisations do not live up to their full potential, but remain non-interactive [13, 24], rely on visual representation techniques [9, 63, 66] and primarily address the visual sense [12, 24, 45, 50]. Often the representations are generic [13], with no meaningful choice of materials [24]. Thus, the main challenge in the field of data physicalisation is still to go beyond visualisation standards and find a unique approach to map data to physical properties in an understandable way [40, 55].

Proceedings of The Seventh Image Schema Day (ISD7), September 2, 2023, Rhodes, Greece
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As image schemas have already been shown to be useful for the design of visual and even tangible user interfaces, they also hold promise for the design of data physicalisations. As image schemas are based on basic mental models, they may provide a strategy to map data to physical properties in an intuitive way [32]. Furthermore, they are based on multisensory experience and can be represented in a visual, tactile, auditory or kinaesthetic way [27, 36, 37], so they could also encourage the use of different sensory modalities. Image schemas have already been shown to work well as inspiration, and their abstract nature leaves room for innovative and individual design choices [40, 55]. This could also support less generic data representation designs.

Before incorporating image schemas into the design process of data representations, we would like to investigate the state of data physicalisation in terms of using image schemas. In this paper we are interested in (1) how image schemas are already used in data physicalisations, and which image schemas and groups of image schemas are most frequently used, and (2) which sensory modalities are addressed. To answer these questions, we analysed 70 data physicalisations. Based on our findings, we developed a model that organises image schema groups according to their potential use in data physicalisations.

2. Background

2.1. Image Schemas

Image schemas were introduced in 1987 by Lakoff [47] and Johnson [42] as "recurring, dynamic pattern of perceptual interactions and motor programs that give coherence and structure to our experience" [42] (p. xiv). They are abstract representations of patterns of recurrently experienced bodily interaction with the world [12], so they are mental representations of embodied experience [45, 51]. Image schemas structure human perception and help us understand the world [7, 42, 48, 53, 68]. Because these mental models are deeply rooted in our minds, we easily understand their properties.

Image schemas are abstract [30, 32, 36, 42], operating on a level between concrete image and abstract propositional structures [42] and can be static or dynamic [69].They are also multimodal [7, 28, 30, 31, 42], as they are formed from visual, haptic, acoustic and kinaesthetic experiences [34], and they are analogue [30, 32] as they maintain the topological relationship with the environment. Because of repeated information encoding and memory retrieval, image schemas operate subconsciously [30, 32, 36, 37]. While we encounter image schemas in our everyday lives, they can be systematically derived from philosophical work (e.g., Johnson [42]), linguistic analysis (e.g., Baldauf [5], [8, 17, 67]) and psychological studies [15]. Hurtienne [32] introduced a list of image schemas organised into seven Image Schema Groups. See Table 1 for an overview [27].

Table 1
Image Schema Groups (from Hurtienne [32])

Groups	Image Schemas
BASIC	OBJECT, SUBSTANCE
SPACE	CENTER-PERIPHERY, CONTACT, FONT-BACK, LEFT-RIGHT, LOCATION, NEAR-FAR, PATH, ROTATION, SCALE, UP-DOWN
CONTAINMENT	CONTAINER, CONTENT, FULL-EMPTY, IN-OUT, SURFACE
MULTIPLICITY	COLLECTION, COUNT-MASS, LINKAGE, MATCHING, MERGING, PART-WHOLE, SPLITTING
PROCESS	CYCLE, ITERATION
FORCE	ATTRACTION, BALANCE, BLOCKAGE, COMPULSION, COUNTERFORCE, DIVERSION, ENABLEMENT, MOMENTUM, RESISTANCE, RESTRAINT REMOVAL, SELF-MOTION
ATTRIBUTE	BIG-SMALL, DARK-BRIGHT, HEAVY-LIGHT, SMOOTH-ROUGH, STRAIGHT, STRONG-WEAK, WARM-COLD

Mandler and Cánovas [54] proposed a three-fold distinction of image schemas: 1) spatial primitives, which are the first spatial building blocks formed in infancy which help to understand our perception (e.g., PATH or CONTAINMENT) 2) image schemas, which use the primitives to represent simple spatial events (e.g., PATH OF THING) and 3) conceptual or schematic integrations, which combines concepts including image schemas with non-spatial elements like force or emotion. Another attempt to organize image schemas are Image Schema Profiles [57]. These collections or clusters of image schemas describe the conceptualization of a particular event or concept. Another approach are Image Schema Families [18, 21], which are interrelated and logical heterogenous theories that provide a hierarchical structure. To address the problem of image schema combinations and to use their formal representation as modelling pattern for the representation of dynamic concepts and events Hedblom [19, 20] introduced a more systematic approach to combine image schemas. She proposes the Image Schema Logic which provides three different methods for combining image schemas: merge (merging image schemas to change their characteristics), collection (combining image schemas), and structured combination (combining image schemas structurally).

Even some of Hurtienne's Image Schema Groups are discussed in the image schema community we decided to use this categorization for our work because they are easily accessible and provide a quick overview.

2.2. Image Schemas in Interface Design

As image schemas are activated unconsciously, incorporated into user interfaces, they have been shown to promote intuitive use [32]. The level of prior technical knowledge is also less important when the interface design is based on image schemas [29, 30]. During the design process, image schemas can support the designer by showing what is essential without being too restrictive [35]. Their abstractness provides freedom to decide on the way of instantiation. Further, drawing inspiration from image schemas rather than from existing technology can also encourage innovative solutions that go beyond the state of the art [29, 30]. In summary, image schemas hold great promise for promoting more intuitive, and innovative user interface designs.

Previous work in the field of HCI explored the potential image schemas provide for the design of graphical user interfaces [36]. Image schemas have been shown to be a powerful language for identifying weaknesses and suggesting solutions. Furthermore, image schemas work well as inspiration [28, 29, 32, 37, 52, 53, 68] and to structure the design process [68].

Image schemas have also been used for designing tangible user interfaces [28, 37, 68] and here their potential for design has been highlighted [37]. Because they are based on multisensory experiences, image schemas are valuable for designing tangible objects. Abstract concepts can be linked to more tangible physical experiences by using metaphorical extensions and so image schemas provide a method to avoid overly literal physical-to-physical mappings [28]. However, there are no rules on how to systematically transfer abstract meaning to the potential of spatial and physical interaction [38, 68].

2.3. Data Physicalisation

For a long time, data physicalisation was defined as "physical artifact whose geometry of material properties encode data" (p. 3228) [40]. Recently, this definition has been questioned [2, 4, 60], as many physicalisations go beyond the scope of this definition (especially more artistic ones). Data physicalisations can serve different purposes such as analytical tasks, communication of information (e.g., in a pedagogical context or for collaborative decision making), making data accessible, supporting self-reflection and self-expression, or promoting meaning making and pleasure through data expression [12]. As diverse as the purposes of data physicalisation their data mappings and representations can be. Going beyond shape and material, some examples map data onto dynamic movements or kinaesthetic experiences (e.g., the kinaesthetic data physicalisation *Move&Find* [33]).

For the user physical representations of data are promising in promoting sense making, exploration, engagement, communication and the representation of data [22, 26, 40, 55, 65], as well as cognition, learning, problem solving and decision making [1, 55]. Further physicalisations of data encourage curiosity and consider the role of emotions [71]. They can not only provide information in a playful way, but also promote information retrieval and memorability [39, 64], they can motivate and encourage [55, 65]. Physicalisations of data are also beneficial as they appeal to more perceptual exploration skills [1] and engage multiple senses, providing sensorimotor feedback while minimising cognitive load [71]. They can promote diverse user experiences [23] and show promise in supporting active perception and interaction [25].

Several analyses of actual data physicalisations have been conducted. Some have found that most physicalisations are passive [24] or non-interactive [13], while other analyses have found most physicalisations to be active [3]. However, these physicalisations are often technically advanced and device-centric or technology-driven [40, 61] instead of following an overall design-strategy. Many data physicalisations were found to use generic representation strategies and metaphors [13]. Even the materials choice is often unrelated to the represented data [24]. Analyses agree that the majority of physicalisations stick too much to the visual, primarily addressing sight [12, 24, 45, 50], using visual principles [9, 63, 66] such as shape and form or colour to encode data [13]. Thus, the most fundamental challenge in the field of data physicalisation is to move beyond the visualisation paradigm and find a way to translate abstract data into physical properties [40, 55]. The main question within the field is how to map data in an understandable way to modalities other than vision [55].

2.4. Do Image Schemas address the Needs of Data Physicalisation?

As discussed earlier, current data physicalisations do not use their full potential. The analyses conducted and frameworks established in the field of data physicalisation work well to identify unused potential but do not address the challenges in a generative way.

Data physicalisations need to realise their full potential, to become interactive without being too attached to the enabling technology. Metaphors could be used to find meaningful mappings of abstract data to physical properties and meaningful material choices. Further data physicalisations need to go beyond visual principles and become true multi-sensory data representations.

Image schemas could act as inspiration, for an overall design-strategy for data physicalisations and support a less generic data representation. The deep connection to multisensory experiences makes image schemas promising to address other senses than vision. That image schemas are based on interactive experiences with the world is also promising for more (inter)active design ideas. Addressing basic mental models could support a more intuitive mapping of abstract data to physical properties and could also support finding less generic metaphors and material choices related to the data.

In this paper we present the first approach to test these conjectures. Before using image schemas for data physicalisation design, we investigate the actual use of image schemas in data physicalisations. We are interested in (1) how image schemas are already used in data physicalisations, and which image schemas and groups of image schemas are most frequently used, and (2) which sensory modalities they address. As first approach we investigated actual use of image schemas in data physicalisations and analysed 70 physicalisations.

3. Method

3.1. Dataset

For the analysis, we selected 70 data physicalisations from the dataset available at dataphys.org [10]. All entries of this extensive collection of physicalisations fit the initial definition of data physicalisation established by Jansen et al. [40], who are also the curators of this database. In order to represent the current state of data physicalisation, the date the physicalisations were created was our selection criteria. We started analysing the most recently created physicalisation and went back in time until we reached a sufficient number of analyses. The analysis was conducted in 2020/2021, in the meantime the curators of dataphys.org added to further physicalisations. Physicalisations that weren't completely clear to the analyst were excluded. Also, in case several physicalisations used the same visualisation technique and/or material and were created by the same author, only one of them was analysed to avoid bias. The used dataset and the full image schema analysis is available as supplemental material (https://github.com/CordulaBaur/Dataphys-Analysis.git)

3.2. Procedure

Starting with the most recently added data physicalisation, we examined one physicalisation after another. The first step was familiarising with each physicalisation through images or if available videos. The second step was reading the description text or, if available, the accompanying research paper. Sometimes external links to videos or project websites were provided, which also were used to investigate the data physicalisation. When we had the feeling to fully understand the physicalisation, the presented data and the data-material mapping, we started to analyse the physicalisation for image schemas. Then the analyses were discussed with the other authors. We decided to analyse the physicalisation itself rather than the description text as the formulation of the description text might add or lose some image schemas. For the analysis, we used a list of image schemas and metaphors extracted from the ISCAT database [35] (similar to Table 1). The extensive collection of the ISCAT database provides an amount of information regarding image schemas, their organisation into groups, their metaphors, their empirical grounding, linguistic examples as well as application examples. Although it offers comprehensive information, it showed to be not useful for providing a convenient overview. Therefore, we chose a selection of information (image schemas, groups, metaphors) that seemed adequate for this task and fit our process. We also investigated which sensory modalities were addressed by the image schema.

3.3. Exemplary Analysis

To illustrate our approach, we describe the example of Jang Lee's *Data Earrings of Country Happiness* [51] (Figure 1). The physicalisation consists of two pairs of earrings. Each earring, representing a different nation, consists of a multi-coloured rectangular element and a yellow circle. The rectangular element consists of three segments, each in a different colour. Each segment, according to its size, indicates the size of the country's service sector (yellow), agricultural sector (red) and industrial sector (green). The whole shape symbolises the country's gross domestic product, while the size of the circle indicates the happiness of the country's citizens.

Each earring can be understood as an OBJECT made up of several PARTS that together form a WHOLE. The different coloured segments and the circular shapes both make use of the BIG-SMALL image schema. A COLLECTION of several earrings exists. Additionally, by wearing one earring in the left ear and one in the right ear, the LEFT-RIGHT image schema can be discovered, although it is not mapped to data. All the image schemas found refer to vision. Only the different sizes of circular objects and rectangular segments could be perceived by touch, although this is not intentional by the designer.

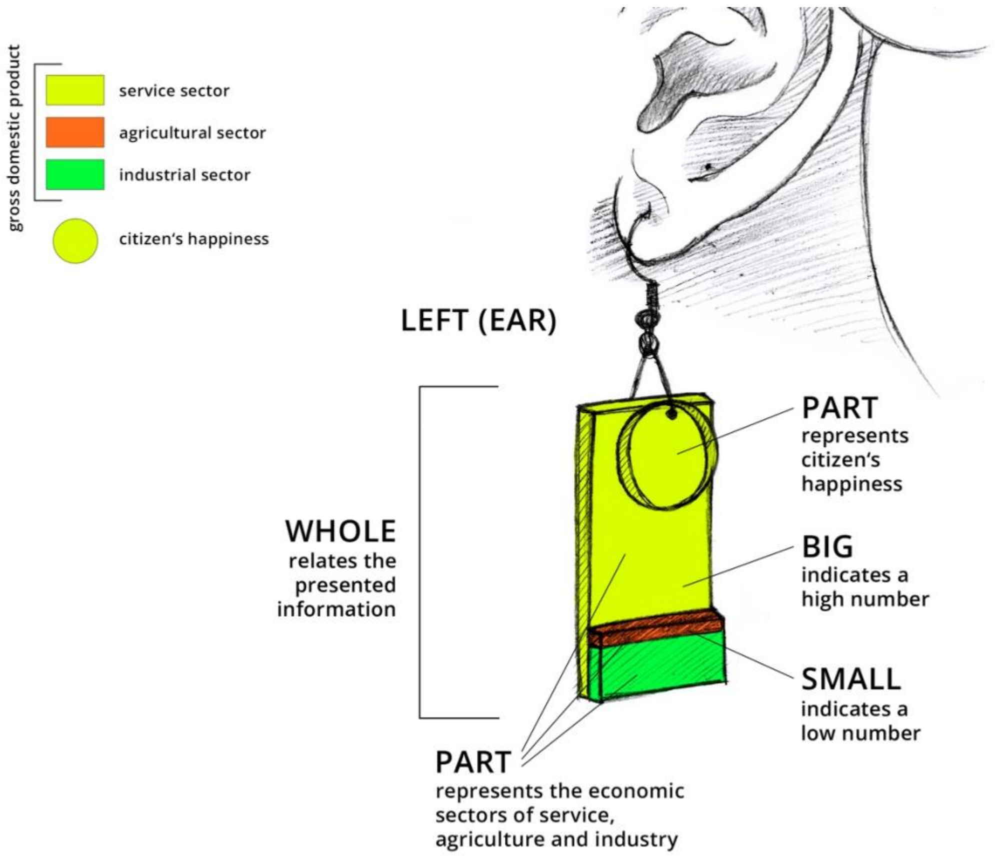

Figure 1: *Data Earrings of Country Happiness* by Jang Lee [51] annotated with incorporated image schemas: LEFT-RIGHT, PART-WHOLE, BIG-SMALL

4. Results

4.1. Image Schemas and Image Schema Groups used in Data Physicalisations

By analysing 70 data physicalisations, we found a total of 625 image schemas instantiated by the designer, either unconsciously or deliberately. On average, each physicalisation contained 8.9 image schemas. The most frequently used image schemas were OBJECT (68 times), UP-DOWN (49 times) and LEFT-RIGHT (44 times).

Sorting the found image schemas regarding their groups, most of the found image schemas belong to the SPACE group (218). The second most frequently found image schemas are of the ATTRIBUTE group (142), followed by image schemas of the MULTIPLICITY group (93). The frequency of all image schemas regarding their groups are shown in Table 2.

As the image schema groups are very different in size, adding the number of instances per group could be misleading. While the BASIC group consists of only two image schemas, the FORCE group consists of eleven image schemas. To avoid this misleading presentation of the data, we considered the number of image schema instances found in relation to the number of image schemas per group. In relation to the number of image schemas per group, the BASIC image schemas were found most often (on average 37.5 times), followed by the SPACE image schemas (on average 21.8 times) and the CONTAINMENT image schemas (on average 16.4 times). The average use of all image schemas regarding their groups is also shown in Table 2.

Table 2
Number of found image schema instantiations regarding their groups and the number of average use of each image schema regarding groups.

Groups	Number of Image Schemas found organized in groups	%	Average use of Image Schemas organized in groups
BASIC	75	12	37.5
SPACE	218	35	21.8
CONTAINMENT	82	13	16.4
MULTIPLICITY	93	15	13.3
PROCESS	2	0	0.7
FORCE	13	2	1.1
ATTRIBUTE	142	23	11.8

4.2. Sensory Modalities addressed by Image Schemas used in Data Physicalisations

The visual sense was most often addressed by the instantiated image schemas (586 times). The sense of touch was addressed 399 times, the sense of sound nine times, taste only three times and smell two times (for an overview see Table 3).

Table 3
Sensory modalities addressed by Image Schemas.

Sensory Modalities	Number of senses addressed by Image Schemas	%
sight	586	59
touch	399	40
sound	9	1
taste	3	0
smell	2	0

5. Discussion

5.1. Frequently used Image Schemas and Groups

The high frequency of OBJECT image schemas (belonging to the BASIC image schema group) may be explained by the universality of this image schema. The Oxford Dictionary describes object as "a material thing that can be seen and touched" [58]. The definition, and therefore the image schema, is very general and abstract. This image schema has already been discussed as being too abstract for an image schema [56].

The image schema group SPACE, which also includes the frequently found image schemas LEFT-RIGHT and UP-DOWN, is promising for tangible interaction, as interacting with physical objects always happens in two- or three-dimensional space. Furthermore, a large number of metaphorical extensions can support data mapping and serve as inspiration [37].

Image schemas of the ATTRIBUTE group, which was found to be the third most used group, showed that they are often used in physicalisations and work well to convey data. The potential of this image schema group to inspire the designer has already been emphasised [37]. These image schemas could not only act as inspiration, but also encourage the use of senses other than vision. The GOOD TASTE-BAD TASTE image schema could incorporate additional modalities like smell and taste, while the image schemas SMOOTH-ROUGH, HARD-SOFT, HEAVY-LIGHT, STRAIGHT-CROOKED or WARM-COLD, BIG-SMALL, and PAINFUL could promote the mapping of abstract information to tactile properties.

5.2. Rarely used Image Schema Groups

The image schema groups FORCE and PROCESS were found least frequently. The FORCE image schemas have already been identified as challenging to apply in the design process, but also difficult to identify and categorise due to their abstract nature [27, 37]. As they rely on physical interactions with the world, these image schemas seem promising for creating more (inter)active data physicalisations.

The PROCESS image schemas also seemed to be too abstract to be used in data physicalisations and/or to be identified by researchers. The low frequency of these image schemas may explain the findings of previous analyses, which identified many physicalisations as non-active or passive. From this we can hypothesise that a more purposeful use of FORCE and PROCESS image schemas could address this untapped opportunity to create more (inter)active designs.

5.3. Sensory Modalities

Previous research has shown that data physicalisations often adhere to visualisation methods [9, 63, 66], using shape and form or colour to encode data [13], primarily addressing sight [12, 24, 45, 50]. In our analysis, vision was also identified as the dominant sense, addressed by the image schemas most often. However, image schemas are based on multisensory experiences and include tactile, auditory, or kinaesthetic experiences as well as visual ones. Used more purposefully, they could address smell and taste (GOOD TASTE-BAD TASTE) and convey information through tactile qualities such as SMOOTH-ROUGH, HARD-SOFT or WARM-COLD. The FORCE image schemas could be used to address the body sense and create kinaesthetic experiences (e.g., MOMENTUM, BALANCE, BLOCKAGE).

5.4. Introducing the Image Schema Model

For the analysis of 70 data physicalisations we used a list of image schemas and metaphors extracted from the ISCAT database [35]. During the initial analyses, the database proved to be too large and complex in structure to be used in a generative way or for our future purpose to be used in the design process.

In the analysis described above, we gained insight into how image schemas are used in current data physicalisations and discussed what potential they hold for the data physicalisation design. We want to use this knowledge to find a new way of structuring image schemas and making them available in a format useful for the design process of data physicalisations. We built a model that arranges the initial image schema groups in terms of their potential for data physicalisation design (Figure 2).

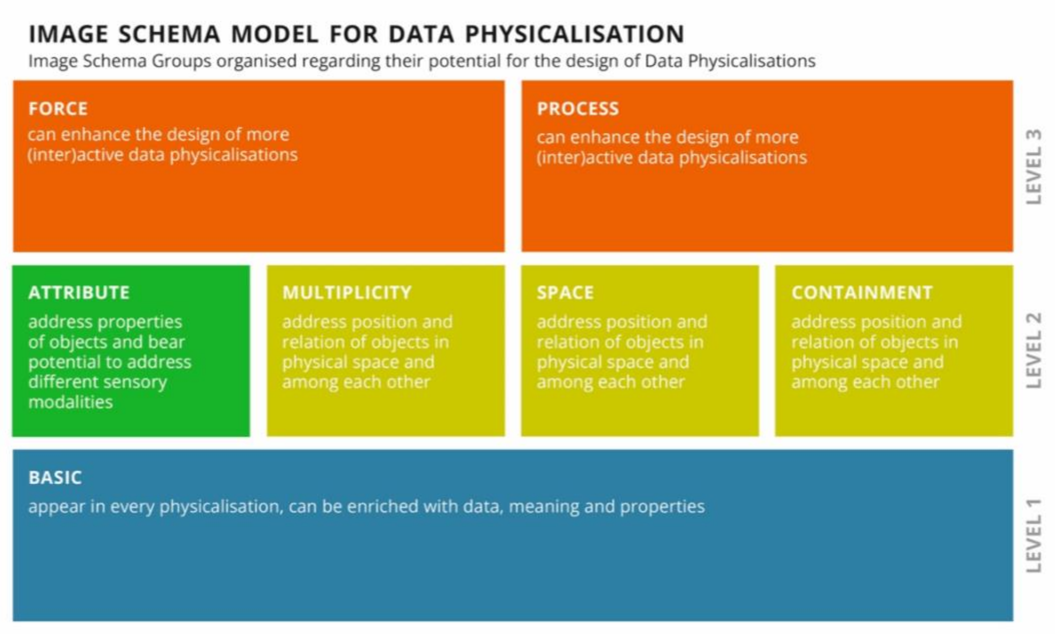

Figure 2: Image Schema Groups organized regarding their potential for data physicalisation design.

5.4.1. Level 1

The BASIC image schema group builds level one. With this foundation of OBJECTS and/or SUBSTANCES any physical installation must begin. These are the basic components that can be enriched with information, meaning and attributes by applying the image schemas of the subsequent levels.

5.4.2. Level 2

The second level is twofold. One part is built by the ATTRIBUTE group, because in our research we have frequently discovered these. They address attributes of objects such as BIG-SMALL or BRIGHT-DARK to convey data. They can also address sensory modalities other than vision, such as WARM-COLD, or GOOD TASTE-BAD TASTE. They can also map abstract information to tactile properties (e.g., HARD-SOFT, SMOOTH-ROUGH).

The other part consist of the image schema groups MULTIPLICITY, SPACE and CONTAINMENT which deal with the positioning of objects and the relationships among them. Using object properties and relationships (LINKAGE, MATCHING, MERGING, PART-WHOLE) and object arrangements (COLLECTION, COUNT-MASS), the MULTIPLICITY group helps to represent data and relationships. Many of its metaphors, such as GOOD IS HOMOGENOUS-BAD IS HETEROGENOUS [44] and LOVE IS A BOND [46], can be helpful in mapping data.

SPACE image schemas support design decisions regarding the placement of artefacts in relation to each other or to the user (NEAR-FAR, CONTACT), their position in physical space (CENTER-PERIPHERY, LEFT-RIGHT, UP-DOWN, FRONT-BACK, PATH, ROTATION) and/or specific aspects or characteristics of the artefacts (FRONT-BACK, LEFT-RIGHT). Here, metaphorical extensions such as IMPORTANCE IS CENTRALITY [14], LESS IS LEFT-MORE IS RIGHT [43], or MORE IS UP-LESS IS DOWN [49] can be helpful in making design decisions.

The CONTAINMENT group extends the other groups by describing how objects are grouped and placed within other objects (CONTAINER, CONTENT, FULL-EMPTY, IN-OUT). As a result of the metaphorical expansion, concepts such as time, mind, memories, emotions, investments, etc. are understood and can be physicalised as CONTAINERS. It is possible to imagine exciting data mappings when using the accompanying image schemas FULL-EMPTY and IN-OUT.

5.4.3. Level 3

The least used image schema groups FORCE and PROCESS, which seem to correspond to the recognised untapped potential of active data physicalisations, form the third level of the model. The design of more active data physicalisations can be enhanced by their application (ATTRACTION, COMPULSION, MOMENTUM, SELF-MOTION, etc.). To construct more (inter)active data physicalisations, metaphors such as CAUSES ARE PHYSICAL FORCES [49] (COMPULSION image schema) and CHANGE OF STATE IS CHANGE OF DIRECTION [14] (DIVERSION image schema) can be used.

5.5. Limitations

The effectiveness of the data physicalisation analysis may have been affected by the following factors. First, the depth of documentation of the data physicalisations varied considerably. There were cases where only a brief description and a picture were available. Here we were forced to rely on our own (visual) knowledge. We tried to obtain more details and visual representations of the data physicalisations through additional external links or the use of search engines, to achieve the same level of understanding and familiarity for all physicalisations.

In addition, the analysis of the data physicalisations was based on photographs and videos rather than on the physical representations themselves. As we have relied on an online collection of data physicalisations, these require the use of another (visual) medium to be perceived. The interplay of the senses is torn as the already dominant visual sense becomes stronger. In their ideal state, data physicalisations are seen and analysed directly, without the use of any other medium. To counteract the artificial dominance of the visual sense, we put a special focus on the addressed sensory modalities and explicitly investigated which are addressed by the image schemas.

The fact that only one researcher carried out the analysis could also be seen as shortcoming. When using image schemas in a design process, it is recommended to carry out the sourcing procedure with more than one researcher [30]. To limit this influence, the analyses were discussed with the co-authors.

6. Conclusion

We present the first approach to investigate the potential of image schemas for the design of data physicalisation and whether they can address the challenges of finding an intuitive mapping of abstract data to physical properties and creating (inter)active, multisensory data physicalisations that make use of individual representation strategies and material choices. In our first attempt, we investigated how image schemas are used in actual data representations and how they affect the sensory modalities addressed. We analysed 70 data physicalisations from the dataphys.org database [10].

We have used image schema theory as a lens to examine the design of data physicalisation. Image schema theory, which has been already applied successfully to the design of visual and tangible user interfaces, was applied to a new domain to explore its potential to support the complex design requirements of data physicalisation. As a first step, we surveyed the actual use of image schemas in data physicalisation, and the sensory modalities addressed. Based on our findings, we were able to hypothesise the impact of a more purposeful use of image schemas in the data physicalisation design process. Using image schemas to guide the mapping of abstract data to physical properties could promote design in line with users' mental models, leading to intuitive design that causes less mental workload. Image schemas can act as inspiration to encourage more innovative designs, while metaphorical extensions can support less generic representation strategies and material choices. Some image schema groups provide the opportunity to address different modalities, while others offer the opportunity to create more (inter)active data physicalisations. Based on our findings, we have organised image schemas according to their potential for designing data physicalisation. With this image schema model for data physicalisation, we want to make the knowledge stored in the ISCAT database accessible to data physicalisation designers. This is the first step in transforming image schema theory into generative tools for the design process.

We want to explore the potential of image schemas for data physicalisation design further through analyses and speculative design approaches. Furthermore, we want to explore different approaches to provide easy access to image schema theory for data physicalisation designers and create different tools that can be integrated into the design process, e.g., by further elaborating the Image Schema Model we introduced in this paper. Further, we are working on a template for analysis and/or design of data physicalisations and visual and physical instantiations of image schemas [6].

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