Design Patterns of Health Animation – Scaling Pattern Languages Into a New Domain

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Abstract. This paper presents the results of a Danish study on the scaling of the design approach of design pattern languages into the context of citizen-oriented health animation. We propose that the use of design patterns, and the development of an emerging pattern library of health animation patterns, can support the design of more informative and useful animations visualizing health information. We mapped 72 Danish citizen-oriented animation products into 23 design categories, including both form-related and content-related elements. We used the design pattern approach to systematize the state-of-art animations to enable an overview of approaches typically applied in health animation across different institutions, producers, and target audiences. We discuss how design patterns can be appropriated from previous uses in e.g. architecture and digital design into a health communication context, and through a pilot split-test we discuss both the benefits but also the limitations of using the design pattern approach to design new health animations.

Keywords: Health animation · Design patterns · Danish study

1 Introduction

Over the past 15 years, there has been a significant increase in the usage of animated films within the area of municipal, regional, and state communication to the public. This form of animation is categorized by its use outside the context of art and entertainment, also labeled 'functional animation' [1]. In this domain, animation is used to promote facts and reduce complexity of information for audiences of different literacy levels across diverse fields such as e.g. governmental communication, science dissemination, interest group communication, and health communication [2]. Previous studies have indicated that health animations can have a positive impact on citizens with low health literacy and their ability to recall health information [3, 4]. Since animations can use various modalities such as visualizations together with text and sound, it has been suggested that this will decrease the cognitive overload of the recipient of the health information [3]. This also seems to be the driving force behind the creation of various health animations that in many cases target people with low health literacy [4]. A health animation can

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therefore be described as an animation that delivers visualized health information in a simple manner to citizens/patients with different literacy levels and does this by using different elements within the animation (icons, speech, text pieces, etc.).

When designing health animations, it is therefore important to find applicable principles and standards to ensure both proper communication as well as a certain level of predictability in terms of production cost and expected outcomes. Surprisingly, there is a lack of research documenting which principles and patterns govern these types of design processes. The majority of research focuses on evaluating how well a designed health communication product worked, without consideration of which design decisions are behind the measured effect. This is a well-established problem in the field of design and has been an area of concern since Christopher Alexander [5] and later contributors sought to bring established conventions to design using pattern libraries. A promising point of venture is thus to ask whether the well-established design tradition of building and working with design patterns can be scaled up to also contribute to the field of health animations?

In this paper, we present the results of a Danish study exploring the application of the design pattern languages method in the context of healthcare-focused citizen-oriented animated explainer videos. The aim is to develop a design pattern library and to use this as a basis to critically question health animation products and generate detailed descriptions and justifications for the way these products are organized and developed. Thus, the knowledge generated in this study aims to qualify both the development and the evaluation of health animations. We work methodically based on previous frameworks for creating "design pattern libraries" – a method deriving from the studies in the field of design illustrating how one specific designed solution exemplifies a broader pattern of the treatment of functional, aesthetic, and communicative issues within a given object field [6–8]. In recent decades, this has become an established approach in a wide range of design fields, including industrial design, architecture, and digital design.

Knowledge about combining possibilities of form and content is collected through design pattern libraries; this knowledge not only helps to systemize the state of art within a given field but also strengthens the basis of design solutions over time. Thus, fewer decisions are based on subjective opinions and styles rather than analytical principles and standards [9]. Particularly the use of analytical principles and standards provides crucial support for the spread of an emerging design field such as health animation by gathering norms, standards, principles and best practices across applications and sectors. In the health animation field, such analytical standards could improve the presentation of health information and as a result make the information more comprehensible to the recipient. An inadequate comprehension of health information can lead to more hospitalizations and poorer health for the citizens [10]. Therefore, an effective communication design through expressive mediums such as health animation can be a crucial part of creating better health management and healthcare behavior among citizens.

Today a wealth of available toolsets has made it possible to gather the analytical standards and best practices, which consequently makes it unnecessary to start a design from scratch. These toolsets exist in many forms and formats including design patterns – a solution to a recurring design problem that can be used repeatedly within a specific context [6, 11].

The purpose of design patterns is to identify the best practices in the field by acquiring existing sustainable solutions formed from the knowledge and experience of designers. This way design knowledge is shared among experts along with novice learners, obviating any need to reinvent the wheel and start a design from scratch [12]. As a result, resources can be managed effectively and ultimately reduce the production cost of e.g. animations, which are generally expensive to produce [1]. Thus, design patterns are an established and pervasive methodology among many design disciplines, including visual design fields in which design patterns have emerged based on e.g. gestalt psychology [13] and patterns of orthodox motion translated into the 12 principles of cartoon animation [14]. This paper takes a special interest in extending the use of design patterns within the domain of designing animation – specifically "functional animation" [1].

The aim of mapping patterns in health animation is to generate new knowledge concerning the types of animation and the approaches typically used to convey health information. We propose that the use of design patterns, and the development of a pattern library of health animation patterns, can support the design of more informative and useful health animations for citizens. Furthermore, it will better articulate how and when health animations borrow patterns and principles from traditional art and entertainment-based animation, and when they diverge into their own unique patterns. As in other design disciplines, this is important to assess what meaningful combinations are possible and for what purposes different elements can be combined. Later, we discuss how the design pattern can be appropriated from its previous uses in e.g. architecture and ICT design into a health communication context, and discuss the limitations of using the approach in the context of animation. Through the developed pattern library, form-related decisions in designing health animations can be analytically compared with existing idioms, conventions, and standards rather than being subject to individual styles and artistic opinions alone.

1.1 Design Patterns – A Broad Approach

The concept of architectural design patterns was introduced by Christopher Alexander in 1964 [5] and later described in more detail by Alexander et al. [6]. They presented more than 250 patterns consisting of reusable architectural solutions to common problems within e.g. regional planning and interior design [15]. Furthermore, the book presents Alexander's theory that the use of his patterns, and thereby his "timeless way of building", will ingrain environments with what he considers the "unnamed quality" ("beauty", "alive", "free", etc.). Alexander's theory received immediate attention along with a high level of criticism among peers. A comprehensive description of the critics of Alexander's theory and his associated patterns can be found in Dawes & Ostwald [15]. The criticism is primarily concerned with Alexander's ontological and epistemological positions, such as his view that there is only one right way of building (the timeless way), his definition of science, and his confusion of subjective and objective phenomena. Furthermore, he received criticism of the logic and reasoning behind the development of his patterns (primarily based on his argument that there is only one right way to build), while he was also criticized for his lack of documentation and proper testing of his patterns. A core criticism concerned the concept of design patterns, namely the difficulty of testing patterns in general, especially regarding sizable design pattern libraries – the point being

that patterns would be difficult to test independently due to the connection between patterns. Therefore, new potential design patterns should be documented properly and subjected to testing. Considering the criticisms of Alexander's theory along with the concept of design patterns, it seems of absolute importance to create patterns that are not based on a rigorous ideology. Design patterns should instead be viable tools that provide proven solutions and a common terminology formed by knowledge and experience of designers that can be used for inspiration. As such, design patterns are a pragmatic tool for design, to balance ideologies and trends, establishing a solid base of experience for dealing with the ultimate particulars of design.

The idea of implementing design patterns in the Human- Computer Interaction (HCI) community was initially mentioned by Donald Norman and Stephen Draper in 1985 [16]. In recent decades, there have been more than 250 HCI patterns published in books and on online sites [11] – patterns involving problems such as how to create a structure to manage pictures and videos and how to design a search area on websites [17]. To ascertain if the solutions in the design patterns are good and worth of being reused, it is of utmost importance to evaluate and validate the patterns. Previously Elisabeth Bayle et al. [18] suggested differentiating patterns into two groups: *Design Patterns* and *Activity Patterns*. Design patterns are proven solutions (across time and circumstances) to a repetitively occurring problem within a specific context. The approval of the solution/pattern can e.g. be done by empirical verification and an overall agreement on the pattern by users [19]. Activity patterns, on the other hand, describe the solutions as they are and present them in a pattern without evaluating on how or if the pattern is worth being preserved [18].

1.2 Practices When Designing Health Animation Products

Traditional animation design patterns exist, most famously embodied by the 12 animation principles of Disney [14]. These are all based on crafting the illusion of life in artificially created motion, by adhering to principles deduced from the early years of cartoon animation. These original patterns of animation design have also been transferred into more functional design domains, such as interface design [20]. We argue that the design pattern approach might also be applicable within domain-specific areas of communication design. Here factors of both form and content must be considered to ensure a positive user experience of the designed form as well as the comprehensibility of the information presented. One such domain is health communication.

In the domain of health animation, studies have aimed to explore knowledge acquisition through the dissemination of functional animations compared to a more traditional mode of information, such as verbal or written. We find studies within a wide range of specialties targeting for example glaucoma patients [21], patients with diabetes [4], patients receiving opioid analgesics [22], patients with periodontitis or periodontal health issues in general [23, 24] and several others [25–28]. These studies all share an overall focus on the effect of animations regarding perceptions, attitudes, beliefs, or knowledge gain. Thus, the focus is on educational aims, and providing recipients with knowledge and skills to prepare for, prevent, or overcome health challenges. While all studies provide a rigorous description of the sampling and effect evaluation, only few provide any details on the actual design choices made. In the few instances where details are given,

the rigor is significantly lower than the other parts of the studies. In Polk et al. [29] the authors provide a technical description on how they translated a 3D model of an infant's cranium into a cartoon flash animation but provide no rationale for the design choice behind this configuration. Another example is Narimatsu et al. [30], which details the digital design of a health e-learning platform and its intended user flow, but only includes one sentence explaining the rationale for the form of its animated contents. We argue that this lack of rigor and transparency in the existing research and state of art is an important design issue to be dealt with – potentially through the development of design pattern libraries.

2 Building and Applying a Pattern Library for Health Animation

In this study, we mapped 72 Danish citizen-oriented functional animation products into 23 design categories including both form- and content-related elements (see Fig. 1). We used the design pattern approach to systematize the state-of-art animations to enable an overview of typically applied approaches in health animation across different institutions, producers, and target audiences. Thus, the outcome of the systematization was the development of a design pattern library. The collection of health animation patterns was restricted to animation products created in and aimed at a Danish context. These animation products were collected from their respective sources (e.g., YouTube, health-related websites or digital applications) – identified both through searching among known animation providers of Danish health animations, through health communication sources in Denmark, and through users of health animations. Afterwards, the collected animations were mapped into 23 design categories according to existing knowledge concerning the form and content of animation products [31–34]. These categories encompass both form-related elements (e.g., visual fidelity, orthodox vs. exaggerated animation, diegetic vs. non-diegetic sounds) and content-related elements (e.g., narrative structure, discourse, and subjective vs. objective communication). Throughout the mapping, some categories were elaborated, and other categories were added because of the pragmatic use of the framework. One example is the sound/narration category, which got elaborated as patterns vaguely started to appear and other elements seemed of importance, e.g., the specific pronouns used by the speaker (you, we, he or she etc.) were included as well as the use of different types of narrators than expected (e.g., visual representation of a third-person narrator). Another example is the category "narrator's gender" which was added later when we discovered through the mapping that the animations generally use a male voiceover. This showed that it was unfeasible to determine all the relevant elements and categories beforehand, and only after watching and mapping the animations was it possible to adjust the categories to fit the pragmatic world.

After categorization, common features, deviations, and variations were identified in order to induce specific elaborated patterns that were then collected and described as patterns for health animation products to support an increased substantiated design process of new health animations. Our aim was to create a framework involving the three important elements in a design pattern: a problem, a context, and a solution [6, 7]. Inspiration was found in the existing frameworks within the Human-Computer Interaction field presented in e.g. [17] and [8]. This led to our version of a design pattern framework consisting of multiple categories, where the emphasis was given to the following categories:

Fig. 1. A snapshot of the mapping of 72 Danish health animations, which forms the basis for inducting specific clusters into design patterns. Each animation is indexed within 23 categories on the horizontal axis. The total mapping can be seen in Appendix 1.

tendency, occurrence, approach, outliers, interpretations, and examples (see Fig. 2). The ultimate objective was to locate potential patterns in the mapping of health animations and turn them into a design pattern by addressing the categories above. In the category *tendency*, we present a broad description of a pattern and its elements that are brought into play. *Occurrence* pinpoints the theme of animations that a pattern encompasses e.g., health animation or public administration. The category *approach* covers the approaches employed and solutions given by previous animations using different elements such as voiceover, perspectives, and icons. *Outliers* is the category the captures the inconsistent data of the concerned pattern. Furthermore, *interpretations* encompass the reasoning for why a specific solution is sought. In *interpretations*, we strive to provide a reasonable argument behind the choice of the adopted approach, though it remains up for debate. Lastly, as the name suggests, the category *examples* include examples of a solution with either a picture, a text or both.

We followed the top-down and bottom-up approaches to discover typically applied solutions in the mapping and turn them into design patterns by addressing the categories in our design pattern framework. Employing the top-down approach allowed us to investigate the data through a general lens, for instance: do animations adopt a specific form while targeting children? Likewise, the bottom-up approach was used to examine whether certain categories, e.g. 2D or 3D animations, contained similarities within the category and therefore form a pattern. In summary, we created a design pattern framework that allowed us to deconstruct and elaborate on the patterns observed in the data from the mapping of 72 health animations. This allowed us to build an emerging design pattern library of the best practices within the field of functional health animations. This design pattern library is constructed as an online accessible database, from general patterns to isolated examples, usable as a reference to support the identification of suitable patterns for a given communication challenge, but also to search for examples of the pattern's use in existing animation practice within health animations. Thus, the database is usable in designing specific health animations, but also serves as a general database for the health sector overall (which could gradually grow in size) comparable

PATTERN NAME	
TENDENCY	
OCCURENCE	
SOLUTIONS/APROACH	
OUTLIERS	
INTERPRETATIONS	
EXAMPLES	

Fig. 2. Our version of the design pattern framework, which include the following categories: tendency, occurrence, solution/approach, outliers, interpretations and examples.

to the design pattern libraries used in other sectors such as software design [35]. The next section will provide an example of the development of a specific pattern from our pattern library. Afterwards a pilot test applying the pattern library in a specific health animation project will be described and analyzed with the purpose of serving as a proof of concept regarding the applicability of the design pattern method within the domain of health animations.

2.1 Inducting a Pattern – An Example

Forming design patterns is predominantly an inductive process of inferring from multiple single instances to a broader general description. During the mapping of the functional animations, some patterns were immediately apparent while others only emerged from details after more careful analysis. This is due to the fact that some patterns were clear formulations of recurring problems, while others arise from sets of 'competing forces' as can be seen from the pattern's scope of applicability. All our identified patterns for health animation can be found in Appendix 2. In the following section we use the pattern "Icons in sickness explanations" to demonstrate how the patterns were inducted from the mapping, while highlighting what the different categories in the pattern contain (see Fig. 3). Later in the text, we discuss two patterns that have gone through a validation process.

"Icons in sickness explanations" is a pattern that deals with the use of similar iconography in animations that explain how a sickness affects the body e.g., bacterial infections or carcinogenic tumors (tendency). Eleven animations embodying the theme "sickness explanation" were located within the mapping (occurrence) and afterwards thoroughly

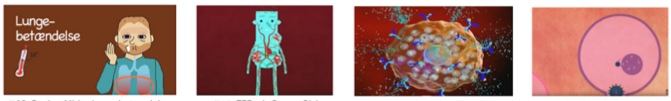
PATTERN NAME: Icons in Sickness Explanation	
TENDENCY	The animations under the theme: 'sickness explanation' have similar iconography. 'Sickness explanations' refers to the animations where the speaker is explaining how the sickness/problem affects the body e.g. bacterial infections, carcinogenic tumor, overall sickness, etc. As such, the pattern deals with the problem of communication the relation between symptom and cause in relation to health.
OCCURENCE	13 instances in the mapping of Health Animations (link)
SOLUTIONS / APPROACH	There are two types of icons that stand out in this type of animation: 1. The use of the transparent body to visualize the location of the health issue, e.g. in an animation about asthma, users can see the lungs in the chest. 2. The visualization of the sickness process. For example, how cancer cells affect the body.
OUTLIERS	No substantial outliers in this pattern. However a small portion do not use any visual icons, but resort only to audio explanations
INTERPRETATIONS	It can be overwhelming and abstract to learn a topic with complex processes and associated terms, that average users are unaware of. Therefore, the visualization of the processes can make it more concrete and understandable. A transparent body in the animations provides a context to the user and knowing the context is a part of understanding the sickness/problem.
EXAMPLES	 #68_Region Midt - Lungebetændelse #10_TEDed- Cancer Risks #23_sundhed.dk - Allergies #26_TedED - Feeling sick
LINKS	Focus on sickness explanation, https://www.youtube.com/watch?v=gVdY9KXF_5g https://www.youtube.com/watch?v=HSzinBjKeT0 https://www.dropbox.com/s/4sn7752xnk6rz4k/jmir_v17i1e11_app1.mp4?dl=0 (Dropbox) https://www.sundhed.dk/borger/patienthaandbogen/allergi/illustrationer/animationer/hoefeber-allergisk-naesetaethed/ https://www.sundhed.dk/borger/patienthaandbogen/oere-naese-hals/illustrationer/animationer/rodbehandling/ http://www.hcand.dk/forside/forside_diagnoser.html https://www.youtube.com/watch?v=zNgf5coML8A Focus on course of treatment (with some sickness explanation) https://www.youtube.com/watch?v=P78s7yB-EUk https://www.youtube.com/watch?v=LI6N9HU-_kk&feature=youtu.be&fbclid=IwAR2LUyahbvRD2rN5pvH6G4wgPoCP4ez-U0LCPtmfiBBVETnJhKzGGv2Cao https://www.youtube.com/watch?v=YAyL2gR6mZA

Fig. 3. Example of one of the eight design patterns of health animations emerging from the mapping of the 72 Danish animation products from the health sector. The full overview of patterns can be found in Appendix 2.

examined for similarities. In this process, we discovered that the animations employed two specific types of icons – 1. A transparent body and 2. The visualization of the sickness process (solution/approach). The 'transparent body' icon enables the animations to visualize the location of the health issue and thereby permits the viewers to see the location of a disease origin, e.g. observation of lungs through the chest in an animation about asthma. The "visualization of the sickness process" icon shows the impact of health issues on internal organs along with cells, i.e., how cancer cells evolve inside the colon. The icons above are observed as core elements of the pattern "Icons in sickness explanations". The next step of action was to determine why these specific icons are chosen. We found that these icons are used to contextualize the health issue, making it less abstract and easier to understand (interpretations). The design problem of conveying complex health issues, in this specific context, can thus be approached by applying the two icons. Consequently, this can be considered a design pattern, since it contains the three important elements: a problem (conveying complex health issues), a solution (two icons: the transparent body and the visualization of the sickness process), and a context (sickness explanations).

The next step in the process was to determine if there were any outliers in the established pattern and if so, would we then be able to discover the reason for this anomaly. Three animations were found to deviate by only using icon 1, a transparent body (outlier). However, these animations focus on treatment of the disease and have only a few details regarding explaining the sickness, whereas the rest of the animations main focus is explaining the sickness. The pattern of these animations is therefore the employment of the transparent body as well as the visualization of the sickness process, which together constitute a template of how to create further animations within the theme of "sickness explanation". This inductive process and the visual framework were utilized

to create a total of eight patterns in the initial pattern library for health animations. The framework itself is based upon a mix of traditions of representing design patterns from both Alexander's original notations [5] as well as later developments within e.g. HCI. The pattern library is available in Appendix 2. A step not accounted for in this stage of the pattern library is whether the patterns represent activity- or design patterns, or whether the characteristics of health animation patterns merit a new interpretation altogether. Therefore, the next section details insights from a pilot split-test based on the pattern library.

3 Putting Patterns to the Test

The exploration of scaling the design pattern approach to health animation was part of the Danish research project "Animation på Tværs" (Cross-Sector Animation). The project's aim is to explore the development, the effect, and the implementation of animation across sectors in the healthcare system. The project's aim was to increase the acquisition of health information regarding treatment and course of disease among citizens with low health literacy when the course of their disease involves treatment across several healthcare sectors. This project was designed to leverage the insights gained from the emerging pattern library by informing the design of 12 health animation videos for citizens with lower back pain. The animations were developed in collaboration with an established health animation company that already had a fundamental structure of visuals and aesthetics along with a repertoire of animation elements from previous projects. Therefore, a majority of the 23 design categories (graphic fidelity, third-person narrator etc.) was already predetermined and unchangeable. However, in this design process we identified a possibility to critically test the assumptions about some of the form and content decisions along with testing the relevant patterns in order to compare the insights from both parts.

We used the health animation videos in the project as the testbed for a split-test exploring the application of two patterns from the pattern library. The split-test was designed based on the knowledge and the general practice gathered from the mapping of the 72 functional animations and the two (out of 8) inducted patterns. The purpose of the test was to validate our design patterns in terms of the patterns' solutions and interpretations along with potential benefits and limitations regarding using the design pattern method. However, a focus was also laid on validating the form and content decisions in the 12 animations from the Cross-Sector Animation project. We differentiate between design patterns and activity patterns (an existing pattern which not necessarily should be reused), whereby our patterns would be considered activity patterns until they have been properly validated by e.g. users. Therefore, the split-test consisted of a focus group of six citizens watching variations of the same health animation. There were three sections within the split-test: facts vs. emotions, male vs. female voiceover, and with text vs. without text. Each section began with showing an animation and then receiving feedback from the citizens. The same animation would then be shown, but it would contain one tweaked variable, e.g., the first animation would have a male voice-over and the second would have a female voice-over, whereas the rest of the animation would be the same (icons, events, information given etc.). Considering the size of the test, we

cannot yet say for sure whether these patterns are recurring enough to be preserved or accepted fully by the users; however, they gave us an insight into which benefits along with problems that might arise for a design pattern library for digital health animations. This way the split-test functioned as a proof of concept and is not an attempt to draw statistical conclusions at this stage.

3.1 Pattern Example 1: Male vs. Female Voiceover

The male vs. female narrator pattern explains the role of narrators in our mapped 72 animations. In the scrutinization process, 55 out of all mapped animations used a third-person view through an omniscient narrator. Further, 89% of the 55 animations employed a male narrator, whereas the remaining 11% used a female narrator. The remaining 17 animations incorporated various other techniques; two animations involved a child's voice, seven used a visual representation of a third-person narrator, two used conversations between animated characters, and the last six did not involve any narrators. The observation shows that male narrators are a dominant choice in functional animations, which makes it a predominant pattern.

To test this pattern, we showed the same animation with the only difference being the gender of the voiceover (see Fig. 4). The animation portrayed a protagonist (a woman with lower back pain) sitting in a chair in her home while being gloomy. Meanwhile the voice-over comments on how people with lower back pain often fear the time of sick leave from their job, since they are afraid, they will get replaced. The speaker then goes on to explain how the job center can help to maintain their relation to the job and employer along with helping with some health courses.

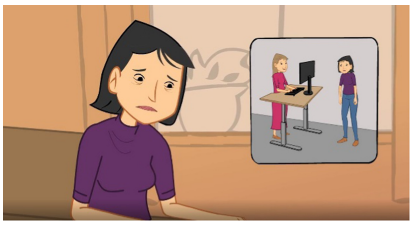


Fig. 4. Still image from the health animation from the split- test, featuring a citizen thinking about her illness with a third-person narrator – in one version a male and in another a female.

In this test, the participants preferred the male voiceover over the female in delivering this message. They described the male with the following words: "I think it is a very pleasant voice" and "He has a good voice" etc. On the other hand, the female voice was described as "… total no-go" and "I just think, it is a bit tiresome" and the participant expressed feeling "a bit uneasy". Overall, the participants perceived the female voice as less pleasant than the male voice. Two of the participants also experienced confusion in understanding the content of the animation as they linked the female voiceover to the main character (a woman). One participant said: "In the beginning, I think, you have doubts about if it is her thoughts or if it is the narrator's (an omniscient narrator)".

While these qualitative remarks are inconclusive about the multitude of different biases there might exist for the interpretations of a voiceover, it does show that if the gender of a voiceover is (wrongfully) associated with the animated character, it can create a potentially unconstructive dissonance for the viewer. To summarize, the male narrator was preferred over the female narrator in the split-test. The possible reasons for this preference could e.g., be a general preference for a male voice, liking and disliking of these specific male and female narrators, or the confusion regarding the female narrator.

A multitude of different biases can therefore be in play, which also can be the case of the remaining 23 design categories of which we mapped the 72 animations into. However, our objective of this test was not to unquestionably define whether the male voice or the female voice would be the right choice in every context. Instead, it was an exploration of the design pattern method's ability to discover specific patterns and test if these patterns could be of value to the users of the health animations and thereby a useful tool within this domain. The result being that this design choice (male vs female) was noticed by the participants in the split-test and did affect their experience with the animated information. Furthermore, the test highlighted the complexity of separating one variable within an animation that consist of various modalities. It indicates the competing forces within a potential pattern and how demanding it can be to sort out. In addition, it shows a potential need for patterns to evolve over time through the testing and evaluation of the patterns.

3.2 Pattern Example 2: No Speaker

The last pattern we wish to present is the pattern we named "no speaker". This pattern consists of animations that do not include a speaker or spoken conversations. After scrutinizing these animations, we identified the following common elements: 1. The speaker is replaced by text-pieces; 2. Intros and outros with text are employed; 3. Lengthy and detailed text is conveyed through metaphors; 4. Music and sound effects are mood-based. The four elements co-exist as the foundation of the "no speaker" pattern. When these animations use text-pieces it is in the form of e.g. text-bubbles or a message on the animated phone instead of typical subtitles. In other words, the text was more actively integrated into the animation. Intros and outros functioned as a space to write short text-pieces that could frame the topic and sum it up in the end, such as "remember to cancel" and "The best position is the next position. Are you going to join?". The third element, the use of visual metaphors, was employed to ensure that the text did not end up too 'long'. One example of this is when the main character was feeling depressed because of an eating disorder. The animation displayed her on a complete black background accompanied with gloomy music along with keywords in a text-bubble and in the end she fell. As a result, they avoided having to explain this through long text-pieces. Furthermore, this example demonstrates how the fourth element (music and sound effects) is applied in the animation. Our interpretation of the application of these four elements is that it can be difficult to convey understandable information through strictly visual techniques (animation, pictures etc.). Therefore, when no speaker is involved, the animations need to incorporate text-pieces. This is also why the intros and outros are employed to frame the context for the viewer or to sum up the problem without a verbal explanation. Furthermore, to make sure the viewer is not overwhelmed

with lengthy texts, there is also a need for visual metaphors to enhance the understanding. Finally, the use of music and sound effects is to create a mood for the viewer. We resolved to explore the strict use of only visual techniques in a visual medium such as animation. Do the visual representations rely on the often-used modality such as either a voice-over or text-pieces?

In this part of the split-test, participants were asked to watch an animation with a voice-over and no text-pieces and then the same animation with accompanying short text-pieces. This animation showed how a potential course of treatment could occur for the patient in the pain clinic. A protagonist (a woman) is shown going through this treatment, while the voiceover explains the different events and health personnel the patient can encounter. Through the animation various scene shifts happen and the voiceover explains some of the information that the patient will receive in the different courses issued from the pain clinic.

The first animation shown was without text (see Fig. 5). As feedback to this animation, it was said: "It went fast… A lot of information". Nevertheless, when asked to repeat the events in the different scenes, the participants were able to recall most of the information. This indicates that a combination of visuals and a voice-over was enough to provide the participants with at least a superficial understanding of the information. The next animation shown included short text-pieces (see Fig. 5). Three of the participants initially missed the text-pieces in the animation, except the part where the text was used to differentiate the different professions visualized (doctor, physiotherapist etc.). They liked that the differentiation was clarified through text: "… the pictures with the five professions… there I thought that it was good, that it said something above". On the other hand, one participant felt that the other text-pieces did not contribute to a better understanding or reflection on the information. This led to a discussion among the participants about the general necessity of text-pieces, whereby some found them important and not distracting.

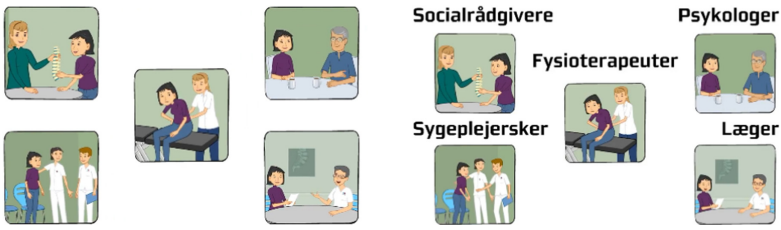


Fig. 5. Still images from the split-test with two versions of the same animated overview of sectors – one with only spoken word, and one with supplemented text overlays.

Afterwards, as a small experiment, the animation with accompanying text-pieces was shown without sound. The participants additionally agreed that the animation did not work without sound because a lot of the meaning was lost. One participant explained: "Because, it lacks a lot of coherence… you all of sudden lack… the context of what you're supposed to do". The participant would in this instance prefer if the animation had subtitles instead. This aligns with the study by Meppelink et al. [3] showing an

increase in comprehension when voiceovers are used to supplement health animations. Therefore, it seems that if the animation is meant to communicate a vast amount of information, it needs either a voice-over or at least 'subtitles', otherwise important information will be lost. However, if a voiceover is already used, short text-pieces can be used to clarify rapid information such as lists of medicines, professions etc. Consequently, the result confirmed our previous interpretation – it is difficult to convey comprehensible information solely through visual techniques. However, the pattern implies no need for a voice-over if text pieces are used. This indicates that the pattern still needs to be elaborated and adjusted through future testing, as we saw in the male vs. female pattern.

4 Discussion

In this study, we explored how a design pattern language approach can support the creation and validation of design choices in health animations. As argued, traditional animation already follows several design patterns including the famous 12 animation principles. These principles explain 'how' to create realistic animation by creating the illusion of obeying the basic law of physics. In contrast, our patterns attempt to explain 'why' certain form and content is chosen and animated in a certain way. This includes answering questions such as: what drove the choice of a male voice-over or the use of a transparent body in sickness-explanation animations. Understanding the 'why' allows stakeholders to critically question the form and content decisions made by others and themselves as well as to evaluate whether the decisions are strongly substantiated or merely a subjective opinion. This further supports transparency in the development process of health animations. The ambition of applying the design pattern approach for health animation was to leverage the same strengths the approach has shown in other domains – from strengthen architectural directions, to informing user-friendly digital interfaces. In health animation, we argue that our analysis indicates that pattern languages can inform the animation process, including the discourse and not only the form. As such, the pattern library of health animations has potential to reduce future communication mistakes and as a result improve the health animation by making it clearer and more comprehensible for the citizen.

The agreement we found between the created patterns and the results from the split-test indicates the achievement of the pattern library. Additionally, the value of the 'right' design choice became evident especially in the test of the male vs female pattern, where the design pattern method enabled the ability to locate a potential relevant design choice. This not only proves the importance of pattern languages but also validates its outcomes in health animations. We argue that a split-test or other tests alone would not be able to create a strong basis for a repeated use of a particular form or content decision e.g., the use of a male voiceover. The reason for this is the many variables at play, which we experienced in our split-test. However, by using a combination of sizeable split-tests (or other tests) along with an emerging pattern library (e.g., male vs. female pattern), it is possible to validate the form and content decision by allowing us to measure the results from the test against best practices in the field. Together, they can indicate which patterns are worth being preserved and repeated even with slight changes in the future.

However, the pattern library method also comes with its limitations and problems. It has previously been reported that the validation and testing of design patterns is a

difficult task due to their competing forces [15]. In the present work, we experienced this difficulty while testing the 'male vs. female voiceover' pattern. The participants preferred the male voiceover as suggested by our pattern. However, the reason for this preference is uncertain because of the challenge of isolating only one variable in an animation. We isolated the variable 'voiceover' by showing the same animation with the only change being the gender of the voiceover. Nevertheless, the feedback showed that the gender of the protagonist was important because it can create confusions when the protagonist has the same gender as the voiceover. We argue that this demonstrates the complexity of design patterns as well as their testing processes. It shows the need of a constant evolving pattern library that gets tested and adjusted over time.

5 Conclusion and Future Work

We initiated this study with a critique of previous studies for providing little-to-no rationale for the form- and content-related choices made in the design process of health animations. On that basis, we asked whether it was viable to scale the well-established design tradition of building and working with design patterns into the domain of health animation?

The initial mapping, of 72 Danish citizen-oriented health animation products, showed a broad range of animation approaches, fidelities and narrative structures being applied. Across the 23 design categories we were able to induct eight design patterns that could be described as tackling similar communicative problems, in a comparable contextual frame, and applying similar form and/or content choices as solutions. This indicates how the design pattern approach can be applied and used to create a frame of reference for health animations. However, the analysis also shows how the inducted patterns tend to blend form and content into patterns of discourse. That is, the patterns tell us more about the communicative dimension in relation to other patterns, rather than the semantics of each individual pattern alone. While this may be interpreted as the 'competing forces' of this specific application of the design pattern approach, it is also a limiting factor in our current attempts of scaling the method into the domain of animation. That being said, there is a definite potential to make the design process of this genre of animation more transparent, by utilizing this approach to articulate when we are making subjective form and content choices, and when we are leveraging past experiences through established patterns. The pilot split-test showed the potential for this by enabling a qualified hypothesis about what would work in the produced health animation variants, and what might fail when viewed by the citizens.

To further improve and develop the approach we argue that a series of further studies are required. First and foremost, the mapped health animations need to be increased from the current 72 to a substantially larger database. Furthermore, this mapping could be enriched by adding the complexity of health animations from other countries, while also creating the need for more fine-grained ways of sorting and analyzing across the categories than the current framework. Increasing the number of mapped animations will likely also produce more induced design patterns than the current eight. Additionally, an increase of mapped animations could potentially further strengthen the existing patterns with more variants, outliers, and connections among patterns.

Another important step is the implementation of this approach in both health practice and in academia. In the health care practice, a prominent issue is to identify the most suitable process of including and using pattern languages to communicate and participate in the design process. In academia, the challenge will be to effectively combine the transparency, made possible through design patterns, with the traditional effect studies most often seen in health animation studies. Combined, the two methods will be able to achieve a more precise determination of which parts of health animations work, for whom, and with what level of effect. Finally, due to the limited pilot split-test, the design patterns within this study are currently to be considered as activity patterns; not yet fully formed and validated by continuous development and testing. In conclusion, the design pattern library of health animation needs to be seen through the same lens of previous pattern libraries in their infancy: as a living 'evolving document' open to be challenged, modified, and even gradually replaced as the scope of their use is tested further by a maturing community of designers of health animations.

Appendix

Appendix 1:

Health Animation Mapping (accessed 16.6.2021)
https://docs.google.com/spreadsheets/d/1CWJwVGx7N9NTYDrIv-FOfC7zxOOp0rpqlS5p9U3SOqw/edit?usp=sharing.

Appendix 2:

Health Animation Design Pattern Library (accessed 27.1.2021)
https://docs.google.com/document/d/1eq373UTr56zNHMfxMDcLQVRHb0fu-ClzgKuCcl9iGlo/edit?usp=sharing.

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