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Chapter · June 2022

DOI: 10.1007/978-3-031-06018-2_29

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Rethinking Pension Communication – The Role of Metaphors in Information Visualization

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Abstract. Pensions are the most important source of income for the elderly. However, old age poverty is a growing issue and conventional communication channels seem insufficient to inform people about how their current decisions will impact their future pensions. This paper provides a practical approach to addressing pension literacy through data visualization via metaphoric storytelling. Information visualizations aid in both communicating complex phenomena and serve an educational role. In particular, metaphors have been widely applied for educational purposes. We recruited participants (N = 11) for a qualitative user study. Participants' prior knowledge of pensions was assessed before presenting them with an animated information visualisation about pensions using a tree metaphor. After the stimulus presentation, a semi structured interview was conducted with the participants to assess differences in pension literacy and to gather feedback on the visualisation. These interviews indicate that the used metaphor successfully communicated information about the pension system. The results of the study indicate that metaphors enable participants to immerse themselves in the story and think of scenarios in which their pension decisions affect them, going thereby beyond simple knowledge recall. This provides evidence that this type of data visualization might be suitable to communicate and educate about abstract, long-term phenomena such as climate change and the spread of infectious diseases.

Keywords: Information visualization · Storytelling · Pension data

1 Introduction

Pensions are the key dimension against poverty and social exclusion for the elderly as they are the most important source of income for this group [23].

V. G. Duffy (Ed.): HCII 2022, LNCS 13320, pp. 416–429, 2022.
https://doi.org/10.1007/978-3-031-06018-2_29

However, the 2021 pension adequacy report of the Social Protection Committee and European Commission indicates that old age poverty is a growing issue within the EU [4]. Existing pension systems are based on the assumption that people will act rationally, following incentives and measures, such as working longer and avoiding part-time positions. However, research shows that people do not react as expected [19]. Despite the impact on their pension, individuals leave the labor market too early, even before retirement age. Surveys show that individuals do not think about their pension [16,24] and have low interest, knowledge, or awareness of pensions [23]. Conventional communication channels no longer suffice. Myriam and Devolder [19] conclude that digitization of pension communications improves the understanding and the accessibility of the information. However, the field remains mute on how this communication should be designed. It is essential to review whether traditional communication strategies transfer well into a digital context.

Collaborating with a large Dutch pension fund, we assess a common method of information communication they use in traditional media and in their digital communication: metaphors. A metaphor is an oversimplification in which one phenomenon (source) is understood by conceptualizing in terms of a different phenomenon (target) [14]. For example, water flowing from a lake through pipes can be used to explain electricity from a battery running through a circuit [10]. We are expected to have a rudimentary knowledge of both batteries and water to understand this concept.

In a participatory design approach, we develop a new animated metaphor story that satisfies the developed criteria and communicates the key messages the pension fund is trying to express to their customer base. We assess this metaphor qualitatively and conclude that a metaphor-driven data story based on pension data can enhance pension communication.

The rest of this paper is organized into five sections. Section 2 reviews the literature on visual metaphors with a special focus on pensions. The method used in this study is described in Sect. 3, followed by the details of the qualitative user study in Sect. 4. Section 5 discusses the results before the conclusion is presented in Sect. 6.

2 Related Work

2.1 Towards Understanding Pension Data

Efficient communication of pension information within the available channels poses a significant challenge [1,2,17,22,31]. Overcoming these difficulties is of vital importance for the years to come [19]. One possible cause of the underlying difficulties might be how information is presented, which is mostly in the form of text and numbers [25]. Therefore, it is not surprising that new forms of presentation with visual means are receiving more attention within the pension domain. For example, Cox et al. [5] suggest using infographics to support financial decisions. As this field of research is relatively new within financial decision making, others propose learning from disciplines with a comparable domain like

health [28]. In the past, most of those approaches presented information in a static manner, which might be inefficient as the underlying process is time based and dynamic [7]. Prast [21] suggests an interactive tool on the pension system containing imagery of pension ownership, outcome estimations, an individual's payments, and how the pension changes over time. This tool might enable users to obtain a better grasp of the risks in their personal situation.

However, animated or interactive visualization of pension data is still very rare. Schroeder et al. [26] developed and evaluated interactive pension data visualization applications for domain experts in two and three-dimensional displays and found that both contexts can be beneficial. More recent work investigated the use of storytelling with pension information to facilitate understanding of individual pension data for citizens [27]. In the latter example, the information was presented solely by showing the visualized data, contextualized through text.

2.2 Contextualization Through Images

A growing body of research utilised metaphors for information visualization [15] and metaphors have been used in the past to communicate about the Dutch pension system [30]. Here, the focus lies on communicating investment uncertainty rather than explaining the financial flows. Although the authors claim the metaphor sufficiently communicates about pension risks, opponents state it might oversimplify and be too positive about the claims made [21].

As described in the introduction, water flowing through a pipe can be considered as a metaphor for understanding electricity flowing through a wire. Here, a property of model transfer takes place, moving attributes from one domain to another. The attributes in question are the finite capacity of pipes, indicating that wires also have a finite capacity and, therefore, a maximum amount of electricity can run through them. This inheritance of properties can be positive if accounted for, or can be negative ans cause misconceptions [12,15]. This can also be seen as a bias because it creates boundaries defined by the creator. Furthermore, it is a possibility that people either misunderstand or do not understand the intended metaphor at all. A model transfer will then be a misconception or non existent [20]. In one experiment on pension system communication and early retirement, manual laborers were used as a metaphor to communicate deserving tired workers. Once a different persona was used to symbolize under-served deserving elders, participants had a hard time adjusting because their understanding of the needs changed accordingly [11].

2.3 Visual Metaphors

The concept of metaphors refers to conveying a message through images. This message is not direct as it is implied through symbols and how these symbols are positioned. Implicit communication carries the risk of misinterpretation of a message [20]. Traegus [29] explores individual and holistic characteristics of an effective explanation by discussing explanatory frameworks. He states that the very basis of explaining unfamiliar concepts is to compare them to familiar

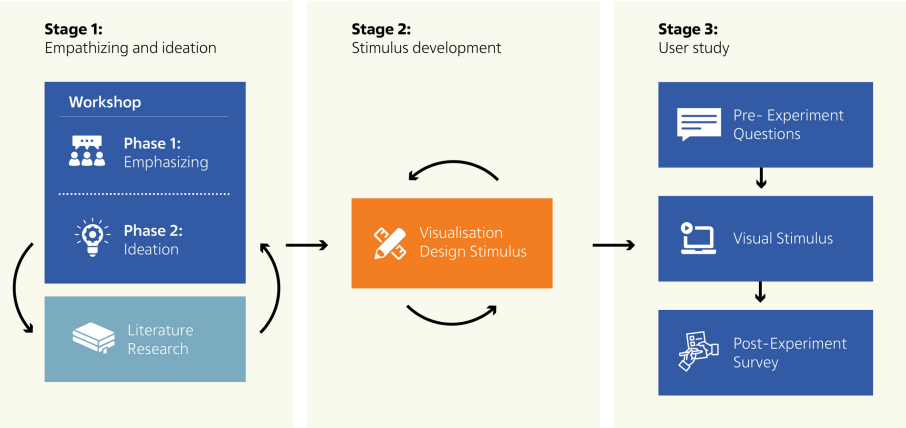

Fig. 1. The individual steps of the story generation and evaluation process as described in Sect. 2.

concepts and processes. For that reason, metaphors are important components in explanatory frameworks. Fry et al.'s [8] research has shown that by designing visualizations that are aligned to "system 1 thinking" [13], metaphors and narrative visualizations can communicate financial concepts in a way that also helps improve financial literacy. Lusardi's research [18] evaluated four educational programs about improving financial literacy. These consisted of an informational brochure, an interactive visual tool, a written narrative, and a video narrative. Outcomes of these evaluations showed how all the programs increased self-efficacy and how interactive programs can be particularly effective in improving financial literacy. Video narratives and visual tools appeared to be most beneficial in terms of financial literacy and financial self-efficacy through the vicarious and mastery experience.

3 Method

The method section presents the methodology followed to develop the visual stimuli used in this research. In Sect. 5, we overview the method used in the user study.

3.1 Participatory Design Process

We used a participatory design process to foster a holistic understanding and integrate domain knowledge from all relevant disciplines with domain experts. This methodology was also applied in other domains with similar challenges [32]. An interdisciplinary research group consisted of two industrial designers focusing on collaborative design methods, one information visualization researcher, four pension communication experts from different pension funds, and a researcher with a background in psychology.

The design process can be split into three different stages as seen in Fig. 1. The first stage focuses on acquiring knowledge on pension communication from experts. Next to that, a literature study is conducted to obtain a scientific perspective on this. The second stage focuses on the development of the stimulus. This is based on the aggregated findings of the first stage. Finally, the third stage involved the user study of the designed stimulus.

3.2 Stage 1: Empathizing and Ideation

To facilitate the design of the stimulus, a workshop was organized. This workshop consists of two phases. The first phase focuses on emphatizing with the end-user. The second phase focuses on ideating possible stimuli for communicating the aspects resulting from the first phase.

In the first phase, knowledge of the fundamental domain-specific conditions was shared. Based on the insights of the participants, lessons learned were distilled, resulting in an overview of insights and challenges covering topics such as the information visualization methodologies, levels of activation and demographics of the target group.

Synthesizing the knowledge gained from the collaboration with the domain experts and with the reviewed literature [6,9,19], three communication guidelines were established for the material, namely:

1. Simple and neutral communication
2. Specific monetary amounts
3. Personalized information

In addition to the communication guidelines, three key messages to be communicated through the visualization were generated:

1. Which money ends up in the pension fund
   This money originates both from the future retiree and the employer. The employer actually contributes a larger amount than the future retiree, which is often not known by the Dutch.
2. Growth of money over time
   Money placed in a pension fund is invested by the pension organization to create interest.This is an exponential relationship, which is hard for individuals to grasp.
3. The monthly retirement income of the individual
   It is assumed this will remain stable as the individual grows older rather than increase. Incomes generally increase as employees become more experienced, but this is not a guarantee that can be made in these visualizations.

An idea generation session was held in the second part of the workshop. The aim of the idea generation session was to generate a data story based on the generated key messages. During this part of the workshop, different kinds of data visualizations within a range of comparable contexts to pensions were

shown as a source of inspiration. Next to that, design cards with triggering questions and self-formulated triggering questions about pensions were presented to the participants to stimulate idea generation. All participants were given time to generate ideas with the help of the provided material and the three earlier defined key messages from the first workshop. These ideas were presented to one another, and the group had an opportunity to build upon each others' ideas. All ideas were documented, resulting in an overview of ideas focusing on the story the visualization should tell, the interaction that the target group should have with the visualization and metaphors that are suitable for the pension context.

3.3 Stage 2: Stimulus Development

Design. The design was developed through an iterative process. The final stimulus is an animation consisting of both text and visual elements. The duration of the animation is 90 s. The text and visual elements are presented dynamically, which results in several screens with different types of information. An overview of the screens is presented in Fig. 2. No interactivity was included in the final stimulus. The story, symbolism and aesthetics of the visualization will be discussed in the next section.

Story. The storyline resulting from the key messages generated in the workshop is threefold. First, the contributions of both employer and employee are presented. Second, what happens to these contributions is detailed. Finally, a total amount of pension is presented. The way these are presented was designed to be in line with the three communication requirements: simple and neutral, actual net amounts, and personalized. Net amounts of contribution and pension and information about the contribution of all parties are retrieved from the domain experts. This eventually led to the following bilingual textual story:

> **Dutch:** *Elke maand gaat er €201 van uw bruto salaris in uw pensioenpot. Uw werkgever voegt daar €456 per maand aan toe. In de loop van de maanden en jaren groeit uw pensioen en [naam van pensioenfonds] maakt daar meer van. Uw pensioenpot groeit door de jaren heen. Uiteindelijk zit er ongeveer €522.000 in uw pensioenpot. Wanneer u de pensioenleeftijd bereikt ontvangt u een pensioen van €1400 netto per maand.*

> **English:** *Every month, €201 from your salary is saved for your pension. In addition, your employer adds €456 per month. Over the months and years, your pension grows, and [name of pension fund] generates interest. Over the years, the pension pot grows. In the end, it will be €522,000 all together. When you reach the retirement age, you get a fixed amount of €1,400 per month.*

The Dutch version of the textual story was used during data collection. The text is aligned with the Dutch B1 level, which is representative of the target group.

Symbolism and Aesthetics. The visual story is conveyed metaphorically. During the first phase of the workshop, domain experts expressed difficulties with conveying pension stories. Based on the reviewed literature, metaphors might help to increase the understanding of pension [30]. To the best of our knowledge, this has only been assessed with a single study, and no replications have been conducted. From a practitioner's point of view, the domain experts expressed that the biggest challenge arises in finding the right metaphor. During the workshop, they expressed that some metaphors, such as coins and a piggy bank, have not worked in the past. Even though a piggy bank is a well-known metaphor representing savings, it is considered insufficient in this context as the pension story is about more than savings. Concluding from the workshops, we decided to develop a new metaphor for the means of this study.

During the second phase of the workshop, participants came up with metaphors that are not directly linked to pensions but do represent a process of change and growth over time. This resulted in the ideas of using the weather or the growth of plants as metaphors. These ideas were developed further during the iterative last stage of the workshop. The final metaphor decided on was the growth of an apple tree. In this visual story, watering cans symbolize the employer and employee contributions, and the growth of apples symbolizes the result of interest that is generated. The choice of the apple tree is based on two Dutch sayings: *Een appeltje voor de dorst* (*A rainy day fund*) and *De vruchten ergens van plukken* (*Reap the fruits of your labor*).

The aesthetics of the visual story are based on the colors and style that are in line with the corporate identity and of the collaborating pension fund, signaling trust and recognition. Colors are used to represent the different parties (dark blue—employee, light blue—employer, red—pension fund) and to emphasize the contributions of these parties in the text as seen in Fig. 2.

4 Stage 3: User Study

The goal of the study was to understand preconceived notions of the pension system and how a visual stimulus conveying the pension system through a metaphor is perceived by participants grasping a greater understanding of the pension system. The designed data visualization has been evaluated qualitatively to better understand how participants perceive and experience this visual stimulus.

4.1 Participants

Eleven participants were interviewed, aged between 32 and 55 (64% men, mean age 46, SD = 6.9). All participants are members of the same pension fund. The experts involved in this research work for this fund. The presented contributions are approximated based on the publicly available wage agreement of the participants. Recruitment of these participants was based on pension fund similarity as the designed data visualization is based on the corporate identity of this pension fund, signaling trust and recognition. Finally, all participants have completed a

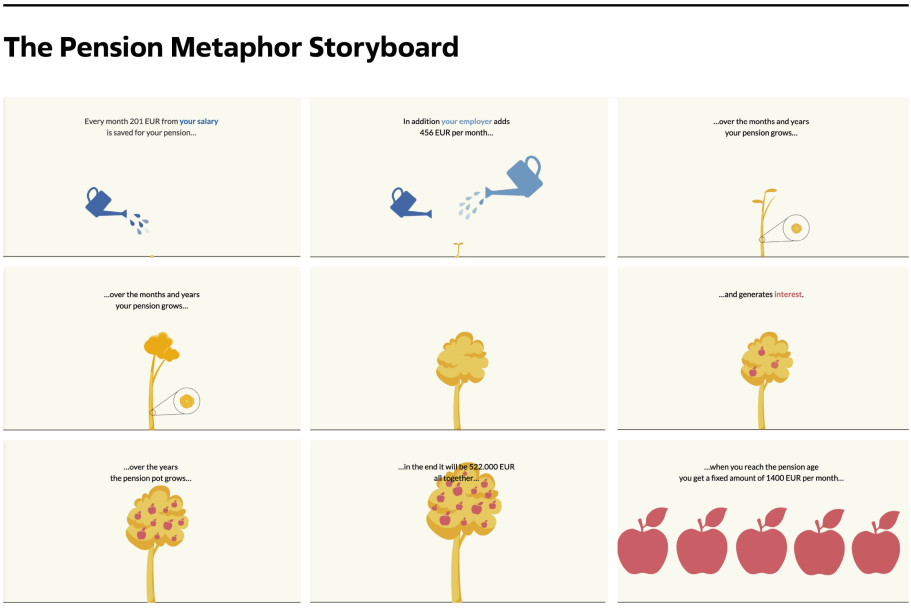

Fig. 2. Storyboard (Color figure online)

Dutch bachelor degree. There appeared to be no clustering of participants based on differences in prior pension knowledge. This is based on the financial literacy questions post-experiment and on insights obtained during the interview about their preconceived notions of the pension system.

4.2 Procedure

The procedure of the user study is visually outlined in the last step of Fig. 1. Each interview lasted approximately 30 min and was conducted using online video conferencing software in which both audio and video streams were recorded. First, the participant was introduced to the study. As a second step, participants were asked to answer demographic questions and questions about their current understanding of the pension system. Then, the visual stimulus was shown. Participants were asked to think out loud while viewing the visual stimulus. A post-interview was conducted afterward.

Pre-experiment Questions. Control variables covering demographics, such as age, education level, work, and family situation, were collected first. Then the participants were asked to share their current understanding and associated feelings with regards to the pension fund and system. The interviewer stressed that these questions were focused on their perception rather than their knowledge of pensions. Questions such as "What do you think of pensions?" were asked

in this step. The relationship between the participant and the pension fund was understood by asking questions about what they think of their pension fund (e.g., distant in communication or a non-sustainable investment portfolio). Furthermore, participants were asked about their relationship with the fund by asking how they had contact with the pension fund and how often. This question covered letters and visiting the public website and their personal environment after logging in on the online portal. Open-ended questions were asked about the monetary flows (e.g., Who puts in money for your future pension, what happens with that money?). The participant was again reassured and told the focus lies not on providing correct answers but on providing personal insights on those mechanisms.

Visual Stimulus. During the stimulus, the participant was asked to think out loud. After the stimulus was shown, the clarity of the visualization was discussed (e.g., can you describe what you have just seen?). In addition, the visualization was compared to their preconceived notions of the pension system, and the differences were discussed. As the interviews were conducted through online video conferencing software, asking the participants to think out loud ensured that the visualization was seen and considered.

Post-experiment Survey. After the participants had observed the stimulus, whether the visualization met their preconceived notions of the Dutch pension system was determined. In addition, participants were asked about the objects used, and more in-depth questions were asked regarding the symbolism (e.g., Can you explain what the apples/tree/watering can symbolize?) and what the colors represent. These questions were asked to learn whether participants understood the metaphor in this particular context. Participants were asked for suggestions about further improving the visualization. This was asked to empower the participant to share thoughts regarding topics that have not been covered by the asked questions. Finally, the participants were asked multiple-choice questions about financial literacy. These questions are used as control variables for financial literacy.

4.3 Analysis

The interviews were recorded and transcribed by the researchers. Considering the relatively small sample size ($N = 11$), the data integrity was maintained. Answers to the posed questions have been summarized as transcript summaries and placed in a spreadsheet to create a legible overview for all researchers involved. Furthermore, researchers made notes during the interview to revisit during the analysis. The research team analyzed the data together in order to minimize biases. During the analysis, the analytical focus was on the participant's perception of pensions and the Dutch pension system rather than knowledge of Dutch pensions. Considering the scarcity of research in this domain, a data-driven approach was used

to derive emerging codes and themes through the data analysis. These are topics that are direct consequences of the posed question topics.

Looking at the quantitative control test on financial literacy, 10 of 11 participants answered these three questions correctly. Only one participant answered only two of three questions correctly. Based on these initial results, no outliers can be detected in terms of participant financial literacy. After conducting the interviews, it appeared that another participant had prior work knowledge in the pension field. This has been taken into account in the analysis of the findings.

5 Results

The participants' knowledge prior to the visual stimulus was assessed based on the pre-test questions. Two of three questions used as the control variable on financial literacy were answered correctly by all participants. One question was answered correctly by ten of eleven participants. Based on this, it can be stated that the financial literacy of all participants was good. All participants know their pension fund and understand its purpose.

Based on the participants' descriptions of their feelings towards their pension fund, two main characteristics can be observed: *trustworthy* and *old-fashioned*. Few participants mentioned a negative association with their pension fund in terms of its investments in particular industries. All participants indicated they had been in contact with their pension fund at some point in their lives. The majority indicated that their only point of contact was the letters they receive from their pension fund on a yearly basis. Some have reached out to the pension fund themselves to get answers to questions raised by life-changing events such as marriage or divorce. Three themes distilled from the rest of the interviews are discussed below.

5.1 Ratio of Contribution

All participants are aware that a part of their salary is set aside for their pension. Only one participant did not know that the employer also contributes to the employee's pension. However, none of the participants either knew or had a correct view of the ratio of the employee and employer contributions. All participants know that their pension fund invests the contribution.

In the visual stimulus, the contributions of the employee and the employer are described numerically. After viewing the visual stimulus, all participants knew the employee's and employer's contribution and the ratio thereof. In addition, all participants were able to recall the approximate amount of the accrued pension and the net amount of their pension. They were all able to exactly reproduce the numbers and express the ratio. Almost all participants expressed that the employer's contribution was higher than expected.

The pension fund's contribution has only been shown visually (apples that grow in the tree) and not numerically. After viewing the visual stimulus, it remained unclear to the participants what the contribution of their pension fund

is exactly and this raised questions. Other questions that arose throughout the interview are related to whether the ratio would change over time, whether this information would still be relevant in 20 years, and what impact life-changing events would have on this scenario.

5.2 Metaphor

During the interview, it became clear that all participants understood the metaphor. They describe that the apple represents interest, the tree represents the contributions from themselves and their employer, and that the watering cans represent the contributing parties. When discussing the metaphor, the apple seemed to draw the most attention from the participants.

Three participants connected the metaphor of the apple to two Dutch proverbs which apples or fruits are part of: *'Een appeltje voor de dorst'* (a rainy day fund) and *'De vruchten ergens van plukken'* (reap the fruits of your labor). Four participants mentioned that the metaphor of the tree is very suitable in this context as it meets the expected and desired image of pension funds. In addition, the participants mentioned that a tree represents healthy growth and stability.

Different questions raised by more than one participant about the metaphor were: *What would happen to my tree when I die?, How do the apples grow exactly? Do they grow healthy?*, Is there something I can do to make the apples grow? and *Can I pick the apples earlier?* The participants expressed that these were not questions that they thought of before viewing the visual stimulus.

5.3 Design

Many comments were made about the colors used in the visual stimulus. The most discussed object was the yellow tree. Participants expressed that the tree should be green and brown. On the one hand, this had to do with the fact that the tree should have "regular" colors. On the other hand, participants expressed that the tree color had been used to indicate the difference in contribution from employee and employer, as discussed earlier. Furthermore, the color scheme as a whole was not appreciated. Participants described it as *boring* and *not colorful.*

Participants expressed confusion about the speed and the size of objects within the animation. The speedy growth of the apples did not represent the participants' perception of the time required to grow a pension. In addition, the total size of the tree was not considered representative of the total amount of a pension.

6 Conclusion

This paper aims to research the potential of metaphors as an alternative to quantitative data visualization approaches in pension communication. Due to regulatory changes in the Dutch pension system, employees will have more control and

ownership of their pension fund. As about 79% of the Dutch working-age people have an incorrect understanding of how pension funds work, it is important to improve pension literacy. The research team created a personalized dynamic visualization of the pension fund, which is told through metaphors aligned with Dutch proverbs. A qualitative study evaluated this visualization with eleven participants. All participants understood the metaphor correctly and were able to explain what they observed.

Our research has two main findings. Primarily, we show that metaphors seem to be a fitting approach to explaining the Dutch pension system. Metaphors can help link a more abstract concept to an individual experience. Through the metaphor, the participants were inclined to think of their own situation and understand the pension system as a whole. This might indicate that participants have surpassed superficial thinking about their pension and are able to question their individual situation through wonderment [3].

Secondly, numerical values used in the data visualization, such as net monthly pension upon retirement or monthly contribution from the employer, appeared to play a stronger role in the comprehension of the pension fund than the metaphor itself. The participants were able to recall these numerical values in the discussion after viewing the visualization. The combination of a metaphor and concrete descriptions might be beneficial in understanding complex and abstract phenomena as they complement each other. Concrete descriptions aid in the general understanding, whereas the metaphor contributes to the role of an individual in this complex phenomenon.

6.1 Limitations

The designed data visualization utilized the colors present in the corporate identity of the pension fund to meet expectations of trust and recognition. However, many participants stated these colors were out of place and raised questions rather than providing recognition. The color used for the tree had a particularly negative impact on the participants' experiences. Still, this does not appear to have negatively influenced the understanding of the pension fund explanation as a whole. Properties of model transfer apply in this case of metaphors. Both predestined attributes and abundant attributes of the source are translated to the field of application. By suggesting the metaphor as a model image function, abundant attributes can be introduced to the concept. This property has both wanted and unwanted effects. On the one hand, it provides learning opportunities to transfer known properties from one domain to another. On the other hand, it also holds true for unwanted or unknown properties, thereby including more uncertainty in the designed data visualization. In the case of this study, the representation of apples as money in the pension fund unintentionally indicated that the pension fund could be accessed before the retirement age is reached.

6.2 Future Research

The studied metaphor caused participants to think about the pension fund in their own situation. It is unclear whether that reaction was caused by this specific metaphor or by the dialogue about pensions in general. Possible explanations are that the animation itself caused the participants to consider their own situation, or that such consideration was an effect caused by the metaphors. Future studies should attempt to isolate this effect by comparing metaphors to non-metaphorical data visualizations in this domain.

Pension research is extensively covered in the scientific literature. Upon transferring this type of study to different fields, research needs to be conducted on the variables that need to be disclosed and the metaphor itself that could complement the data story.

The results of this study show the potential for the application of metaphorical data visualization to comparable abstract processes in the public sector such as regulations and laws and for similarly complex and abstract phenomena such as climate change and the spread of infectious diseases.

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