Embellishments Revisited: Perceptions of Embellished Visualisations Through the Viewer’s Lens

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Abstract—Embellishments are features commonly used in everyday visualisations which are demonstrated to enhance assimilation and memorability. Despite their popularity, little is known about their impact on enticing readers to explore visualisations. To address this gap, we conducted 18 interviews with a diverse group of participants who were consumers of news media but non-experts in visualisation and design. Participants were shown ten embellished and plain visualisations collected from the news and asked to rank them based on enticement and ease of understanding. Extending prior work, our interview results suggest that visualisations with multiple embellishment types might make a visualisation perceived as more enticing. An important finding from our study is that the widespread of certain embellishments in the media might have made them part of visualisation conventions, making a visualisation appear more objective but less enticing. Based on these findings, we ran a follow-up online user study showing participants variations of the visualisations with multiple embellishments to isolate each embellishment type and investigate its effect. We found that variations with salient embellishments were perceived as more enticing. We argue that to unpack the concept of embellishments; we must consider two factors: embellishment saliency and editorial styles. Our study contributes concept and design considerations to the literature concerned with visualisation design for non-experts in visualisation and design.

Index Terms—Visualisations, Embellishments, Non-experts in visualisation and design

1 INTRODUCTION

Historically, news media employed visualisations as a storytelling strategy to simplify complex ideas and reach a broad audience. News visualisations are consumed by a wide range of readers, varying in their motivation. Prior work indicated that consumers of such visualisations are not always motivated by productivity and financial incentives [34, 38]; instead, gaining insights and a pleasing experience are important goals as well. In parallel, we have seen a growing interest in news visualisations within the Human-Computer Interaction (HCI) and Information Visualisation communities, for instance, examining crisis visualisations [25, 47], and visualisations in storytelling articles [14].

Various visual elements are commonly used to attract readers’ attention to visualisations in the news media, such as icons, pictographs, images, and others, all known as embellishments. There has been an ongoing debate over the usefulness of embellishments. On the one hand, pioneers in the visualisation community, such as Edward Tufte [40], proposed the ‘above all else show data’ principle and considered embellishments distracting, implying they should be avoided. On the other hand, empirical research has provided evidence that contradicts this stance. For instance, embellishments were found to not hinder comprehension [4], but to make a visualisation memorable [5, 26, 33], engaging [3], accessible [44], and imaginative [11].

Prior research has demonstrated that readers look at visualisations and do not ignore them in a news article [13]. Specifically, research showed that embellishments (stacked pictographs) attract initial attention more than bar charts and text [16]. However, little is known about how other embellishment types attract attention and how personal contexts, such as interests and attitudes, may contribute. Several studies (e.g., [6, 24, 42]) indicated that accuracy and time were dominant measures in visualisation evaluations while others, such as emotion, attention and engagement, gained less attention. Therefore, we collected a range of embellished and plain visualisations from the news and explored whether and why people find them enticing. For this study, we understand embellishments as the elements that make a visualisation deviate from an assumed standard (minimum ink, space and colour). We define Enticement as the level at which the visual representation feels inviting and encourages viewers to look and explore [46], and we treat it as a proxy of initial engagement. Moreover, given the criticism that embellishments may distract the reader [40], we also examined their effect on perceived ease of understanding.

We adopted a qualitative approach: we interviewed 18 participants who were consumers of news media but not experts in visualisation or design. We showed them a selection of ten visualisations that included various embellishment types (e.g., icons, backgrounds) and plain visualisations. We asked participants to rank these visualisations based on enticement and ease of understanding to initiate a discussion. Following the interview results, which suggested that visualisations with multiple embellishment types were perceived as more enticing, we wanted to identify the specific embellishment type that brought this effect. For this purpose, we ran a follow-up online user study where we showed participants multiple visualisation variations that showed each embellishment type individually and in combination and asked participants to rate them based on enticement.

Our findings suggest that visualisations with salient embellishments (e.g., large-sized icons on their own or combined with other elements) are perceived as more enticing as these visualisations looked less like graphs. At the same time, visualisations that maintained the look of a graph and used subtle embellishment types (e.g., icon labels) were seen as less enticing, even indifferent to their plain version. Participants associated certain visualisations with a particular editorial style or publication venue, which indicates the impact these styles and venues have on the visualisation convention. Our results also suggest that visualisations with salient embellishments were perceived to help sense-making and encourage participants to consider topics that otherwise would have been ignored. However, such embellishments made participants feel patronised and distrusted the visualisations as their style was associated with specific news outlets, such as tabloid newspapers.

The contribution of this work is twofold: (1) First, we extend the conversations about embellishments by proposing revisiting the current binary opposition where visualisation is embellished or not, which is often used in the literature (e.g., [3, 4]). We call for an embellishment typology considering embellishment saliency and editorial style. (2) Second, we demonstrate the positive and negative sides of various
embellishments on engagement, sense-making, and emotions.

2 BACKGROUND

Researchers and designers use several terms to describe embellishments, such as chart junk, clutter, decorations, and non-essential data; however, there is no unified definition. From the minimalist perspective, visualisations should be simple. Decorations such as gridlines and colour or artistic elements such as images and icons are all described as Chart Junk – a notion introduced by Tufte [40] and endorsed by others [12, 39]. From the embellishment perspective, embellishments refer less to decoration and more to images, shapes, and icons. For instance, Ajani et al. [1] distinguished between ‘clutter’ and ‘chart junk’, where the first refers to graph conventions such as tick marks and gridlines, whereas the latter refers to images and icons. Also, there is a loose understanding of embellishments among designers. For example, Parsons and Shukla [30] conducted an interview study with 20 visualisation practitioners in which they found that designers perceived animation and interactivity as embellishments. For this study, we use Tufte [40] guidelines to define embellishments. We consider icons, pictograms, backgrounds, textual annotations (other than data labels), and colour (if not used as a visual channel) as embellishments to achieve maximum contrast. We do not consider tick marks and gridlines as embellishments, as participants might find visualisations without these elements to be unfamiliar [17].

2.1 The Effects of Visual Embellishments

One of the earlier concerns about embellishments was related to comprehension. Bateman et al. [4] demonstrated that the assumption that embellishments hinder comprehension might have been overestimated by running a comparative study between embellished and plain visualisations. Similarly, Park, Kaufman, and Mueller [29] showed that integrating a line chart with an aesthetically pleasing background does not cause an increase in error rate or response time. In line with these results, Burns et al. [11] found that icon arrays and plain charts similarly affect understanding using multiple tasks. Skau and Kosara [37] found that pictorials within a bar chart have a limited impact on accuracy for absolute and relative judgement tasks. In contrast, Borgo et al. [5] found that embellishments may slow the visual search but can assist in concept grasping. They used a variety of embellishment types (e.g., stacked pictograms, icon labels) and concluded that concept grasping results were mixed based on the embellishment type. In our work, we sampled visualisations published in the media and explored different embellishment types from enticement and sense-making perspectives. Kelly [19] evaluated embellished visualisations found in American newspapers. They compared ten low data-ink ratio visualisations (i.e., embellished) with high data-ink ratio visualisations (i.e., plain) and did not detect differences in accuracy. Thus, there is evidence that embellishments might have been perceived to be more harmful than they are. Most of the studies above were lab-based, where participants were given a task to complete, which helped extract tangible insights and the mental effort used to extract insights, both used as an indication of engagement. Similarly, Vande Moere et al. [41] investigated engagement through insights and found no differences between visualisations with an artistic style, analytic style, and magazine style; however, the artistic version (i.e., embellished) encouraged reflective and subjective interpretation, which could indicate a higher level of engagement. Andry et al. [3] showed 40 digital communication professionals plain and embellished visualisations and asked them to explore the visualisation, follow the labels, and complete a survey about their experience, followed by a short interview. They found that people liked the embellished visualisations more and felt immersed.

Engagement is a multifaceted concept that requires investigating its different components. Mahy et al. [27] provide a helpful taxonomy for how the visualisation community could approach different engagement levels using depth of understanding. For instance, the studies mentioned above [11, 41] target a higher level of engagement where insights were used as a proxy for engagement. Nevertheless, the taxonomy relies on the level of involvement with the data, assuming that people are motivated to look at the visualisation in the first place. Few studies investigated whether embellishments ‘entice’ people to look and attract their attention, although motivation is essential in creating engaging visualisations. For instance, Huang and Parsons [18] reviewed literature from education, gaming, HCI, and information visualisation and found that intention and autonomy were common attributes to be considered when defining the scope of engagement with visualisations. Haroz et al. [16] evaluated initial attention by presenting participants with a blurred grid with three stacked pictogram charts, bar charts, and text and calculated the proportion of participants who looked at each item within the first minute of exposure. They found stacked pictograms captured participants’ initial attention more than bar charts and text. We have identified this as an opportunity to explore the different embellishment types and how they entice the non-experts in visualisation and design to look at and explore the visualisation.

2.2 Visualisations in the Media

Few contributions investigate visualisations by taking a sample from the media (e.g., [3, 8, 19]), meaning that most researchers mainly ‘created’ the visualisations rather than ‘found’ them. This is not to imply that studying embellishments with published visualisations is better than investigating embellishments with custom-made visualisations but to hint that there is a scarcity of contributions that use visualisations published in the media. The importance of using such visualisations when exploring embellishments comes from the fact that multiple factors contribute to the readers’ engagement with visualisations and which, in turn, need to be considered when evaluating visualisations; these factors are topic, source, beliefs and opinions, confidence in skills, time, and emotions [22]. Peck et al. [31] evaluated ten visualisations collected from various sources by interviewing 42 participants from diverse backgrounds; participants were asked to rank these visualisations based on usefulness. They reported that participants gravitated toward visualisations that speak to their personal experiences. De Haan et al. [13] echoed these observations using a mixed-methods approach: eye-tracking, focus groups, and surveys with subscribers and readers of Dutch newspapers. They found that interest was the most critical factor for readers when deciding to read an article. Moreover, when readers perceived a visualisation as interesting and beautiful, they were more willing to read the news article. Nevertheless, participants reported that colours, images, and icons must serve a purpose and align with the article to be appreciated. We conclude that there is value in considering personal interests, attitudes and beliefs when exploring embellished visualisations aimed at non-experts in visualisations and design.
them based on two prompts to initiate a discussion about their rationale. The following sections provide details about (1) our recruitment process, (2) the method we used to select the visualisation set for the interview, and (3) our interview.

3.1 Recruitment

To recruit a diverse sample of participants for our study, we used a crowdsourcing platform (Prolific). In recruiting the participants, we applied two levels of participant screening: (a) built-in Prolific screening and (b) custom screening (i.e., using a short survey). In the Prolific screening, we limited our recruitment to participants in the UK to ensure that participants were familiar with the news media platforms we selected. We also limited participation to those fluent in English to avoid language limitations. Moreover, we required participants to have completed at least 100 studies with a minimum 95% approval rate, as prior work indicated that this combination could ensure data quality [32] when recruiting from crowdsourcing platforms. Also, we restricted participation to people who disclosed that they were not actively working on other crowdsourcing platforms.

In our custom screening survey, we considered eligible for the study participants who indicated that: (i) graphic design is not their hobby or profession, (ii) they do not frequently create visualisations or visit forums, blogs or websites about data visualisations (this is because such participants have a high extrinsic motivation to look at visualisations [34]), (iii) they use English as the primary language for reading the news, (iv) they read or subscribe to one of the following news media platforms: BBC, Daily Mail, The Guardian, or The Telegraph (this is because we wanted to recruit participants who consume news content and consequently news visualisations. It also ensures that participants have at least some familiarity with the publication venues. We elaborate on the choice of venues in Sec. 3.2), (v) they do not analyse the original dataset after seeing a visualisation in the news (this is to limit recruitment to the non-experts rather than enthusiasts about data visualisations), and (vii) they are not colour-blind. Of the 145 participants who responded to the survey (N = 145), 60 were eligible to participate in our study. We paid participants £0.37 to complete our two-minute survey, based on an £11.05 hourly rate corresponding to the UK minimum wage [15].

3.2 Visualisation Selection

We selected the visualisations we used in the interview study by following two steps: (1) selecting a set of visualisations from the news and (2) running a short pilot survey to help us filter and select ten visualisations for the interview. We manually collected 64 (34 embellished and 30 plain) static visualisations from UK news media over eight weeks (February to April 2022). We selected the top four news media platforms in the UK (BBC, Daily Mail, The Guardian, The Telegraph) based on monthly visits in 2021 [43]. We searched for up-to-date visualisations through official websites by looking at the most viewed, commented on, shared, and featured articles. We avoided collecting visualisations from data blogs in these news platforms as such visualisations might be targeted to the visualisation enthusiast, which goes beyond our scope.

The visualisation topics were diverse: politics, business and economics, health, climate change, society, and science. We found the following range of visualisation techniques within our sample: lines (n = 27), bars (n = 24), icon arrays (n = 4), dumbbells (n = 2), and donut (n = 1) charts. Most of our visualisations were line and bar charts (42% and 38% respectively), similar to [8] analysis of news visualisations. Our sample set covered a wide range of embellishment types: background image (n = 18), icon labels (n = 9), pictorial bars (n = 3), icon arrays (n = 3), illustration graphics next to the visualisation (n = 2), and thematic images (visualisations embedded in an image. e.g., visualisation E in Fig. 1) (n = 1). Some visualisations were counted twice as they had multiple embellishment types.

We then excluded 40 visualisations because (a) the topic might cause distress to participants (e.g., war, COVID-19, cancer) (n = 24), (b) they used abbreviations that needed prior knowledge (n = 6), (c) were against heuristics (e.g., the y-axis is on the right) (n = 1), and (d) were very specific (e.g., water levels in a small town in Germany) (n = 9). Overall, we were left with 24 visualisations. To help us select ten visualisations, we ran a pilot study using a short survey. We then selected visualisations participants perceived as beautiful, interesting, understandable, and preferable.

![Fig. 1: The selected visualisations that were used in the interviews. Each visualisation is identified with an ID. Embellished visualisations are identified with grey boxes and plain ones with red boxes.](https://example.com/fig1)
We recruited 18 participants (10 men, 8 women) from a diverse range of professional backgrounds to ensure a varied representation of the target audience. Also, the ten selected visualisations cover four of six visualisation techniques in the initial selection. Moreover, our selection falls into all the visualisation topics in the initial selection. Our results indicate that the selection set is a good representation of embellished visualisations found in the news.

Table 1: Description of the visualisations used in the interviews. Type indicates whether the visualisation is embellished (E) or plain (P).

<table>
<thead>
<tr>
<th>ID</th>
<th>Topic</th>
<th>Source</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Expected food price increases</td>
<td>Daily Mail</td>
<td>E</td>
</tr>
<tr>
<td>B</td>
<td>How Britons spend their money</td>
<td>Daily Mail</td>
<td>E</td>
</tr>
<tr>
<td>C</td>
<td>Food footprint</td>
<td>BBC</td>
<td>E</td>
</tr>
<tr>
<td>D</td>
<td>Wildlife Services’ most-killed species</td>
<td>The Guardian</td>
<td>E</td>
</tr>
<tr>
<td>E</td>
<td>What currently makes the cost of fuel higher?</td>
<td>Daily Mail</td>
<td>E</td>
</tr>
<tr>
<td>F</td>
<td>Russia’s gas exports</td>
<td>BBC</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>Comparison of space rockets</td>
<td>BBC</td>
<td>E</td>
</tr>
<tr>
<td>H</td>
<td>Sick pay coverage</td>
<td>The Guardian</td>
<td>E</td>
</tr>
<tr>
<td>I</td>
<td>China’s carbon emissions</td>
<td>BBC</td>
<td>E</td>
</tr>
<tr>
<td>J</td>
<td>Long waits for gynaecology</td>
<td>BBC</td>
<td>F</td>
</tr>
</tbody>
</table>

### 3.2.2 Outcome

Figure 1 displays the visualisations we used in the interviews. We provide details about these visualisations in Tab. 1. As evident, the visualisations included a relatively wide range of embellishment types. The selected visualisations represent five of six embellishment types found in our initial visualisation selection as mentioned above in Sec. 3.2. Also, the ten selected visualisations cover four of six visualisation techniques in the initial selection. Moreover, our selection falls into all the visualisation topics in the initial selection. Our results indicate that the selection set is a good representation of embellished visualisations found in the news.

Table 2: Overview of our interview participants' demographic data

<table>
<thead>
<tr>
<th>P#</th>
<th>Professional Background</th>
<th>Chart Familiarity</th>
<th>50</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>10</th>
<th>Age</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Sales Consultant</td>
<td>3</td>
<td>66</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>M</td>
</tr>
<tr>
<td>P2</td>
<td>HR Consultant</td>
<td>4</td>
<td>57</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>F</td>
</tr>
<tr>
<td>P3</td>
<td>Military</td>
<td>3</td>
<td>33</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>34</td>
<td>F</td>
</tr>
<tr>
<td>P4</td>
<td>Teacher</td>
<td>3</td>
<td>51</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>M</td>
</tr>
<tr>
<td>P5</td>
<td>Science</td>
<td>2</td>
<td>52</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>F</td>
</tr>
<tr>
<td>P6</td>
<td>Head of Communication</td>
<td>2</td>
<td>49</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>F</td>
</tr>
<tr>
<td>P7</td>
<td>Primary School Teacher</td>
<td>3</td>
<td>49</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>34</td>
<td>F</td>
</tr>
<tr>
<td>P8</td>
<td>Psychology Researcher</td>
<td>4</td>
<td>48</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>F</td>
</tr>
<tr>
<td>P9</td>
<td>IT System Consultant</td>
<td>4</td>
<td>62</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>M</td>
</tr>
<tr>
<td>P10</td>
<td>Vicar</td>
<td>3</td>
<td>70</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td>M</td>
</tr>
<tr>
<td>P11</td>
<td>Self-Employed</td>
<td>3</td>
<td>49</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
<td>F</td>
</tr>
<tr>
<td>P12</td>
<td>Speech Therapist</td>
<td>3</td>
<td>44</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>F</td>
</tr>
<tr>
<td>P13</td>
<td>Sales Assistant</td>
<td>3</td>
<td>29</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>F</td>
</tr>
<tr>
<td>P14</td>
<td>Civil Engineer</td>
<td>3</td>
<td>34</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>M</td>
</tr>
<tr>
<td>P15</td>
<td>Painter</td>
<td>2</td>
<td>30</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
<td>M</td>
</tr>
<tr>
<td>P16</td>
<td>Business Consultant</td>
<td>5</td>
<td>59</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>34</td>
<td>M</td>
</tr>
<tr>
<td>P17</td>
<td>Sales and Distribution</td>
<td>4</td>
<td>46</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>M</td>
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<tr>
<td>P18</td>
<td>Procurement Professional</td>
<td>4</td>
<td>66</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>36</td>
<td>M</td>
</tr>
</tbody>
</table>

### 3.3 Interviews

#### 3.3.1 Participants

We recruited 18 participants ($M_{Age} = 49.7$, $SD_{Age} = 12.4$, 10 women) from the screened eligible participants (see Sec. 3.1). Participants completed a chart familiarity survey with a 5-point Likert scale adapted from Pandey et al. [28], which could be used as a proxy of visualisation literacy. Our participants had a mid-scale chart familiarity ($M = 3.17$, $SD = 0.79$). We required participants to attend the interview from a desktop or a laptop computer to ensure the resolution of the visualisation. We used $M_{Age} = 49.7$, $SD_{Age} = 12.4$, 10 women to maintain the source. However, we refrained from removing colour because we were aiming to understand whether and how participants were attracted or engaged with the visualisations without biasing their responses. We decided to add “You can imagine that you are reading the news and encounter them” to the instructions as we thought it would be helpful for participants to imagine these visualisations in a particular context. Based on participants’ rankings, we asked them follow-up questions about their rationale regarding the most and least enticing visualisations. In addition, we asked participants to explain how they decided on the ranking of the bar charts (I, F, H) as they were similar to each other. Furthermore, we asked participants whether they would change their ranking if the criteria were based on ease of understanding. Whenever a participant showed a willingness to change their ranking, we duplicated the ranking table and randomised the visualisations in the Miro board for the participant to rank them separately; otherwise, we did not duplicate the table. We asked about the reasons behind their willingness or reluctance to change their ranking. We made the re-ranking optional, inspired by Peck et al.’s [31], where they allowed participants to re-rank the visualisations after the source was revealed. Also, we did not want to overwhelm our participants with the ranking tasks. It is important to emphasise that these rankings are not the primary outcome of this study but rather an approach to initiate a discussion. We acknowledge that other elements (e.g., article title, content) may contribute to ease of understanding, but we focus on ease of understanding within a visualisation to maintain the study scope and help us discriminate between the different designs.

Finally, we presented a plain version of the embellished visualisations (see supplementary material). These versions were created following our embellishment definition (see Sec. 2). We removed all the graphics, textual annotations, and colour as much as possible, but we maintained the source. However, we refrained from removing colour for visualisations B and E as it would have been difficult to read the visualisation without them. The plain visualisations were displayed in random order. We asked participants whether they would like to exchange the visualisations with any of the embellished versions in either ranking, and we asked about their reasoning.

### 3.4 Results

We report the qualitative results from the interview while providing the ranking results in the supplementary material. During the interviews, we avoided referring to visualisations using numbers to prevent biasing the ranking. Interviews lasted, on average, 41 minutes and we compensated participants with £10 for their time. We fully transcribed interviews worth 12 hours. The transcripts were edited to refer to each visualisation mentioned by the participants by the letter used in Tab. 1 to make the transcriptions easier to read. We analysed the transcriptions using thematic analysis [10]. Initially, the first and second authors read the transcriptions to familiarise themselves with the interview data. Next, initial codes were drawn from our research question as the following topic: (e.g., personal relevance), visual aspect (e.g., cluttered, novel), and reception (e.g., easy to see, effort required). Then the first author supplemented these codes with the ones we identified from the interviews using manual line-by-line coding. We revisited the initial
codes and modified their definition based on the newly emerged codes. Moreover, the first author tagged each code instance with the visualisation letter defined in Tab. 1. The first author coded the interviews progressively and stopped recruitment when we were editing the code labels instead of adding new codes to our code book [10]. After the first author did the initial coding, a discussion with the second author resulted in a second code iteration. The coding process was revisited three times to ensure that codes were relevant to the visualisations, consistent throughout transcripts, and without duplication, which resulted in 56 codes (see supplementary material). We want to emphasise that while some codes might have a low frequency, this is not indicative of the significance of the results. Thematic analysis theory [10] emphasises that due to the nature of semi-structured interviews, the lack of reporting (or infrequent reporting) on certain experiences, does not mean these experiences did not exist. The first and second authors held regular meetings to discuss the themes, during which the third author was also introduced to the themes. After reflection and several iterations, the authors reached an agreement on defining five themes, which we introduce next.

3.4.1 Topic matters but so does embellishment

The personal relevancy of the visualisation topic was an important factor in enticing participants (coded 40 times). Participants (n = 9) felt connected to the visualisations about the cost of living (e.g., A, E), which directly impacted their daily lives, and considered these visualisations high on enticement. For example, in reference to visualisation A we heard: “it’s a salient subject. Everybody’s interested in at the moment, that has an impact on you as an individual. So I suppose that was the first thing that I looked at cause I thought it had a certain amount of relevance [P8]”, and: “it’s food price increase, something that really quite catches my eye. I want to know more about it because it affects me [P15]”, and about visualisation E, P10 explained: “it’s got an immediate relevance to me”.

In other comments, participants (n = 5) explicitly suggested that embellishments positively impacted their enticement when the topic was less relevant to them. For example, P6 who had a low chart familiarity (M = 2) felt encouraged to explore visualisations depicting topics beyond their interest area: “whilst I’m interested in this matter [refers to sustainability] [...] I feel that visually those other ones [E, A, G, B] are far superior [...], much more enticing than [I]”. Similarly, P16 who had a high chart familiarity (M = 5), stated: “I’m not really so keen on the topic [spaceship], but I thought the visualisation [G] was kind enticing. I thought it was kind of cool”. P4, who expressed confidence with charts, considered visualisation G as the most enticing and commented: “I don’t know enough about it [...] I’m exhausted of it (newspaper articles about living crisis and war), it’s everywhere, it’s a constant news cycle. Everything is just doom and gloom and how awful the world is [...] But you asked me to look at the ones that jumped out at me, [G] really did leap out for me”.

We observed a sense of disappointment towards bland or plain visualisations used for topics that participants (n = 4) regarded as “important” not only for themselves but for others as well. For example, referring to visualisation J, which is about the waiting time women face to see a gynaecologist, P1, who put visualisation J towards the bottom of their ranking (rank 8) stated: “it’s a shame that a subject such as that, because of the format or the design of the graph, has minimised the information. It doesn’t make it as appealing, and yet the subject that you’re looking at should be more appealing to you or of more interest”. Similarly, referring to visualisation F (about Russia’s gas exports) P18, who had a medium to high chart familiarity (M = 4), ranked it very low (rank 9) stated: “The problem with [F], [is] the content is important, but the graphics is very bland”.

3.4.2 It looks like a picture, not like a graph

When ranking the visualisations based on enticement, participants (n = 14) expressed preference and appreciation for visualisations A, E and G. While exploring the visual aspect of the visualisations, participants reported being more enticed with these visualisations because they looked less like graphs and more like pictures, making them visually appealing (coded 16 times) and noticeable (n = 10) compared to other visualisations (e.g., I, H). For instance, P8, who had a medium to high chart familiarity (M = 4) stated: “So the ones [A, E, G] that I’ve picked [...] are the ones that are basically like pictures”, and we heard: “they don’t really look like graphs [P9]”. We also observed 14 instances in which visualisations A, E, and G were viewed as non-traditional. For instance: “they [A, E, G] are using graphics that you wouldn’t normally expect to see on an information graph [...] that just makes them a bit more interesting [P11]”, “The first two [A, E], the colour use, the animation kind of thing, it didn’t look standardly boring, it looked a little bit more interesting to look at, it grabbed my attention [P3]”. Since participants found these visualisations unconventional, we observed from 6 participants a sense of surprise toward them. For instance, P17 described visualisations A and E as “visually, very striking both of them”; similarly, P18, who had a medium to high chart familiarity (M = 4) described visualisation G as: “a very striking sort of slide”.

In contrast, when we asked participants whether they would like to replace embellished visualisations with plain equivalents, we noticed that many participants (n = 14) treated some visualisations (e.g., using icon labels embellishments, as in visualisations H and I) as the same as visualisations without embellishments (F, J). For example, P13, who had a medium chart familiarity (M = 3), stated: “they’re [F, I] not pretty different, they’re pretty much the same”; similarly, P16 who had a high chart familiarity (M = 5) reported: “this [ranking of F, H, I] was sort of interchangeable to a degree. It’s not like I felt really strongly about one or the other”, and P10: “no difference [between H and its plain version]. It’s neither more nor less appealing”. Moreover, we found participants (n = 14) less enthusiastic about plain visualisations (F, J) and visualisations I, H, and C. For instance, when we presented P5 with the plain version of the embellished visualisations and asked if they wanted to exchange any of them, they replied that the plain versions (H, I) were “even more boring” implying that the embellished version itself was boring.

3.4.3 Sense-making and embellishments

Visual embellishments were mentioned (by 16 participants) when we asked participants to rank the visualisations in terms of ease of understanding and to justify their choices. Since participants ranked the visualisations first based on enticement, we focused our analysis on how participants perceived embellishments to impact sense-making for each visualisation, rather than comparing across visualisations. Participants (n = 4) commented on the benefit of using arrows to represent the rising food prices and the actual images of the food items in visualisation A. For example: “it’s [A] straight away, it’s easy to see, they’ve got the percentages on there, but then it’s measuring it in the arrows as well to show which is increasing the most and by how much. So it’s like giving you two lots of information [P11]”, or: “you sort of look at it [A] and you can immediately see what kinds of foods and things are talking about, and then it’s got arrows pointing up so you know the prices are going up [...] It’s just very simple to understand [P8]”. These participants explicitly mentioned how the visualisation emphasises the overall message using arrows and icons, suggesting that embellishments matter for sense-making.

Participants (n = 7) also commented on the type of icons used. Visualisation A was the only visualisation in our selection that used realistic icons, which participants commented on as improving sense-making and relatability: “the pictures of the food are recognisable and clear. So you can actually associate that with a real product that you have in your cupboard or your fridge [P6]”, “because of the way it’s presented with the pictures and it’s got items that I believe are popular in most households [P7]”, “it’s the combination of the pictures of the actual food staff and the heights of the arrows [P5]”. We did not observe a similar perception about visualisation C, which uses abstract icons.

3.4.4 Visualisation seriousness

We observed two contrasting phenomena around how the presence of embellishments mediated how our participants related to the visualisa-
tion. On the one hand, some participants (n = 4) felt that the embellished visualisations underestimated their ability to read a visualisation. Such observations applied to all of our embellished visualisations. Visualisations A, E, and G were described by some participants as “childish", “cheesy", “gimmicky", and “cartoony” (n = 6). For instance, P7 commented about visualisation E: “I come from a background teaching in primary schools and it looks like a slide I might put up for a group of maybe nine-year-olds", and P6 predicted that other people might find visualisation E patronising: “All of those [H, I, F, J], I think my dad, who is an engineer, and his wife who is a chemist, I think they are so used to dealing with information in that format [plain style] and I think that they might find [E] quite Janet-and-John [i.e., a phrase used to describe something that is obvious and childish] and patronising".

Even with other embellished visualisations not described as childish, participants still highlighted feeling underestimated as readers. For example, P4 who had a medium to high chart familiarity (M = 4), felt patronised by the highlighting technique (i.e., using the colour highlight for key points) on visualisation I: “the red colour [referring to the highlighted bar in visualisation I] annoys me [...] that sort of thing where a visualisation assumes that I wouldn’t understand and goes forward to give me more information than I actually need [...] can come across as quite patronising", and P10 who had a medium chart familiarity (M = 3) felt the same about the textual annotations in visualisation C: “I think the additional text is cluttering and it also told me that I wouldn’t be able to read the graph. It’s just sort of a subconscious message, this is too complicated for you dear, don’t bother!”. Therefore, embellishments, in general, can possibly bring people away from visualisation.

On the other hand, another group of participants engaged with embellished visualisations by deeply reflecting upon their data. For instance, some participants (n = 7) drew personal conclusions from the embellished visualisations: “visualisation A just shows me why I’ve got no money left at the end of every month because the cost of living is horrendous [P12]", others (n = 5) saw actionable data: “because that’s [C] something I would definitely want to have more knowledge about, to inform my own practice when I’m shopping and making decisions at home [P7]", and encouraged some participants (n = 4) to ask questions: “[A] made me wonder why that particular type of wheat, I know pasta is made from durum wheat. I sort of wondered what was going on in there or if the Ukraine war was a factor [P16]”.

3.4.5 Trustworthiness: visual style and source

Participants judged a visualisation as trustworthy based on multiple factors, among which the visualisation’s embellishment type. Specifically, participants associated a particular visual style (the way the data are presented considering the amount of white space and clutter, colours, and size of the elements occupying the space) with different levels of objectivity. For instance, participants (n = 7) perceived plain (F, J) and embellished visualisations that used icon labels (C, H, I) as objective, implying that the two have a similar visual style. For instance, participants commented: “[F] Seems to be much more factual [P4]”, P11 who stated that they would trust visualisation I slightly more than visualisation A, justified it with “it [I] looks more like official data, whereas the other one [A] looks less official, it could be seen as more trustworthy [...] it just looks more like something that you’ve taken from a proper visual lecture." Someone [I] feels a bit more authoritative probably because it doesn’t have the gimmicky visuals [P2]”.

Embellished Visualisations A, E, and G were associated with untrustworthy news sources. For example, P16, who reads the BBC and The Guardian, described visualisations A and G as “deceiving", commented: “[A] reminds me of a CNN graphic or something you would find on mainstream news or the local news [...], [F] is definitely kind of like the Economist, I used to subscribe to the Economist for a long time”. Visualisations A, E, and G were also associated with tabloids (a newspaper style popular in the UK that publishes controversial articles). For instance, P7, who reads the BBC, was less trusting of visualisations A, E, and G and stated: “It [E] looks like something you would find on a tabloid newspaper”. This is especially interesting since visualisations A, E, and B, which came from the Daily Mail (i.e., a tabloid newspaper in the UK), did not have the news source visible (we presented the visualisations as we found them). We also found that five participants reported feeling suspicious of the visualisation’s primary goal because of the embellishment type used: “So sometimes they use pictures like [A, E, B] to kind of draw the crowd rather than just showing the clear facts like [J] would [P3]”. “I also find that sometimes those graphics like [A, G] they’re a little bit sensational like they’re trying to get clicks or to get views or whatever [...] these graphics can be a little deceiving [P16]”.

Still, the visual style was not the sole factor for trustworthiness. For instance, P1 stated: “It wouldn’t make any difference [visual style] to me as long as I know that when I’m studying them that the information, it’s trusted, and it’s reliable, and it’s factual. If you got factual information then how you choose to present it, whether or not a very clinical way or in a more interesting way like say [G, J], that would be the person’s individual choice”. Others indicated that the news source is a priority for trusting a visualisation. For instance, when we asked P11 whether they trusted the embellished visualisations, they replied: “On the whole, yes [...] it’s more the source that they’re printed in”. On a similar pattern, P5 stated: “Whether I trusted them would depend on where I saw them so if they were on a website that I trust, [...] I see some of them got BBC icons on them; I would trust the BBC to be delivering accurate data to the best of their knowledge, some other websites, possibly not”. 4 FOLLOW-UP STUDY: EMBELLISHMENT STRATEGIES

During our interviews, we observed the majority of participants (n = 12) grouping visualisations A, E, and G in their discussion. Moreover, participants commented on how the icons in A, pictorial bars in G, and thematic images in E helped them make sense of the data. We speculate that participants grouped these visualisations together because their embellishments are salient. Here we refer to saliency as the extent to which embellishments are noticeable in a visualisation. For example, we consider the pictorial elements in A, E, and G to have high saliency because of their large size with respect to the size of the visualisation. To investigate that, we designed a follow-up study where we isolated embellishments in some of these visualisations controlling for the topic and the chart type. In other words, we decided to investigate embellishments within a single visualisation to counter the limitation of the interview study that we had a diversity of topics and chart types. Moreover, we explored each embellishment type individually and in combination with other embellishment types. We selected Visualisations A and G for this as they had two or more embellishment types that were not addressed in our plain version exchange task during the interviews.

We manipulated the visualisations by removing icons and pictographs, backgrounds, and arrows, to create eight variations of Visualisation A and six of Visualisation G, as illustrated in Fig. 2 and Fig. 4. We kept other elements such as textual labels, titles, sources and bar colours. We decided to remove embellishments rather than add them so as to keep the visualisations consistent with the original ones from the media. We collaborated with a graphic designer to help create the visualisation variations. While we initially considered bar colour as an embellishment, our embellishment definition evolved based on the interview results where the plain versions of some of the visualisations that had icon labels and colour were perceived to be indifferent. We, therefore, decided not to manipulate the bar colour.

To avoid order and bias effects, each participant saw only variations of one visualisation (either A or G). We ensured that both groups of participants had a similar chart familiarity to ensure that results came from the same population. We presented participants with all visualisation variations at once (so they could compare them, similar to the interview). We randomised the location of each variation for each participant. Participants were asked to rate each variation in terms of enticement. We used a 5-point Likert scale ranging from ‘Extremely enticing’ to ‘Not at all enticing’. We chose a rating rather than a ranking task to allow participants equal ratings of the visualisations. Given the brevity of the task, for simplicity, the pre-screening questionnaire (same as above Sec. 3.1) was included with the main task, and participants were excluded from the analysis based on the same criteria. The task
4.1 Embellishment Strategies: Visualisation A

4.1.1 Participants

We recruited 59 participants from Prolific. We excluded 19 participants using our pre-screening criteria (see Sec. 3.1). Also, we excluded three participants due to technical glitches while performing the task. We further excluded 17 participants as their chart familiarity was significantly higher than the interview participants. We analysed the data from 20 participants ($M_{Age} = 39.2, SD_{Age} = 9.93, 12$ women) where these participants had a similar chart familiarity level ($M = 3.4, SD = 0.42$) to our interview participants.

4.1.2 Visualisations Design

As shown in Fig. 2, participants saw eight visualisations, including the original (A.1). For the second variation (A.2), we replaced the arrows with bars. We removed the background in the third variation (A.3). For the fourth variation (A.4), we replaced the arrows with bars and removed the background. We removed the background and icons for the fifth variation (A.5). We removed the icons for the sixth variation (A.6). We removed the icons and replaced the arrows with bars for the seventh variation (A.7). Finally, in A.8, we removed the background, and icons, and replaced the arrows with bars.

4.1.3 Results

A Friedman test revealed a significant difference in how participants rated the eight variations of visualisation A ($\chi^2(7, N = 20) = 38.66$, $p < .001$). Using Cohen’s interpretations, the effect size was moderate ($W = 0.3$). Furthermore, post-hoc comparison revealed that variations with icons by themselves or combined with other elements were generally preferred, as shown in Fig. 3 (adjusted $p$-values using the Benjamini-Hochberg correction method). For instance, our results show that variations (A.1, A.2, A.3) were rated higher than variations that did not have icons (A.5, A.6, A.7, A.8). Moreover, we did not find evidence that the background affected the participants’ ratings between each variation its equivalent (e.g. A.1 vs A.3 or A.7 vs A.8).

4.2 Embellishment Strategies: Visualisation G

4.2.1 Participants

We recruited 46 participants from Prolific and excluded 13 participants using our pre-screening criteria. We also excluded two participants due to technical glitches while performing the task. We further excluded 12 participants from the analysis as their chart familiarity was significantly higher than the interview participants. We analysed the data of 20 participants ($M_{Age} = 39.37, SD_{Age} = 12.01, 12$ women) where these participants had a similar chart familiarity level ($M = 3.31, SD = .46$) to our interview participants.

4.2.2 Visualisations Design

Participants saw six visualisations as shown in Fig. 4, including the original (G.1). In the second variation (G.2), we removed the background. We replaced the pictorial bars with large icons for the third variation (G.3). We were inspired to add this variation from visualisation A. We removed the background and replaced the pictorial bars with large icons for the fourth variation (G.4). For the fifth variation (G.5), we removed the pictorial bars. We removed the background and pictorial bars for the sixth variation (G.6).

4.2.3 Results

A Friedman test revealed significant differences in how participants rated the six variations of visualisation G ($\chi^2(5, N = 20) = 52.01, p < .001$). Using Cohen’s interpretations, the effect size was large ($W = 0.5$). Post-hoc comparisons revealed a similar pattern found in visualisation A (see Fig. 3); participants preferred the presence of icons and pictorials (G.1, G.2, G.3, G.4) over the other variations (G.5, G.6). Also, we did not find evidence that the background contributed to how participants perceived the visualisations except in one case where participants preferred the combination of background and pictorials (G.1) over icons (G.4). However, participants did not rate the original visualisation higher than its equivalent without the background (G.2).
5 DISCUSSION

Through interviews and a follow-up study, we explored the factors in an embellished visualisation that make people perceive it to be more or less enticing and how people perceive the visualisation in terms of ease of understanding. Next, we discuss our main findings, how they can be applied in practice and recommend future research directions.

5.1 Revisiting How We Treat Embellishments

Factors such as embellishment saliency and editorial styles influenced how people perceived embellished visualisations, which indicates a need to go beyond the binary classification for a more nuanced understanding of embellishments. This perspective extends recent research on embellishments [3, 5, 33], which has, until now, investigated embellishments by treating visualisation as simply embellished or not. Such prior work made important initial contributions to understanding embellishments, particularly in light of the traditional dismissal from the visualisation community [40]. Moreover, while prior work [4, 5] acknowledged the importance of investigating different types of embellishments with different extremity levels, based on our findings on enticement and sense-making, we argue that there is a need to go beyond to understand embellishments by considering the impact of embellishment saliency and editorial styles in enticing readers. The concept of embellishment has also been critically discussed in recent literature. For instance, Shukla and Parsons [36] proposed maintaining the definition of ‘chartjunk’ as it is less restrictive and promotes reflection among designers because of its ambiguity. We argue that an embellishment typology may be beneficial, not only for empirical researchers but also for practitioners with less design experience who would benefit from a more descriptive language. On the other hand, Akkaba et al. [2] encouraged the community to move away from seeing the term ‘chartjunk’ as it is negative. We extend this work by proposing the need to not only move away from the negative association embellishments have but also move away from the binary opposition where visualisation is embellished or not. We propose factors that could help us have a better understanding of embellishments and their impact.

5.1.1 Embellishment saliency

Our results indicate that embellishment saliency (as defined in Sec. 4) could help unpack how we treat embellishments and understand their impact. Our qualitative data suggest that participants were leaning toward visualisations A, E, and G. We argue that salient embellishments made these visualisations perceived as more enticing. The follow-up study (see Sec. 4) supports this claim, where we found that the variations of visualisation G with pictorials and large-sized icons were rated as more enticing than plain variations with and without the background. We also found that the combination of pictorials and backgrounds scored higher than large-sized icons in visualisation G. Variations of visualisation A with large-sized icons by themselves or in combination with other elements were rated as more enticing than the other variations (e.g., arrow and background (A.6), plain with background (A.7)). Therefore, large icons and pictorials individually have a positive impact on enticement, which is maintained even when used in combination with other elements. However, our results do not undermine the value of the other variations that were less enticing, as they could add value to other measures. Although less salient embellishment types, such as arrows and backgrounds (by themselves or a combination of the two), were inferior, the qualitative data suggest that these elements did not adversely affect the user experience: therefore, designers may choose to use them. However, caution should be paid about the background type as prior work [16] showed that irrelevant pictorials in the background negatively impact recall accuracy.

5.1.2 Editorial styles

Another factor is editorial style which influenced how people perceive certain embellishment types to the extent that we can treat these embellishments as visualisation conventions. We define editorial style as the style dictated by influential publications where a consistent format is used as part of the publication branding image. Participants associated certain embellished visualisations with editorial styles they are familiar with and expressed an expectation of the visualisation style (see Sec. 3.4.5). As another example, the interview data suggest that visualisations with icon labels were treated indifferently to plain charts, indicating that editorial styles may have normalised such designs to become a visualisation standard. Perhaps these embellished visualisations (e.g., with icon labels) looked expected, mundane, and unsurprising, which made them less enticing. Instead, others that ‘look like pictures’ were perceived to have some level of novelty were more enticing. In particular, our follow-up study suggests that salient embellishments (e.g., the combination of icons and arrows) contributed to making these visualisations perceived as more enticing. Burns et al. [11] compared icon arrays with plain charts and found the two versions similarly affect engagement. In light of our findings, this could be explained by icon arrays maintaining the look of a conventional graph. We suggest considering the changing conventions when unpacking what we consider an embellishment. Our work identified this pattern for icon labels; future work could further sample visualisations with different embellishment types (e.g., stacked pictographs) from the media and survey viewers to investigate whether these embellishments became part of the convention based on their impact on enticement.

Another example demonstrating how participants associated certain editorial styles with specific embellishment types is by inheriting qualities of these publications such as objectivity and trustworthiness. Our results suggest that subtle additions, such as icon labels, do not seem to degrade the trustworthiness of visualisation (see Sec. 3.4.5). Visualisations with icon labels seemed to be viewed as objective and impartial. Kennedy et al. [21] have already shown that certain design conventions, such as clean layouts, including data sources, two-dimensional viewpoints, and geometric shapes and lines, give the impression that a visualisation is transparent and objective. We extend this work by demonstrating how certain embellishment types (e.g., icon labels) may have the same effect. This is important because it encourages designers to think of embellishments on a spectrum ranging from (1) novel and potentially untrustworthy and (2) conventional and potentially more trustworthy. For instance, if a designer communicates sensitive data, such as health or safety data, where trust is critical, icon labels may be more suitable.

We found that trusting a source was associated with editorial styles, which can become a standard for what a visualisation should look like. For instance, on the one hand, some participants expressed faith in the BBC, which translated into trusting its visualisations. On the other hand, some participants had sceptical views about tabloids, where they expressed that they would not trust their visualisations or visualisations that looked similar. This also explains why visualisation G, which had the source visible but was found sensational and less trustworthy, shared some of the qualities (i.e., embellishment types) of an untrustworthy source. Prior work [20, 22] showed that source is a contributing factor influencing emotional engagement and trust in visualisations. We extend that work by demonstrating the interaction between embellishments and the source. Critically questioning a visualisation can encourage viewers to consider the messy data underlying it. This is because people generally treat visualisations as solid facts [31], and prior work has demonstrated how subtle manipulation in the visualisation influences a reader’s perception [23].

5.2 When Can Embellishments Be Helpful?

Our interviews suggest that embellishments may entice and engage viewers even when the topic is not personally relevant. For instance, most of our participants commented that they were not interested in or knowledgeable about the topic of visualisation G (space). Yet during the interviews, we noticed that participants had put visualisation G with visualisations A and E, which were more prominent in the participants’ discussion about enticement in comparison to the other visualisations. Our follow-up study (see Sec. 4) suggests that the salient embellishments (icons by themselves or in combination with other elements) may be what made visualisation G perceived as more enticing.

We also observed that plain visualisations on topics our participants considered important (e.g., gynaecologists’ waiting time) were not considered high on enticement. This challenges the idea that participants
found visualisations A and E more enticing merely because the topic was personally relevant and vital. Moreover, within a single topic, we observed a considerable consistency in perceiving visualisations with salient embellishments as more enticing in our follow-up study. We acknowledge that relatability attracts people, and we found that participants gravitated toward the visualisations related to their experiences and everyday preoccupations, similar to the findings of Peck et al. [31]. Additionally, we extended that work with embellished visualisations, suggesting that embellishments could entice viewers even when the topic is far from personal. This has implications that can help news media where they have available data about visitor’s interactions (e.g., dwell time) with different news genres (e.g., politics, sports), which can be used as an index of which visualisations to embellish.

Our qualitative findings in Sec. 3.4.3 suggest that since embellishments act as a form of redundancy, they may help sense-making and immediate recognition. For instance, participants commented that arrows and icons on visualisation A delivered the message of ‘food price inflation’ efficiently and clearly. This result confirms Borkin et al. [7] findings that data and message redundancy improves data communication. Designers could use various embellishment types to achieve different goals. For instance, they could use large-sized icons to attract attention, and use the data with visualisation as a form of redundancy to improve concept grasping. Another interesting finding from our analysis of sense-making is that picture realism may benefit relatability and sense-making in data visualisations. Our participants reported that the food icons in visualisation A were recognisable and familiar, making the visualisation straightforward. Part of these results confirms Borkin et al. [8] findings where human-recognisable icons improved recognition. While prior work [9] showed inconclusive results about the impact of realism in promoting empathy and prosocial behaviour, we speculate that realism might have potential in other settings, such as improving sense-making for data communication. Recent findings also seem to have promising indications about realism; for instance, Salminen et al. [35] showed that realism increases positive perceptions (e.g., clarity, completeness) about personas. Future research could compare different levels of realism with plain visualisations to understand its impact.

5.3 Patronised by Embellishments

Our interviews demonstrate that certain embellishment types could make visualisations perceived as patronising their viewers. For instance, we found that embellishment types, such as the ones used in visualisation A, E, and G, might induce emotions related to feeling under-estimated and sometimes even be described as coming from tabloids (see Sec. 3.4.4 and Sec. 3.4.5). We confirm Ajani et al.’s work [11], which reported that particular design choices, such as annotating a visualisation or highlighting a trend, might be perceived as condescending and childish. We extend their work by showcasing how other elements, such as salient embellishments, might cause the same effect. Although prior work advises designers to make the patterns or insights more evident through visualisations, it is important to note that these visualisations can sometimes be perceived as patronising.

We uncovered how embellishments could also bring people away from a visualisation if it underestimates the viewer. We observed this effect across the different embellishment types and textual elements (see Sec. 3.4.4). Participants expressed that certain embellishment types deprived them of independently interpreting the visualisation’s meaning or gave them the impression that it was too difficult to decipher. Nevertheless, participants in our study showed their engagement with the embellished visualisations. This generally aligns with the work of Andry et al. [3]. However, while that work was conducted with experts in digital communication, in our research, we focused on the non-expert in visualisation and design, and we also demonstrated when embellishments might lead to disengagement. We speculate that personal style preferences could have had an impact. For instance, we heard from the participants who found some visualisations patronising that they like a ‘pure graph’; further work is needed to understand this phenomenon (patronising) in interaction with personal preferences.

6 LIMITATIONS

Some limitations should be considered. First, the variety of the visualisation types shown to participants. It was challenging to accommodate because we wanted to use visualisations from the media and maintain ecological validity. Nevertheless, these visualisations came from one source type (news) which allowed us to extract insights about the source’s impact on embellished visualisations. [35] also investigated enticement within a single topic in the follow-up study. Second, we showed participants stand-alone visualisations rather than full articles. We aimed to explore whether the visualisation looked inviting to explore rather than to encourage people to read the article behind it. Also, because of time limitations, exploring a wide range of embellished visualisations would not have been possible if we had presented participants with full articles. Indeed, investigating visualisations as stand-alone has been used frequently in the literature [20, 22, 31]. Future research should explore whether our results extend to embellished visualisations within articles. Third, participants were asked to rank the visualisations based on enticement and ease of understanding. We encourage exploring other prompts. Lastly, participants ranked the visualisations based on ease of understanding after ranking them based on enticement, which could have biased their second ranking. We encourage future research to explore ease of understanding in isolation.

7 CONCLUSION

We reported a qualitative study with 18 participants (consumers of news media but non-experts in visualisation and design) in which we explored how embellishments were perceived with enticement and ease of understanding. In the interview, participants were shown ten diverse embellished and plain visualisations collected from news media and asked to rank them based on enticement and ease of understanding. Based on how particular embellished visualisations enticed participants, our analysis reveals how editorial styles made certain embellishment types become part of a visualisation convention. As a result, these embellishment types make a visualisation perceived as factual and objective. Our results suggest that some of the visualisations participants perceived as more enticing had multiple embellishment types. We, therefore, ran a follow-up online user study where we isolated each embellishment to understand the cause of that effect. The study demonstrated that visualisations with salient embellishments (e.g., large icons or in combination with other embellishment types) were perceived as more enticing than visualisations with less salient embellishments. We argue that to unpack the concept of embellishments, we need to consider editorial styles and embellishment saliency. We also found that embellishments are helpful even when the topic is personally irrelevant. Our findings highlight the importance of investigating embellishments within visualisations published in the media, as our participants attached some pre-existing attitudes and beliefs about the source and the topic to the embellished visualisation. In contrast, we observed that certain embellishment types and their salience could make a chart feel patronising because of the lack of autonomy. Based on our findings, we propose design recommendations and future work directions on exploring embellished visualisations.

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