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The Effect of Narration on User Comprehension and Recall of Information Visualisations

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***Abstract*—Information visualisation researchers have posited that author-driven narratives will allow information to be conveyed efficiently and argue for the adoption of storytelling techniques in information visualisation. However, there is limited work describing the effects of author-driven narratives in users' comprehension and memorability of visualisations in relation to interactive visualisations. Recommendations for author-driven visualisation stories are largely based on anecdotal reports and/or research from the arts, and not on studies in information visualisation. To investigate these issues, we carried out a study that compared purely author-driven narratives with interactive visualisations devoid of author narratives, in terms of comprehension and short-term and long-term memorability. We found that the presence of narration in author-driven stories significantly aided the understanding of information but had no significant effect on the long-term recall of information from visualisations.**

I. Introduction

Research in the field of information visualisation has highlighted the barriers encountered by users in engaging with information visualisations [1], [2]. These studies mainly identify users' challenges in understanding and interpreting information visualisations. Consequently, new approaches are emerging to tackle these issues.

A promising approach is the adoption of narrative visualisation - the combination of information visualisations with storytelling mechanisms.

Borrowing from research in the arts that depict stories as engaging and memorable [3], information visualisation researchers have posited that author-driven narratives will allow information visualisations to be conveyed efficiently and argue for the adoption of storytelling techniques in information visualisation [4]. Others have suggested that visualisations presented in the form of narrative stories are "psychologically efficient" [5] and call for its advancement as a primary way of communicating information visualisation [6].

However, while stories, as utilised in the arts, have been shown to be effective [3], [7], there is no empirical evidence to support this claim in the field of information visualisation because the information content communicated in visualisations are not just entertainment but the communication of much more complex information [8]. The current narrative visualisation literature offers little insights on the role and limitations of author narratives on the comprehension and recall of information visualisation. In this paper, we summarise the results of our study investigating the effects of author-driven narration in user comprehension, and short-term and long-term memorability of information visualisations.

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II. Experimentation

We formulated a within-subject user study (with the ethics board approval) to examine the benefits and limitations of author-driven narratives using presentation videos in relation to interactive visualisations (devoid of author narratives), in terms of comprehension and memorability. The data used for the study is from the United Nations Common Database [9]. Our choice of this data was partly influenced by a high quality related study carried out by Robertson et al. [10]. For our presentation videos, we created 8 excerpts from 8 Han's Roslings' data visualisation talks [11] (See Figure 1). We chose Hans Rosling' talks because the underlying data and Gapminder tool are readily available to recreate the visualisations with all the features (e.g., animation) used in the talks. Moreover, Rosling's data visualisation talks are good examples of author-driven stories [4]. The video excerpts contain visualisations created using the Gapminder software [12] with the presenter describing the visualisation elements and providing a specific value message based on the trend of the data over time.

For each of the presentation videos, we created a fully interactive visualisation **similar** to the one in the video using the Gapminder software, with the same data and graph elements, e.g., same y-axis, x-axis (See Figure 2), and the same interation elements, e.g., play/pause button, time-slider.

A. Participants

We recruited a total of 40 participants (32 male and 8 female, between 18 and 50 years old) to participate in the user study. Of the 40 participants, there were 11 working adults in diverse fields and the remaining 29 were a mix of both undergraduate and postgraduate university students from 3 different universities studying different courses covering arts and humanities, and sciences and engineering disciplines.

B. Procedure

The user study was carried out in 2 phases: a comprehension phase and a recall phase. Participants were not informed about the recall phase in order to avoid active memorisation during the comprehension phase. They were only told that there is a second phase of the study to be carried out at a later time. Participants were randomly placed in one of two recall groups (short-term recall or long-term recall), with 20 participants in each group.

In addition, the entire experiment takes approximately 70 minutes to complete - 40 minutes for the comprehension phase and 30 minutes for the recall phase.

C. Comprehension Phase

The comprehension phase commenced by showing participants a counterbalanced presentation of the interactive visualisations (devoid of author narratives) and the presentation videos. There were 3 questions associated with any of the interactive visualisations or presentation videos, making it a total of 24 questions in the comprehension task. The first and second questions are multiple choice questions (MCQ) about related ***facts*** - the approximation of a data point or set of data points or categories that meet some attribute criteria while the third question is an open-ended question about the ***value message*** - the primary narrative of the visualisation.

Each participant saw 4 presentation videos and 4 interactive visualisations. The order of the presentation videos and interactive visualisations was counterbalanced for all participants so as not to confound the order in which the task is performed with the experimental treatment.

After completing the comprehension phase task questions, participants completed an open-ended survey about the knowledge gained from the visualisations.

D. Recall Phase

Participants were assigned to one of two recall groups (short-term or long-term recall). Each group had 20 members. Participants in the short-term recall group completed the recall task 5 minutes after the comprehension phase while those in the long-term recall group completed the recall task in 2 to 3 weeks' time.

The main recall task began by asking participants to write down in the spaces provided on the survey and describe the contents of the visualisations they saw in the comprehension phase with as many details as they could remember, including graph elements (e.g., x-axis, y-axis etc.), the value messages and narratives of the visualisations. When participants were satisfied with how much they recalled, they then proceeded to answer fact-related multiple choice questions.

At the end of the recall phase, participants completed a subjective preference questionnaire indicating their leaning towards the author-driven narrative based on the presentation videos or the interactive visualisations by answering questions related to the comprehension and recall of the visualisations.

III. Results

We applied the pair-wise t-test ($\alpha = 0.05$) for all our analysis in contrasting the author-driven narratives based on presentation videos and interactive visualisations covering comprehension, short-term and long-term recall. A two-tailed t-test was used in the places where we sought to examine if either the presentation videos (with author-driven narratives) was significantly better or worse than interactive visualisations (without author narratives). We highlight the main findings from the study below:

- There were no significant differences in the comprehension of facts between presentation videos and interactive visualisations.
- There were significant differences in the comprehension of value messages between presentation videos and interactive visualisations. Participants showed better comprehension of the value messages in the presentation videos compared to their interactive visualisations counterparts.
- After a 5-minute break, there were significant differences in the recall of facts between presentation videos and interactive visualisations. Participants showed better short-term recall of the facts in the presentation videos compared to their interactive visualisations counterparts.
- After a 5-minute break, there was no significant difference in the recall of value messages between presentation videos and interactive visualisations.
- After a 2-3 weeks break, there were no significant differences in the recall of facts and value messages between presentation videos and interactive visualisations.
- Participants found the presentation videos both easier to understand and faster to describe and found the interactive visualisations more accurate to describe.

IV. Summary

Information visualisation researchers have supported the adoption of storytelling techniques for the effective communication of visualisations. While storytelling may be effective in other fields, there is little evidence showing that the same level of effectiveness can be achieved in information visualisation. The results of our study investigating this show that the presence of narration in the presentation videos significantly aided the understanding of the value messages and short-term recall of facts from the visualisations but had no significant effect in the long-term. Furthermore, the results show that users can quickly describe the information contained in the presentation videos; they chose interactive visualisations as more accurate to describe, and found the information content in the presentation videos easier to understand.

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APPENDIX

Fig. 1. A sample screenshot taken from an author-driven presentation video with a narrator providing commentary on the visualisation.

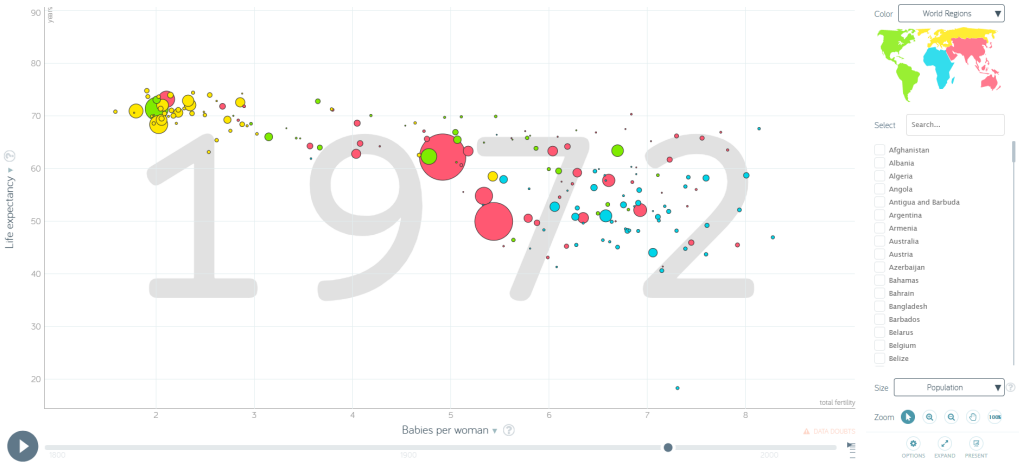

Fig. 2. A sample screenshot of a fully interactive visualisation (devoid of narration) created to match the one shown in the presentation video in Figure 1 above.