# Infographic Aesthetics: Designing for the First Impression

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## ABSTRACT

Information graphics, or infographics, combine elements of data visualization with design and have become an increasingly popular means for disseminating data. While several studies have suggested that aesthetics in visualization and infographics relate to desirable outcomes like engagement and memorability, it remains unknown how quickly aesthetic impressions are formed, and what it is that makes an infographic appealing. We address these questions by analyzing 1,278 participants' ratings on appeal after seeing infographics for 500ms. Our results establish that: 1) people form a reliable first impression of the appeal of an infographic based on a mere exposure effect, 2) this first impression is largely based on colorfulness and visual complexity, and 3) age, gender, and education level influence the preferred level of colorfulness and complexity. More generally, these findings suggest that outcomes such as engagement and memorability might be determined much earlier than previously thought.

## Author Keywords

Visualization; Infographics; Aesthetics

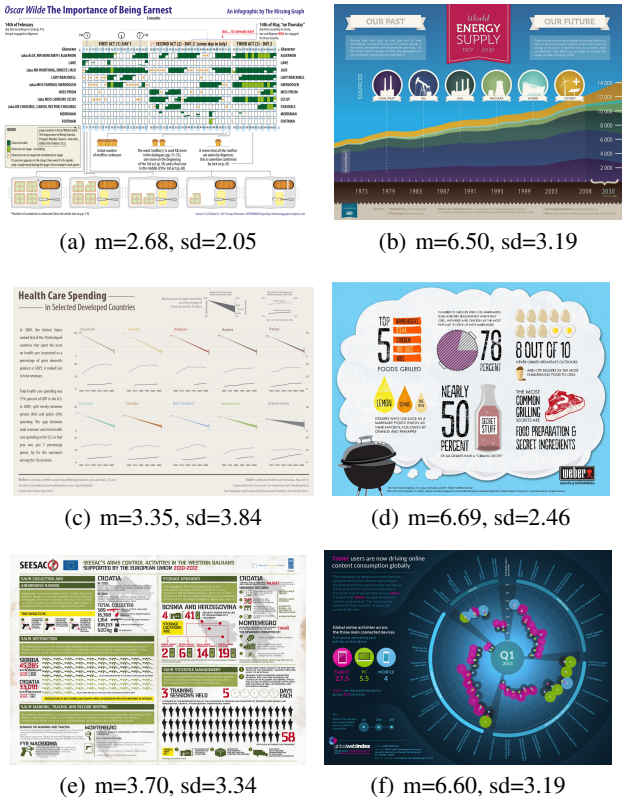
## ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

## INTRODUCTION

Information graphics, commonly called "infographics", are used to communicate complex data in an engaging manner. Defined as a collection of one or more visualizations that have been manually modified (or "adorned" [1]) to highlight specific points about the data [1, 3], infographics provide readers with an overview of a topic through data and other available information. Infographics are an effective means for telling stories about data, as they capture a reader's attention by structuring these stories using principles of graphic design.

Given these features, it is not surprising that infographics have become one of the most popular means for communicating data to large, diverse audiences [1, 3]. Companies and non-profit organizations are increasingly using infographics to attract customers and contributors. At the same time, infographics are being used to disseminate more critical information. In 2013, for example, the Centers for Disease Control (CDC) produced a series of infographics targeting health issues in the US such as high blood pressure and child vaccinations. Trends like these underscore the need for understanding the underlying factors that modulate the effectiveness of infographics.




(a) m=2.68, sd=2.05 (b) m=6.50, sd=3.19

(c) m=3.35, sd=3.84 (d) m=6.69, sd=2.46

(e) m=3.70, sd=3.34 (f) m=6.60, sd=3.19

Figure 1: Infographics that resulted in the lowest (on the left) and highest (on the right) ratings of appeal (mean ratings on a 9-point Likert scale).

The heavy reliance of infographics on design has led researchers to suggest that aesthetics are among the main contributors for their success [4, 1, 3]. Infographics and data visualizations that have been rated as more aesthetically appealing have been found to have positive effects on engagement [4] and memorability [3]. However, it remains unknown how quickly these aesthetic impressions form: What is it that makes an infographic appealing to people at first sight? Are these judgements consistent within a person? What role do demographic factors play?

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*CHI 2015*, April 18–23, 2015, Seoul, Republic of Korea.
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ACM 978-1-4503-3145-6/15/04$15.00
http://dx.doi.org/10.1145/2702123.2702545

To investigate people's judgements of the aesthetic appeal of infographics, we conducted an online experiment with 1,278 participants, collecting approximately 83,000 ratings of appeal on a sample of 330 infographics from Visually, an online community for infographic designers. The results contribute to our understanding of aesthetics in visualization and infographics by establishing that:

- People form a reliable opinion of the appeal of an infographic within the first 500ms. Seeing that appeal is associated with engagement and memorability [4, 3], our results suggest that the first impression counts.
- Some infographics appeal broadly, but the majority produced controversial judgements. Although people are consistent in their judgements, they have strong, diverse opinions about the infographics they like/dislike.
- Demographic factors such as gender, age, and education level impact perceived appeal. We discuss how designers can optimize the first impression by adjusting the colorfulness and visual complexity of an infographic.

## RELATED WORK

A key insight to the role of aesthetics in visualization and infographics is that the value of a visualization increases the more time is spent with it [10]. It follows that making visual representations of data engaging and memorable increases their value. In recent years, researchers have begun to explore the relationship between these ideas and aesthetics in information visualization [4, 1, 3]. Examining aesthetics in data visualization and task performance, Cawthon and Vande Moere found that appealing visualizations led to increased task engagement [4]. Similarly, Bateman et al. evaluated the effects of graphical embellishments (otherwise known as ChartJunk) on visualization performance, and hypothesized that the aesthetic qualities of embellished visualizations may make them more memorable [1]. Borkin et al. recently confirmed this hypothesis by identifying design techniques in visualizations and infographics that make them memorable [3].

A missing component from these studies of visualizations and infographics is to understand how aesthetic judgements form, and the factors that influence these judgements. The area of website aesthetics in human-computer interaction, in contrast, has established several methodologies for examining the aesthetic appeal of websites. The experiments of Lindgaard [6], for example, established that lasting impressions of website appeal form within 500ms of seeing it for the first time. The results of judgements like these were also shown to correlate with participant's perceptions of website usability and trustworthiness [5]. More recently, Reinecke et al. developed computational models that predict the first impression of websites using low-level image metrics of website colorfulness and complexity [9].

## EXPERIMENT

### Materials

To generate a representative set of stimuli, we used a two-stage process involving sampling and curation. First, we randomly chose a sample of 2,000 infographics from the approximately 40,000 available on Visually. Three coders then independently rated each infographic in this sample on representativeness (to exclude images that did not contain data visualizations or were simply images of interactive systems), content suitability (to avoid controversial infographics e.g. those concerning Israel and Palestine, or pornography), dissemination (to exclude widely known infographics), and language (to avoid the influence of non-english infographics with different language scripts). We excluded any infographic that was marked as unacceptable according to these criteria by one or more coders. The remaining 330 infographics were used in the main experiment.

### Procedure

The experiment was conducted as a 10-minute online test, and advertised via online social networks. This online test included informed consent but did not collect personally identifiable information. The protocol was approved by IRBs at two institutions. As an incentive for participation, we promoted the experiment with the slogan "Do you have the eye of a designer?", and added a personalized feedback page at the end that compared a participant's ratings to the number of "likes" and "views" of the Visually community. Participants did not receive any financial compensation. Mobile users were not permitted during the experiment period.

Following the experiment procedure in [6], participants rated 30 infographics (presented in randomized order and drawn from the larger set of 330 infographics) on a 9-point Likert scale on appeal (from "not at all appealing" to "very appealing"). Infographics flashed for 500ms each, immediately followed by a screen that only showed the Likert scale. The 500s stimulus exposure time was used to capture participants' first impression of the overall aesthetics and to avoid an in-depth engagement with the information presented. The experiment started with a voluntary questionnaire collecting basic demographics information, instructions, as well as a short practice phase of five infographics, targeted at anchoring participants' responses. The main part of the experiment was divided into two phases, during which each participant was shown a random sample of 30 infographics in different randomized order. Hence, participants provided two ratings for the same 30 infographics. In-between the two phases, we presented participants with a humorous photo for distraction, and asked them to take a break. Participants were then able to add comments about possible distractions or technical issues, before being presented with their personalized results page.

### Participants

A total of 1,278 participants (77.5% female) completed the experiment between June and September 2014. Participants were between 6-80 years old (m=23, sd=11 years). (Parental consent for participants under 18 years of age was waived by our IRB.) Most participants were currently enrolled in college (41.8%) or in high school or professional school (40%). Participants came from 71 countries, with the majority being based in the US (60%). Eight percent worked in a creative occupation. Since their mean ratings did not significantly differ from participants in other occupations, we did not include occupation as a factor in the analysis.

## RESULTS

### Consistency

To evaluate whether people form reliable first impressions of an infographic's appeal, we computed the difference between participants' ratings of the same websites between phase 1 and 2 (following Lindgaard [6] and Reinecke [9]). Of rating pairs, 37.5% were the same and 39.4% differed by 1. In contrast, only 7.9% differed by more than 2 points on the 9-point Likert scale, indicating that participants provided consistent ratings. Participants therefore form a reliable opinion of the appeal of an infographic within the first 500ms – a time that constitues a mere exposure effect [6].

### Variance in an individual's aesthetic impressions

The previous result is further emphasized given that participants provided strongly varying ratings for the 30 infographics each of them saw. The mean range of a participant's ratings on the 9-point Likert scale (averaged across all participants) was 6.4 (sd=1.3), showing that individuals rated some infographics highly on appeal, while strongly disliking others. This shows that people have strong opinions about the design of infographics, which emphasizes the importance of exploring what it is that makes an infographic appealing.

### Controversial infographics

While participants were consistent in their individual ratings for a given infographic between the two experiment phases, the diversity in ratings for the 330 infographics suggest that only a few infographics are universally appealing. The mean range of ratings on the 9-point Likert scale (averaged across all participants' ratings for one infographic) was 7.07 (sd=0.45), showing that what appeals to some can be highly disliked by others.

### Effects of colorfulness, complexity, and demographics

Colorfulness and visual complexity explain roughly half of the variance in people's judgements of the appeal of websites [9] and are considered some of the most salient features that humans perceive within the first 500ms [6]. We therefore followed the procedure outlined in [9] to compute perceptual models of colorfulness and complexity of each of our infographics as an estimate for visual appeal. Reinecke et al.'s models [9] use a combination of several low-level image statistics: Colorfulness integrates specific colors with the saturation and number of image areas in a given image, while visual complexity is computed based on text and image areas, as well as color features that contribute to perceived complexity (see [9] for references to the full models and algorithms). The computed values for both demonstrate that our set of infographics cover a broad range of low to high colorfulness/complexity (colorfulness range=0-175, m=58, sd=27; complexity range=0-28, m=8, sd=4).

To analyze the effects of demographics on a preference for certain levels of colorfulness and complexity, we constructed a series of mixed-effects models using the *R* lme4 package [2]. ParticipantID and InfographicID were modeled as random effects, and the fixed effects Colorfulness, Complexity, and demographic variables (Age, Gender, EducationLevel, Country) were modeled to test for interactions. Demographic variables were added or excluded based on Akaikes Information Criteria (AIC) to determine which variables significantly improved the model fit.

A comparison of two models (one without demographics and one with) shows that demographic factors significantly affect ratings of appeal ($\chi^2_{45} = 118.2, p < .0001$). Country did not significantly improve the model fit (most likely because our sample size in most of the 71 countries was small), and was therefore omitted. The resulting model includes Gender, Age, and EducationLevel, and explains 34% of the variance of participants' ratings of appeal (based on an $R^2$ calculation using a combination of fixed and random effects [7]).

Our results indicate that the colorfulness of an infographic determines appeal more than visual complexity. This is in contrast to the finding of Reinecke et al. [9] who found that the complexity of a website plays a more important role than colorfulness as a predictor variable. One possible reason might be that infographics rely on color and color composition as a design element much more than websites.

The results also show that, in general, colorfulness is slightly positively correlated with ratings on appeal ($\beta = -0.0009, se = 0.0007, t = 1.3, p < .001$). As Figure 1 shows, some of the most highly rated infographics use a higher number, and more saturated colors (right side) than those that received some of the lowest average ratings (left side of Figure 1). However, we found a significant interaction effect of gender and colorfulness ($F_1 = 4.02, p < .001$), suggesting that the general preference for a higher colorfulness is almost reversed for male participants ($\beta = -0.0006, se = 0.0003, t = -2.4, p < .001$, see also Figure 2): While males rate colorless infographics slightly higher than females on average, they dislike highly colorful infographics more than females. Figure 1(d), for instance, was rated significantly higher by females ($m = 6.89$) than by males ($m = 6.19$) (independent t-test, $t = -2.53, p < .05$). A visual inspection of similar infographics suggests that female-preferred infographics predominantly use a higher number of different colors than those preferred by male participants.

We observed a similar effect of gender on the preferred complexity of infographics ($F_1 = 5.61, p < .001$). On average, male participants were relatively unaffected by complexity. Ratings by females, however, produced a weak negative relationship with complexity ($\beta = -0.004, se = 0.002, t = -2.4, p < .001$). Comparing Figure 1(d)—the infographic that received among the highest ratings—with Figures 1(a) and 1(e), text-heavy figures that were among the lowest

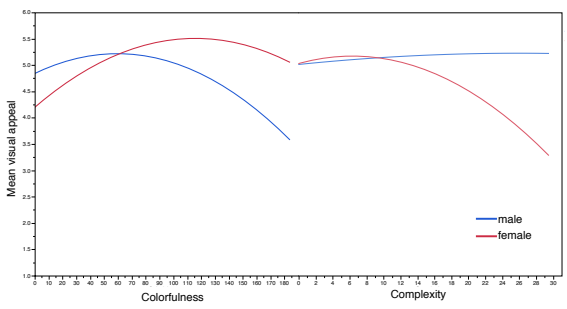


Figure 2: Average visual appeal ratings for different levels of colorfulness and complexity for females and males.

rated. While the latter two received higher ratings from males ($m = 2.94$, $m = 4.08$ respectively) than from females ($m = 2.63$, $m = 3.51$), these results were not significantly different (independent t-test, 1(a): $t = 0.877, p = 0.39$; 1(e): $t = 0.971, p = 0.35$). However, the direct comparison between these two infographics exemplifies an overall trend in our data: Men seem to be less negatively influenced by a higher number of text areas than women, who seem to generally prefer more area devoted to images.

Our analysis showed that age significantly affected participants' preferred levels of visual complexity ($F_1 = 10.9, p < .001$), but that it only has a marginal effect on the preferred colorfulness. The older participants were, the less they liked complex infographics ($\beta = -0.0004, se = 0.00004, t = -4.8, p < .001$). Previous results for websites suggested the reverse: Older participants found more complex websites more appealing [8]. However, this previous result was based on a higher sample size, and in particular, a higher average age, and might therefore not be comparable to ours.

We additionally found that participants' education level significantly affected their preference for colorfulness ($F_7 = 3.13, p < .001$) and complexity ($F_7 = 3.01, p < .001$). In general, a higher education level negatively affects the ratings of appeal for highly colorful and complex infographics, although this effect is less strong than that of gender and age.

## DISCUSSION AND DESIGN GUIDELINES

One of the most important findings of this research is that people form a reliable opinion of an infographics' appeal within the first 500ms of seeing it. Given the rising use of infographics to depict important information coupled with increasing demands on user attention, this finding highlights the need for optimizing the perceived appeal of information at first sight. Furthermore, since appeal has been identified as having a positive effect on engagement and memorability, our results suggest that these effects may be formed much earlier than previously thought.

To a large extent, the first impression of appeal is based on how colorful and visually complex an infographic is. We found that colorfulness and complexity explain 34% of the variance in participants' ratings on appeal. Because colorfulness and complexity are computational metrics (see [9]), an increase in these metrics can be attributed to a number of actions a designer may take, including adding images, icons, changing the size/color of text, or by manipulating white space and layout. When optimizing the design of an infographic to make a good first impression, therefore, designers should aim for a low to medium complexity (e.g., by choosing a limited number of image and text areas), and a medium to high colorfulness (e.g., by increasing the saturation and contrast between colors). Figures 1(b), 1(d), and 1(f) are examples of an infographics that were widely judged as appealing.

Our results also show that these general guidelines can be further optimized for particular audiences, given the significant effects of age, gender, and education level. Females prefer more colorful, yet less complex infographics than males, while males generally prefer fewer and less saturated colors and are relatively unaffected by different levels of complexity. Preference for simple infographics slightly increases with age and education level. Thus, the general preference for colorful infographics with few text and image areas might appeal to most participants in our sample, but not to all.

## FUTURE WORK AND CONCLUSION

This research established that people decide about an infographic's appeal based on minimal exposure, and that several demographic factors contribute to this impression. Opportunities for future work include analyzing consistency in people's ratings across a longer period of time, identifying additional factors that impact the appeal of infographics (e.g. country), and investigating how initial judgements of appeal impacts reasoning and judgements with information. As research continues to explore human-centric factors in visualization such as engagement and memorability, the results in this note provide a baseline to investigate the relationship between these factors and aesthetics.

## DATASET

To facilitate future work, all stimuli, participant data, and analyses scripts are available on the authors website: http://valt.cs.tufts.edu/papers/infographic-aesthetics.


## ACKNOWLEDGEMENTS

We thank Simon Warchol for help debugging the computational metrics, and Visually for providing the infographics.


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