Visualizing Trust: How Chart Embellishments Influence Perceptions of Credibility

Hayeong Song, Aeree Cho, Cindy Xiong Bearfield and John Stasko

Fig. 1: An overview of the different visualizations used for the four data topics. The figure also indicates the four chart pairs from Experiment 2, which tested how color, typeface, and bar style influence credibility ratings. Results revealed that color enhances perceived credibility, while cartoon-style bars and hand-drawn fonts reduce it ($P < 0.0001$).

Abstract—Effective data visualizations enhance perception, support cognitive processing, and facilitate informed decision-making by aligning with human perceptual strengths. Conversely, poorly designed visualizations can impede comprehension, introduce interpretive bias, and diminish the perceived credibility of the conveyed message. This paper investigates the extent to which visual embellishments influence perceived message credibility in data visualizations. We conducted two crowdsourced experiments to examine both holistic and component-level effects of embellishment. In the first experiment, participants evaluated the relative credibility of plain bar charts versus two embellished variants—cartoon-style and image-style—across topics. Participants provided both comparative judgments and qualitative feedback. In the second experiment, we systematically isolated the influence of specific design elements—color, font, and bar style—on credibility perceptions through controlled variations. Our findings reveal that the impact of embellishments on perceived message credibility is complex and context-dependent. While certain embellishments, such as the use of color and image style bars, enhanced credibility, others—most notably hand-drawn fonts and cartoon-style bars—significantly undermined it. By operationalizing trust through the lens of message credibility, this work offers empirical insight into the design factors that shape viewers' perceptions. We conclude by proposing actionable design guidelines to support the creation of visualizations that are effective for communication and credible.

Index Terms—Data Visualization, Visual Embellishment, Trust, Credibility, Chart Design, Perception

- *Hayeong Song is with Sandisk Technologies Inc. E-mail: hayeong.song@sandisk.com*
- *Aeree Cho is with Georgia Institute of Technology. E-mail: aeree@gatech.edu.*
- *Cindy Xiong Bearfield is with Georgia Institute of Technology. E-mail:cxiong@gatech.edu*
- *John Stasko is with Georgia Institute of Technology. E-mail:john.stasko@cc.gatech.edu*

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1 Introduction

Well-designed visualizations can leverage the strength of people's perceptual capabilities and augment their cognition to find insights about data, facilitate content comprehension, and enable informed decision-making [29, 35]. However, poorly designed visualizations can obstruct

understanding of the content and can even bias viewers' data interpretation and analysis.

Previous effort in the visualization community has focused on establishing "best design practices" that aim to make visualization readable and memorable [12, 76]. But little is known about how design choices might affect a viewers' willingness to *trust* the visualization.

This is a challenging topic to study because trust is multi-faceted [61]. Existing work by Elhamdadi et al. [25] has proposed that trust in visualization can be deconstructed into several components: trust in the data (and source), trust in the visual design, and individual characteristics (tendencies to trust, visualization literacy, etc.). To fully understand trust in a visualization, we argue that research must systematically examine its multiple components. In this paper, we focus specifically on trust in visual design. Prior work in visualization rhetoric has shown that all design choices—even those perceived as 'neutral' or 'standard'—can carry social and rhetorical meanings that can shape trust judgments [43, 45]. Building on this perspective, we identified several design components that could be considered chart embellishments, and investigated how they influence perceptions of credibility. Chart embellishment has long been a topic of debate in the visualization community [28, 31, 70, 72]. However, we adopt the view that all visualizations belong to distinct visual genres with their own conventions, rather than existing on a simple neutral-to-decorated spectrum [43]. While critics argue that embellishments are merely decorative and distract from the core message [28, 31, 70, 72], our work examines how such design elements may, in fact, affect viewer trust.

Others challenge this view, demonstrating that embellishments can enhance engagement [5], improve aesthetics [50], and support longer-term memory retention of chart content [8, 11, 12]. Cognitive research suggests that humans often conflate familiarity with trustworthiness [48]. Since visualization embellishments frequently incorporate familiar objects such as pictographs or cultural references [15], they may strengthen connections between visualized data and viewers' existing mental models, potentially affecting perceived trustworthiness. This intersection between embellishment and trust remains largely unexplored in visualization research, despite its implications for how viewers evaluate the information.

Our study therefore investigates whether *embellishments* influence trust in visualizations, and if so, which specific design characteristics shape these perceptions. Rather than assuming embellishments inherently undermine trust simply because they deviate from familiar visualization norms, we examine how different embellishment styles might impact trust across various data topics.

However, because there is no standardized methodology to measure 'trust', we draw on existing literature for appropriate proxies. Kong et al. [44] and Lucassen & Schraagen [54] have successfully employed 'message credibility' as a proxy for viewer trust in visualizations. Scholars have further noted that credibility tends to be a less subjective and contextual variable to measure in studies [7, 14, 21, 32]. This motivated us to operationalize trust as the credibility of the message conveyed through the visualization in this study. This operationalization enables our results to be comparable with that in existing literature [30, 57].

In summary, our study examines trust in visualization by exploring the relationship between visual design choices and trust operationalized as 'message credibility'. We conducted two crowd-sourced studies to examine how chart embellishments impact perceived message credibility of visualizations. In Experiment 1, participants compared plain (i.e., not-embellished) bar charts with two types of embellished charts — cartoon-style and image-style — on a variety of topics. Participants selected the chart they found more credible and provided qualitative feedback about their views. We also collected absolute ratings to help identify visualization elements that influence credibility. Our results showed that individual attributes, such as font, color, and bar shape, impact viewers' perception of credibility. In Experiment 2, we conducted a series of studies to identify the driving factors behind viewer ratings of message credibility: color, fonts, and visual mark (bar) styles.

We found that when colors were used, it enhanced credibility compared to grayscale. For font, when hand-drawn fonts were used compared to common fonts, it reduced credibility significantly. Visual mark styles—specifically bar style—significantly impacted message credibility in visualizations. Specifically, cartoon-style bar marks were associated with lower credibility (likely due to their informal appearance). In contrast, image-like bar marks that resembled real-world objects were associated with higher credibility, supplementing existing work linking familiarity with higher trustworthiness [48]. Our findings highlight how visualizations can use embellishments and design elements to communicate effectively without compromising perceived credibility. Our contributions are twofold. First, through Likert scale ratings, A/B choice tasks, and ranking tasks, we empirically measure and quantify the effects of a few specific design alternatives on participants' perceptions of visualization message credibility. Second, based on these findings, we provide actionable guidelines to inform future visualization design practices.

2 Related Work

2.1 Credibility and Trust in Visualization

The topics of trust and credibility in visualization have recently garnered increasing attention [37, 53, 56], with some work even proposing models of trust in information. Mayr et al. studied how trust is established in information visualization [56] and introduced a trust framework that identifies several factors to consider when evaluating trust in visualization, such as viewers' tasks and data quality. This model positions visualizations as mediators between viewers and information, facilitating trust in the communicated message. However, the academic community has yet to reach consensus regarding a trust model specifically tailored for visualization. Pandey et al. noted the complexity of evaluating trust in visualization, emphasizing its multidimensional nature [61], where trust is affected by multiple factors such as the quality of data and visual representation. Recent work in affective visualization design has challenged the assumption that minimalistic visualizations are inherently more objective or credible [48]. Research suggests that trust in a visualization is not only a function of the accuracy of the data it presents but also the emotional and rhetorical cues embedded in its design [41, 48].

Prior research has demonstrated that visualizations in news articles enhance perceived news quality [37] and message credibility [16]. For instance, static data visualizations were found to increase credibility compared to articles without visualizations [16], while interactive visualizations boosted engagement without significantly affecting credibility [53]. However, these studies primarily focused on plain charts and did not explore how specific design choices, such as visual embellishments, influence perceived credibility. Our work addresses this gap by examining the impact of visualization design choices on message credibility, providing insights into how embellishments shape viewers' credibility perceptions.

2.2 Cognitive Perception of Visualization

The previous section highlighted that visualization's effects on perceived credibility depend on multiple factors. Here, we review studies on graphical perception and discuss additional factors influencing data interpretation and credibility. Prior studies in graphical perception have shown that visualization methods can significantly impact people's interpretation and perception of data quality. Research demonstrates that visualization design affects statistical data interpretation and estimation [3, 36, 69], perception of data quality [69], and confidence in decision-making [1, 68]. Consequently, visualization design can potentially influence whether viewers perceive a chart's message as credible and their willingness to trust the represented data. Previous research has established that design factors such as aesthetics, usability, and user experience can enhance viewers' perception of credibility in user interfaces and visualizations [22]. For example, positive experiences with an interface (e.g., web pages) led viewers to trust the information more, while issues like bugs reduced credibility. This led us to consider how visual design elements, particularly embellished charts (i.e., infographics), could increase engagement and aesthetic appeal, helping viewers connect more effectively with the message [12]. Studies have shown that infographics using icons improve memorability and recall compared to simple charts [33], and lead to higher ratings of engagement

and aesthetics [5, 50]. While previous research has explored how visualization design influences engagement, aesthetics, memorability, and comprehension, there remains a knowledge gap regarding how various design choices collectively shape viewers' perceptions of credibility. Our work seeks to understand and quantify these effects.

2.3 Infographics and Visual Embellishment

The term "infographic" originated in data journalism, initially referring to any graphic displaying information [17], and evolved to describe a mix of text and graphics for effective communication [65]. Unlike data visualizations, which serve multiple purposes including exploration and analysis, infographics prioritize communication [15]. "Visually embellished charts" include non-data elements that are "not essential to understanding the data" [8, 72]. Critics like Tufte labeled these as "chartjunk," arguing they distract from a chart's message [72], while others viewed embellishments as purely artistic [28, 31]. However, research suggests embellishments can enhance engagement, aesthetics, and memorability without reducing functionality [5, 8, 50]. Minimalist designs, while clear, may hinder comprehension for viewers unfamiliar with the topic [38, 42]. Despite these insights, how embellishments impact perceived credibility remains underexplored. We studied how different embellishment styles influence the credibility of visualizations and identified the characteristics that shape this perception.

To understand how embellishments affect perceived credibility, we investigated the design space of visual embellishments, which are yet unexplored due to diverse styles and subjective preferences. Designers like Mona Chalabi [19], Nigel Holmes [40], and Giorgia Lupi [55] illustrate this complexity, with Chalabi's comic-style visuals, Holmes's playful precision, and Lupi's intricate, human-centered layouts. Chen et al. [20] took a step to address this complexity by developing a framework that categorizes embellishments by goals and techniques, demonstrating its effectiveness through usability studies. Drawing from this framework, we selected well-established styles for testing and focused on bar graphs with stretched images of objects to balance visual appeal with experimental control.

3 Experiment One

To evaluate the impact of different visualization design choices on perceived message credibility, we conducted a crowd-sourced study comparing *plain charts* (without embellishments) and *visually embellished charts*. The study included two styles of chart embellishment, one providing a more cartoon-ish appearance and another using images and pictures. Participants rated credibility, selected the more credible visualization between two options (*plain* vs. *embellished*), and answered proxy questions (e.g., choosing a chart for a professional presentation) to assess credibility. The study included topics like politics, public health, and sports, covering both *potentially more* and *potentially less belief-triggering* topics to generalize results and examine potential differences in perceived credibility across topics. To measure perceived credibility, we adapted questions and terminology directly from well-established 'propensity to trust' instruments [44, 54], which have been shown to use message-credibility judgments as a reliable proxy for viewers' trust in visualizations. Each item was reworded to refer specifically to user specific tasks (e.g., credibility Likert scale, a/b options).

3.1 Hypotheses

Our hypotheses for the experiment were:

- **H1**: Participants will perceive plain charts as more credible than embellished charts.
- **H2a**: Participants will perceive a plain chart as more credible than a cartoon-style chart.
- **H2b**: Participants will perceive a plain chart as more credible than an image-style chart.
- **H3**: Participants will perceive a plain chart as more credible than an embellished chart more for belief triggering topics than for less belief triggering topics.

H1-H2 are grounded in the theory that embellished charts can distract from data comprehension [72], potentially undermining credibility by diverging from principles of faithful data representation. **H3** predicts a topic-dependent effect: participants may find embellished visualizations more credible for *less belief-triggering topics* (e.g., hobbies) due to the neutral nature of these topics, while preferring plain visualizations for *more belief-triggering topics* (e.g., politics) where perceived objectivity becomes critical.

3.2 Methodology

We conducted a 2 (visualization style) × 2 (topics) within-subjects study to examine how visualization design choices impact perceived credibility, focusing on bar graphs. The survey was hosted by Qualtrics [66]. Participants saw one of the embellishment styles—cartoon-style and image-style—against plain charts. The independent variables were visualization style and topic (more or less belief triggering), while the dependent variables were perceived credibility, measured using Likert scales, a/b option selection, and open-ended responses [74]. We studied two embellishment styles—cartoon-style and image-style—drawing from the design space proposed by Chen et al. [20]. The cartoon-style, with hand-drawn lines, evokes a casual, lively feel, while image-style connects with real-world items, bridging plain and infographic charts. To isolate embellishment effects, we focused solely on bar charts. We included an attention check following Oppenheimer et al. [60], requiring participants to select 'strongly agree' to demonstrate attention.

3.2.1 Stimuli & Task

Both embellished and plain charts represented the same data, focusing on visual embellishments such as icons, pictographs, backgrounds, annotations, and color, inspired by Tufte's guidelines [71]. Tick marks and grid lines were excluded. We tested only bar charts, using stretched icons or clip-art bars for embellished charts. We selected visually embellished charts from different sources including news articles, web blogs, and internet searches. We curated a collection of eight infographics, consisting of two distinct embellishment styles: image-style and cartoon-style, with four examples of each style. Next, we created comparable plain charts, removing visual embellishments (explained in more detail below).

Embellished Charts. These charts used stretched icons/drawings or clip-art bars proportional in length to the data values. We employed icons relevant to the chart, either uniformly (e.g., rainbows) or varied (e.g., flags). We tested two embellishment styles:

1.**Cartoon-Style:** We used charts following the design style of Mona Chalabi [18, 19], featuring hand-drawn elements and fonts that give a casual and lively feel.

2.**Image-Style:** Inspired by skeuomorphism, this style uses images of real-world objects, potentially aiding comprehension and reducing learning effort [20]. We sourced the charts from Behance [9] for stylistic consistency.

Plain Charts. Plain bar charts displayed categorical data using proportional rectangular bars without embellishments, such as icons, gradients, or redundant labels. We applied common fonts (e.g., Helvetica), and we created the charts using Excel, Photoshop, and PowerPoint, following prior methodologies [6]. For each embellished infographic, a corresponding plain version was designed. These plain charts retained the original data and its layout but removed all decorative elements, ensuring that any differences in user response could be attributed solely to the presence or absence of embellishments. This methodology can allow us to isolate the effect of embellishments by ensuring that both versions of each visualizations were identical in data content and layout, differing only in the presence of decorative elements.

Topics. We presented data across diverse topics including politics, society, public health, and Olympic performance, which we categorized as either potentially more or less belief-triggering to enhance the generalizability of our results. We define potentially less belief-triggering topics as neutral and fact-based subjects that provoke minimal emotional reactions, such as everyday activities. In contrast, we define

potentially more belief-triggering topics that generate strong emotions and opinions, typically connected to personal values or identity, like CO2 emissions or political events. We classified public health and Olympic performance as less belief-triggering (more innocuous), while categorizing politics and society as more belief-triggering. This classification was informed by established literature on confirmation bias associated with strong beliefs [51] and explored in a small pilot study (N = 14) where participants rated emotional engagement with these topics, providing preliminary support for our categorization. Pilot study details are included in the supplementary materials.

3.2.2 Procedure

We recruited 148 participants through the Prolific platform, applying screening to exclude residents of the EU and China while including only those fluent in English. Residents of the EU and mainland China were excluded due to regulatory constraints (e.g., GDPR and PIPL requirements) and prior institutional IRB guidance. All participants ultimately were US residents. We stipulated that participants needed at least 100 completed studies and a 95% approval rate to help achieve data quality [64].

At the start of the experiment, participants provided informed consent in accordance with our IRB protocols. The study consisted of 26 questions, followed by a mini-VLAT assessment [61] and a demographic questionnaire (age, gender, education). The study took approximately 15 minutes, and participants were compensated $3.50. To comprehensively assess perceived message credibility, we employed three complementary measurement approaches: Likert scale ratings, A/B comparison choices, and open-ended responses.

For each visualization stimulus, participants completed the following tasks:

1. **(Credibility Perception)** I find the message of the visualization credible. (1-Strongly disagree, 7-Strongly agree)
2. **(Comparison of Credibility)** Which visualization communicates the message in a more credible way?

   a-embellished chart, b-plain chart

   Why did you select that chart? Please respond in a sentence.
3. **(Professional Context: Proxy for credibility)** In a professional presentation, which visualization would you use to convince your audience about the chart's message?

   Plain chart or Embellished chart? Why?

This triangulation approach allowed us to capture both absolute credibility ratings via Likert scales and direct comparative judgments through A/B choices, while open-ended responses provided qualitative insights into participants' decision-making processes. For a subset of the study, we included a "neither" option (a-plain, b-embellished, c-neither) to examine potential changes in response distribution. The specific task language was refined through pilot testing to ensure clarity. The complete experimental instruments are provided in the Supplemental Materials.

3.3 Results: Measure & Analysis

3.3.1 Objective Results: Credibility single ratings

We collected participants' perceived message credibility of charts on a Likert scale (1 - being low, 7 - being high). We performed a two-way ANOVA to analyze the effect of independent variables; *vis type* and *topic* on dependent variable *credibility*. We used Tukey's HSD test with α = .05 for post-hoc analyses. We conducted post-hoc power analysis with G*Power [27] for a single item *credibility* rating between *embellished* and *plain* charts (2 groups) with sample size 148 and with an alpha level of 0.05. Our results showed that we had 0.88 output power (good).

We constructed a linear mixed-effect model predicting credibility with *vis type*, *topic*, *embellishment style*, and the interaction between *vis type* and *topic*, *vis type* and *embellishment style*, along with *vis literacy* as a co-variate, and adding participants as a random factor to account for individual differences (see Figure 2 for summary).

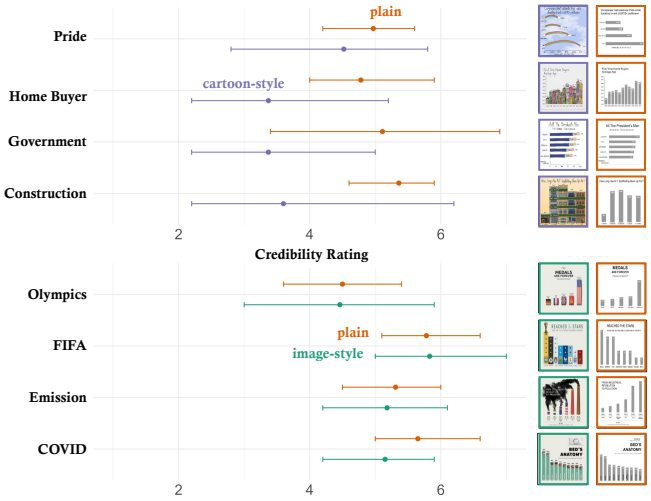

Fig. 2: Credibility ratings comparing embellished vs. plain charts (scale: 1-low to 7-high credibility; error bars show SD). **Plain charts** generally received higher credibility scores than **cartoon-style** across topics, though differences varied by context. **Image-style** showed mixed effects on perceived credibility across topics when compared to **plain charts**.

Visualization type (vis type). There was a main effect of *vis type* ($F(1,142) = 32.82$, $p \prec 0.0001$), with participants rating *plain* charts (M = 5.04, SD = 1.16) as more credible than *embellished* charts (M = 4.34, SD = 1.47). This effect was consistent across *less belief triggering* topics (*plain*: M = 5, SD = 1.10; *embellished*: M = 4.24, SD = 1.64) and *more belief triggering* topics (*plain*: M = 5.08, SD = 1.23; *embellished*: M = 4.45, SD = 1.27).

Topic. There was no main effect of *topics* ($F(1,142) = 0.36$, $p = 0.5485$), as participants rated *more belief triggering* (M = 4.59, SD = 1.45) and *less belief triggering* (M = 4.76, SD = 1.28) topics as equally credible. This suggests topics did not significantly affect credibility perceptions.

Embellishment style. There was a main effect of *embellishment style* ($F(1,142) = 10.48$, $p = 0.0016$). Participants rated *plain* charts as more credible than both *cartoon-style* (M = 3.76, SD = 1.46, $p \prec 0.0001$) and *image-style* (M = 4.88, SD = 1.28, $p = 0.0075$) charts. Among *embellished* charts, *image-style* (M = 4.88, SD = 1.28) were rated more credible than *cartoon-style* (M = 3.76, SD = 1.46, $p = 0.0079$).

Interaction effects

Topic * vis type. We found no interaction effect between *vis type* and *level of belief triggering topics* on credibility ($F(1,42) = 0.36$, $p = 0.5476$).

Embellishment style * vis type. No interaction effect was found between *vis type* and *embellishment style* on credibility ($F(1,42) = 1.58$, $p = 0.2112$).

Vis literacy. For potential demographic impact, we hypothesized that visualization literacy might influence perceived credibility, as it affects how viewers interpret data visualizations. We examined the relationship between *vis literacy* and *credibility*. However, we found no significant relationship between *vis literacy* and *credibility* (Estimate = -0.035, Std Error = 0.07, $p = 0.649$), indicating that visualization literacy did not affect perceived message credibility. Across all 148 responses, 'vis literacy' averaged 9.38 (SD = 1.62), with scores spanning from 6 to 12. The middle 50% of scores fell between 8 and 11, indicating most ratings were on the higher end of the scale.

3.3.2 Objective results: Credibility A/B choice

We collected participants' paired choice responses (plain vs. embellished) to assess perceived credibility. Odds ratio analysis was performed to evaluate the effects of *topic* and *embellishment style* on *credibility.*

Embellishment style. We constructed a logistic model and found a significant effect of *embellishment style* (ChiSquare = 31.16, p $\prec$ 0.0001). Participants were 15.37 times more likely to choose *plain* charts over *cartoon-style* charts for message credibility (p $\prec$ 0.0001, CI = [5.93, 39.83]). No significant effect was found for *plain* vs. *image-style*.

Topic. We constructed a logistic model to predict whether participants chose *plain* or *embellished* charts as more credible based on *topics*. No significant effect was found (ChiSquare = 3.37, p $\prec$ 0.0663), though *more belief-triggering topics* made participants 2.44 times more likely to prefer *plain* charts (CI = [0.94, 6.32]). This suggests the results may generalize across belief-triggering and non-belief-triggering topics.

3.3.3 Professional presentation (credibility proxy)

We performed an odds ratio analysis on our credibility proxy question that asked about which visualization a participant would choose to include in their slides for a professional presentation.

Embellishment style. We constructed a logistic model and found a significant effect of *embellishment style* (ChiSquare = 38.66, p $\prec$ 0.0001). Participants were 12.93 times more likely to choose *plain* charts over *cartoon-style* charts (p $\prec$ 0.0001, CI = [5.77, 28.96]) for inclusion. No significant effect was found for *plain* vs. *image-style*.

Topic. We constructed a logistic model and found no significant effect of *topics* on choice (ChiSquare = 1.13, p $\prec$ 0.2877). For *more belief-triggering* topics, participants were 1.55 times more likely to choose *plain* charts over *embellished* charts (CI = [0.69, 3.47]), but this difference was not significant.

3.3.4 Neither option

For a quarter of the participants, we added a "neither" option to assess its impact on response distribution among the binary choice options. We compared distributions between the standard A/B choice and A/B with a "neither" option included, using a chi-square test.

A/B option. A significant effect of *embellishment style* was found ($X^2(1, N = 141) = 43.55, p \prec 0.0001$), with participants more likely to choose *plain* charts over *cartoon-style* charts as more credible.

A/B option with "neither". We found a significant effect of *embellishment style* X^2 (2, N = 45) = 10.59, p $\prec$ 0.0050), with participants more likely to choose *plain* charts over *cartoon-style* charts. Adding the "neither" option weakened this preference but remained significant, suggesting that a subset of participants viewed *plain* and *embellished* charts as equally credible.

3.4 Qualitative Results

We collected participants' open-ended comments which helped to explain which aspect(s) of a visualization led them to perceive its message as being more credible.

We conducted a two-coder analysis using an open-coding approach. Both coders independently analyzed open-ended comments, creating codes based on observed patterns and generating new ones for recurring concepts. We then iteratively refined and aligned the codes, resulting in six categories: visual appeal, clarity, equality, seriousness, professionalism, and source. Each category included codes reflecting positive or negative sentiments (see Figure 3). Negative sentiments were coded when participants disliked certain visualization characteristics, such as P112's comment: *"The chart on the right is too busy and confusing. Too many colors and too much detail to get the point across,"* which related to the *clarity theme*. Positive sentiments, such as P86's remark—*"I think the message is conveyed better through Option A [image-style] simply because it has a more vibrant and user-friendly appearance,"*—were coded under *professionalism*.

Below we discuss visualization characteristics that made participants view charts as more or less credible. When discussing our results, codes are italicized, and "n=" represents the number of participants who mentioned a concept or idea.

1. What makes a chart's message credible? For each visualization style, we discuss aspects of the visualization that led participants to have a higher perception of message credibility.

a) Plain charts. Participants perceived the message of plain visualizations as being credible for their *clarity*, *seriousness*, and *professional* aspects.

Clean, structured, simple graph helps with comprehension. Participants liked the *simplicity* of plain charts (n = 23) stating that the plain chart was self-explanatory and *helped with comprehension* (n = 11), such as by being able to see patterns and messages more clearly. P99 expressed *"Because it is clean and easy to read, thus it was more credible. There are no distractions from bright colors and art, like in the other one [embellished]"*

Faithful representation of data. Participants valued the *faithful representation of data* (n = 19) without distractions, such as distracting images (e.g., a fist bump). They appreciated neutral, objective visualizations focused on the data rather than design, which they perceived as more credible. P18 said *"I tend to trust the plain chart more because it seems more focused on the facts than the design."* P101 noted *"It presents the data in a straightforward way without editorializing."*

More serious & professional. Participants stated that the plain charts looked more *serious* (n = 7) and *professional* (n = 11) due to their lack of unusual design, and by using plain bars, neutral colors, and fonts. They stated that these components made a chart's message more credible. P4 stated *"It is a more formal representation of the numbers unencumbered by extraneous details and was more professional."*

b) Image-style of visualization. Participants perceived image-style visualization's message as credible for their *visual appeal*, *clarity*, and *professional* aspects.

Visual appeal, engaging, more effort. Participants appreciated the *aesthetics* (n = 9) of these charts, with *embellishments* (n = 28) like colors, icons, and images drawing attention and making the charts more *engaging* (n = 22). Similarly, they stated that the visualization was more credible because it had a *better representation of data* (n = 11). P13 expressed that *"It seems like more effort was put into this chart to make it a better representation because it's more illustrative, making me think that it's more credible."*

Clarity, professional & serious. Participants found these charts *easier to understand* (n=11), better at *communicating a message* (n=4), and more *professional* (n = 6) and *serious* (n=3). P66 stated *"Both are visually credible but the one in color is easier to read while displaying the information more clearly."* P11 commented *"This looks more professional. Someone was paid to make this aesthetically pleasing and it looks like it comes from a magazine."*

c) Cartoon-style visualization. Participants perceived cartoon-style visualization's message as credible for their *visual appeal*. While we present the qualitative results for cartoon-style visualization in this section for context, we note that these views were uncommon.

Visual appeal, engaging, more effort. Participants appreciated such visualizations as artwork (e.g., home buyer's age) and thought that it *took more effort to create it* (n = 6), which led them to perceive its message as more credible. P1 stated *"This image was slightly easier to understand and more effort put into, the visual makes me feel more likely to trust the researcher."* Similarly, participants found this style of visualization more *engaging* (n = 6). P77 noted *"It presents the data in a more visual/appealing way. It ties the data back to the issue."*

2. What makes a chart's message less credible? Overall, participants found plain charts credible and provided minimal feedback on why they might be perceived as less credible. Thus, below we focus on aspects of image-style visualizations and cartoon-style visualizations that detracted from credibility.

a) Image-style visualization. Participants perceived image-style visualization's message as less credible for including *distracting visual elements*. Participants reported that visualization design was *distracting* (n = 6) toward understanding the message of the chart. P9 said *"In this example[plain chart], it is much easier to see that 65% of the world's pollution is caused by only six countries which is, I believe, the point of the chart. In this case, the colors/graphics seem to detract from the message."*

b) Cartoon-style visualization. Participants perceived cartoon-style

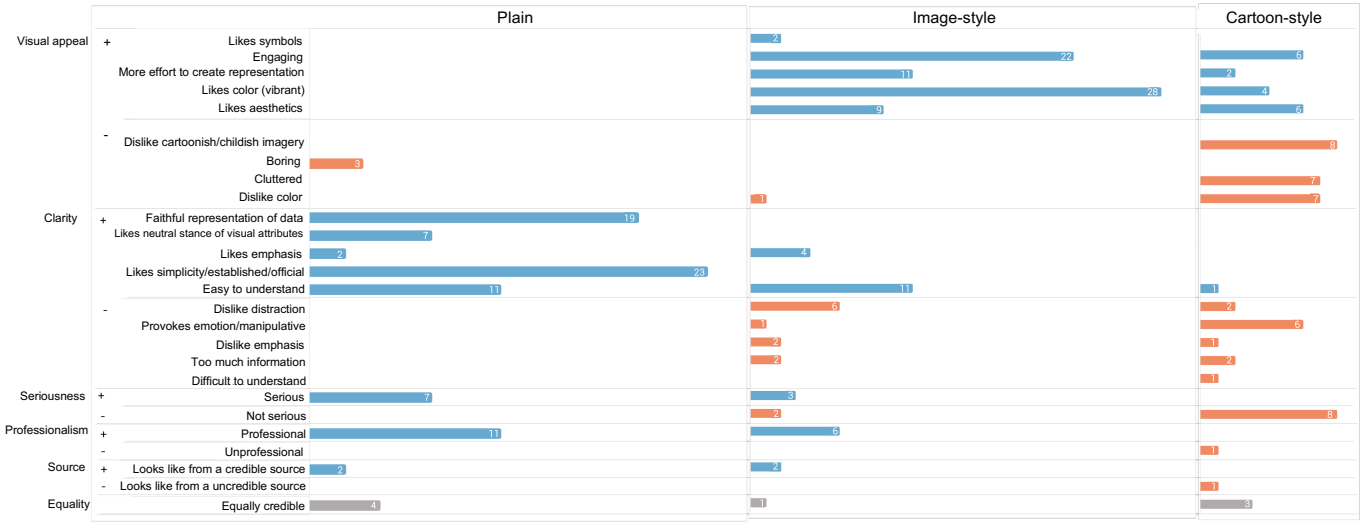

Fig. 3: Summary of qualitative coding results for different styles of visualizations for perceptions of credibility; plain, image-style, and cartoon-style visualizations. Blue bars indicate positive sentiment, orange bars indicate negative sentiment, and gray bars indicate neutral sentiment. Numbers show frequency of mentions.

visualization's message as less credible for their *distracting visual elements*, *lack of clarity*, and *less serious* aspects.

Distracting visual elements. Participants found certain design elements, such as *clutter* (n=7), *vibrant colors* (n=7), *cartoon-style bars* (n=8), and hand-drawn fonts, distracting. Participants reported that these visual embellishments detracted them from reading the message of charts and even biased them. P112 expressed *"The chart on the right is too busy and confusing. Too many colors and too much detail to get my point across."* P86 noted *"The font and the drawings in the other image make it look unprofessional. The normal bar graph is more professional and easier to read."*

Lack of clarity and provokes emotions. Participants found this style distracting and manipulative, *evoking emotion* (n=6) rather than allowing objective interpretation. P37 stated *"The first [plain] shows the message accurately but still clearly. The second [cartoon style] is not only misleading but harder to understand."*

Seriousness and source. Participants reported that some of the visualizations seemed *less serious* (n = 8) due to childish or gimmicky designs, reducing credibility. P19 stated, *"The first one [plain] because it has more of a science aesthetic. The other visualization [cartoon-style] is cute, but too artsy to take seriously."* Similarly, P57 said, *"I chose this one [plain] because it looks like actual data that will be taken seriously. The other image [cartoon-style] is too playful and represents a lack of intention around the seriousness of the subject."* One participant questioned the credibility of the information (*source*) stating *"This visualization looks like a cartoon that I will see in a newspaper. It looks childish and not credible."*

3.5 Synthesis of Results

We re-evaluated our hypotheses with respect to the statistical analysis of experimental data. Our findings from the experiment were:

- **H1** (Partially confirm): Participants will perceive plain charts as more credible than embellished charts.
- **H2a** (Confirm): Participants will perceive the plain chart as more credible than the cartoon-style visualization.
- **H2b** (Fail to confirm): Participants will perceive the plain chart as more credible than the image-style visualization.*Participants perceived both of these visualization styles as credible.*
- **H3** (Fail to confirm): Participants will perceive plain charts as more credible than embellished charts for more belief triggering topics than less belief triggering topics. *We did not see a difference in credibility ratings across the more or less belief triggering topics.*

Regarding our first research question, "Do embellishments undermine perceived message credibility of charts?", our findings were more nuanced than our initial hypothesis suggested. Cartoon-style visualizations, featuring hand-drawn imagery and fonts, were generally perceived as less credible due to their informal appearance and perceived imprecision. In contrast, image-style visualizations, which incorporated realistic images and colors, were often rated as more credible than plain charts in certain contexts.

For our second research question, "Which visualization design elements contribute to perceived credibility?", participants identified specific elements that influenced their judgments. Font choice, color palette, and bar style emerged as key factors. Cartoon-style bars and vibrant colors were associated with a less serious appearance, reducing perceived credibility. Conversely, plain fonts and natural colors conveyed objectivity and professionalism. Building on these findings, our second experiment isolated and systematically tested these visual elements to better understand their individual effects on perceived message credibility.

4 Experiment Two

4.1 Motivation and Hypotheses

Experiment 1 revealed three key factors that potentially influence chart credibility ratings: color, font, and bar styles. To systematically evaluate their effect sizes, we developed three sets of hypotheses and corresponding experiments, connecting our observations with established research. Previous studies by Engebretsen et al. [26] and D'Ignazio et al. [23] have demonstrated that vivid colors can trigger stronger emotional responses, potentially influencing perceived credibility. Additionally, research by Lauer et al. [49] and Wood et al. [13] found that imprecise elements such as rough lines or hand-drawn features can make people perceive visualized information as less serious. As shown in Figure 4, these findings suggest that hand-written fonts and cartoon-style imagery might adversely impact perceived message credibility compared to traditional typefaces and realistic representations (image-styled bars). We formulated the following hypotheses:

- **H1 Color:** Color usage will degrade the perception of the credibility of charts compared to the usage of grayscale.
- **H2 Font:** Usage of hand-drawn cartoon-style fonts will degrade the perception of the credibility of charts compared to the usage of common/traditional fonts (e.g., Helvetica).

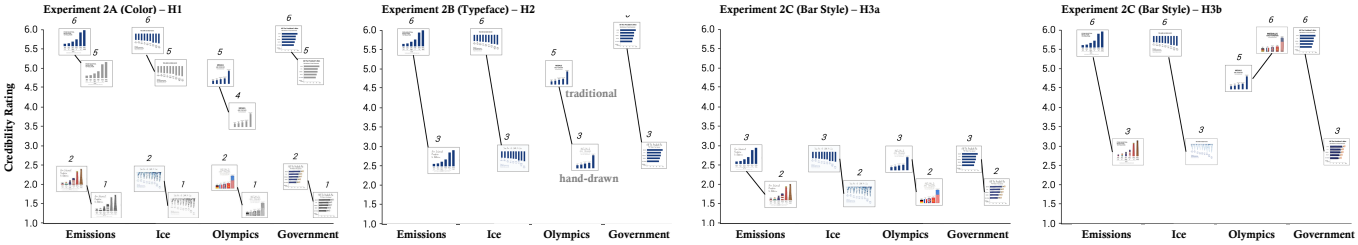

Fig. 4: Single-winner ranked choice rankings (1 = least credible, 6 = most credible) for four topics (CO2 emissions, ice, Olympic medals, and male-dominant government administration) under different design manipulations in Experiment 2. Connecting lines highlight consistent trends across topics within each design condition. Font, color, and style of bars all had significant effects on perceived message credibility ($P < 0.0001$). Color increases perceived credibility, whereas cartoon-style bars and hand-drawn fonts decrease it.

- **H3a Bar Styles:** Usage of cartoon-style bars will degrade the perception of the credibility of charts compared to the usage of plain bars.
- **H3b Bar Styles:** Usage of image-style bars will degrade the perception of the credibility of charts compared to the usage of plain bars.

4.2 General Method

For each set of experiments associated with each hypotheses, we created six visualization designs, manipulating their color (H1), typeface (H2), and bar style (H3), as shown in Figure 1. We chose four visualization topics, including two more belief-triggering ones (US government demographics, air pollution) and two less belief-triggering ones (weather, sports). These topics were selected based on past work on confirmation bias in data visualizations, including the works by Xiong et al. [75] and Li et al. [51], and further tested with a pilot study where participants rated their emotional investment while reading about these topics.

To reduce the demand of experimenters and the social desirability effects [39], we asked participants to rank six visualizations, all covering the same topic, but differing in design. They did this four times, for each topic. We measured perceived credibility through message-credibility judgments [44, 54] as done for Experiment 1, using a direct ranking task [34] to capture how graphical elements affect perceived message credibility in visualizations.

To control for individual differences and ensure comparability, every participant viewed the same six visualizations for each topic. However, only one pair within the set was experimentally manipulated—differing in a single variable, while all other design elements remained constant. For example, in Experiment 2A, one pair differed only in color (color vs. grayscale), with bar style and typeface held constant. This design allows us to isolate the effect of a single experimental variable using participants' relative rankings, minimizing the influence of confounding factors.

The primary dependent variable was the **credibility ranking** assigned to each visualization. To supplement participant rankings, we also collected qualitative data to understand which specific visual attributes influenced participants' credibility judgments via a multiple-choice. Additionally, using Likert scales (1-strongly disagree, 7-strongly agree), we asked participants how much they cared about the topic portrayed in each visualization. This methodical approach enabled us to evaluate both the individual and combined effects of different visual elements on perceived credibility, contributing to a more nuanced understanding of how design choices influence the message credibility of data visualizations.

4.3 Procedure

We recruited 160 participants through the Prolific platform and the survey was hosted by Qualtrics [66], applying screening criteria to ensure data quality. Participants were non-EU, non-China residents fluent in English, who had completed at least 100 studies with a 95% approval rate. All participants ultimately were US residents. We used identical procedures to Experiment 1 for participant exclusions and attention checks, dropping 3% of responses. At the beginning of the experiment, participants provided informed consent following our IRB protocols. The study consisted of 16 questions, followed by a mini-VLAT assessment [61] and a demographic questionnaire. Visual literacy scores averaged 8.8 (SD = 2.2), ranging from 1 to 12, with most participants scoring in the higher range. We found similar results to Experiment 1, with no significant effect of visualization literacy on perceived credibility. Each session took approximately 10 minutes, and participants were compensated $2.

4.4 Experiment 2A: Color Effect

This experiment tested our hypothesis H1 that color usage affects credibility perception in visualizations. We compared the pairs of visualizations that differed only in their color scheme (colored bars versus grayscale bars), across all other visual elements (bar style and font) and all topics.

We analyzed the ranking data using the Kruskal-Wallis Test, with *color* (colored/grayscale) as the independent variable and *credibility rank* as the dependent variable. Our analysis revealed significant effects of color on perceived credibility across different bar styles:

Plain Bars: The visualization with colored plain bars ($vis_{\text{plainBar, color, commonFont}}$) was ranked significantly more credible than its grayscale counterpart ($vis_{\text{plainBar, noColor, commonFont}}$) ($P < 0.0001$).

Cartoon-Style Bars: Similarly, the visualization with colored cartoon-style bars ($vis_{\text{cartoon-styleBar, color, hand-drawnFont}}$) was ranked significantly more credible than the grayscale version ($vis_{\text{cartoon-styleBar, noColor, hand-drawnFont}}$) ($P < 0.0001$) (see Figure **??** for examples) .

Conclusion: These results indicate that colored visualizations were consistently perceived as more credible than grayscale visualizations, regardless of bar style. Although we did not find support for H1, our results suggest that while participants in the first study perceived grayscale as more scientific, their actual credibility rankings favored color visualizations.

4.5 Experiment 2B: Font Effect

Just as in 2A, participants ranked the same six visualizations for all four topics. To test the effect of font typeface (hand-drawn vs. traditional typeface), we compared the ranking of the pairs of visualizations that differed only in their font style (hand-drawn cartoon-style fonts versus common traditional fonts), across all other visual elements to control for their effects. This approach allowed us to assess how font alone influences perceived credibility, without the confounding effects from stylized bars or color palettes.

We analyzed the ranking data using the Kruskal-Wallis Test, with *font style* as the primary independent variable and *credibility rank* as the dependent variable. We controlled for *color* and *bar style* to isolate the font effect. Our analysis revealed a significant effect of font style on perceived credibility.

Visualizations with common fonts ($vis_{\text{plainBar, color, commonFont}}$) were ranked significantly more credible than those with hand-drawn fonts ($vis_{\text{plainBar, color, hand-drawnFont}}$) ($P < 0.0001$).

Conclusion: These results support H2 that hand-drawn fonts reduce perceived credibility compared to common fonts. This finding aligns with participant feedback from our first study where hand-drawn fonts were described as distracting and less professional, while common fonts were perceived as more neutral and authoritative.

4.6 Experiment 2C: Bar Styles Effect

This experiment tested our hypotheses H3a and H3b regarding how different bar styles affect credibility perception. As before, we presented participants with all six visualization designs but specifically compared only the pairs that differed in bar stayles: plain bars, image-style bars, and cartoon-style bars, while all other visual elements stayed the same. Following the same procedure as previous experiments, participants ranked visualizations by perceived credibility.

We analyzed the ranking data using the Kruskal-Wallis Test, with *bar style* as the primary independent variable and *credibility rank* as the dependent variable, while controlling for font and color. Our analysis revealed significant effects of bar style on perceived credibility:

Plain vs. Cartoon-Style Bars: Visualizations with plain bars ($vis_{\text{plainBar, color, hand-drawnFont}}$) were ranked significantly more credible than those with cartoon-style bars ($vis_{\text{cartoon-styleBar, color, hand-drawnFont}}$) ($P < 0.0001$). This finding supports hypothesis H3a.

Plain vs. Image Bars: Visualizations with plain bars ($vis_{\text{plainBar, color, commonFont}}$) were ranked significantly more credible than those with image-style bars ($vis_{\text{imageBar, color, commonFont}}$) ($P < 0.0001$). This finding supports hypothesis H3b.

Conclusion: These results support both hypotheses H3a and H3b, suggesting that plain bars are consistently perceived as more credible than both cartoon-style and image-style bars. This suggests that visual embellishments in bar representation, regardless of their form, may reduce perceived credibility of data visualizations.

5 Cross-Cutting Analyses

To improve the generalizability of our findings, we conducted several additional analyses to further understand the effect of topic and potential reasoning behind the differences in participants' credibility rankings.

5.1 Topic Sensitivity Analysis

We performed a Kruskal-Wallis test on the ranks of six visualization conditions across *more* and *less belief-triggering* topics to assess their effect on perceived credibility. The results did not show a significant effect for most conditions, except condition 1) *plain bar, color, hand-drawn font* ($H(1) = 3.8992, P < 0.0483$), where the rankings were significantly lower (less credible) for *more belief-triggering* topics compared to *less belief-triggering* topics. For the remaining conditions, no significant differences were found in the credibility rankings.

5.2 Multiple choice: visual elements effect

Participants explicitly identified which visual elements influenced their credibility judgments through multiple-choice questions. Across all topics, participants consistently reported that *common fonts* (61%) and *plain bars* (54%) enhanced credibility, while *cartoon-style bars* (44%) and *hand-drawn fonts* (71%) diminished credibility. The results of this experiment support the findings from Experiment 1, where participants also favored common fonts and plain bars. This consistency indicates that participants likely view these visual elements as signals of professionalism and trustworthiness. Additionally, it aligns with Experiment 1, where participants noted that cartoon-style bars and hand-drawn fonts lowered the perceived credibility of the message.

6 Synthesis of Results

We re-evaluated our hypotheses with respect to our statistical analysis.

- **H1 (Fail to support) :** Color usage will degrade the perception of the credibility of charts compared to grayscale.
- **H2 (support) :** Usage of hand-drawn fonts will degrade the perception of the credibility of charts compared to common fonts.
- **H3a (support) :** Cartoon-style bars will degrade the perception of the credibility of charts compared to plain bars.
- **H3b (Partially support) :** Image bars will degrade the perception of the credibility of charts compared to plain bars.

What factors in visualization erode chart credibility? Our second experiment measured the effects of fonts, colors, and bar styles on perceived credibility.

Color. Contrary to our hypothesis (**H1**), participants rated colored charts as more credible than grayscale ones. Colored visualizations ranked, on average, one position higher in perceived credibility across topics, suggesting appropriate use of color enhances credibility.

Style of fonts. We hypothesized that hand-drawn fonts would degrade credibility compared to common fonts (**H2**). Results confirmed this, with hand-drawn fonts ranked about 2.75 positions lower on average across topics.

Style of bars. We hypothesized that cartoon-style and image bars would be less credible than plain bars. Cartoon-style bars ranked about one position lower in credibility across topics (**H3a**). Similarly, image-bars were ranked lower in credibility mostly across topics except one topic, partially confirming (**H3b**).

7 Discussion

Our work started with the question "Does embellishment in visualization undermine the credibility of charts?" Our results showed that visual embellishments did not necessarily degrade the perceived credibility of charts. Perceptions depended on the visualization design and usage of visual elements that composed the chart. Our results showed that:

- Comic-style visualizations were perceived as less credible compared to standard visualizations.
- Image-like visualizations were perceived as similarly credible compared to standard visualizations.
- The visual elements composing a visualization, such as font, color, and style of bar affected people's perception of credibility.

  (**Font**) Usage of a common font led to a higher perception of credibility compared to use of a hand-drawn font.

  (**Colors**) Usage of color led to a higher perception of credibility compared to grayscale.

  (**Bars**) Plain bars were perceived as more credible than cartoon-style bars, while both plain bars and image bars were perceived as similarly credible.

Beyond the Plain vs. Embellished Dichotomy (Theoretical Implications):

In this work, we refer to our stimuli as 'plain' and 'embellished' charts to distinguish our experimental manipulation. Yet visualization design does not fall neatly along a binary axis of 'plain' versus 'embellished'; each style constitutes a distinct visual genre, shaped by cultural norms and rhetorical conventions that influence how viewers interpret, evaluate, and place trust in visual representations [43, 45, 46]. Our experiments compared several visual genres, including conventional institutional styles, comic-style visuals, and image-based designs, with the goal of investigating their rhetorical effects rather than treating embellishment as a single construct. This effort aligns with recent critiques of the dichotomous framing of embellishment as 'chart junk' [2]. We build on these critiques by empirically examining how different visual genres may enhance or undermine perceived message credibility, and we call for further work to deepen our understanding of visualization design and trust through the lens of visual rhetoric.

The Role of Default-Style Ethos and Visual Rhetoric: Our findings demonstrate that visualizations can incorporate embellishments and design elements while maintaining acceptable levels of perceived credibility. While participants consistently rated plain-looking bar charts as more credible, we interpret this advantage as a *default-style ethos effect*: decades of software presets (typefaces, muted palettes, gridlines) have accrued cultural meaning and now signal scientific

detachment and trustworthiness rather than providing a neutral baseline [43, 48]. Prior research suggests that viewers automatically associate 'plain' chart designs with objectivity and scientific rigor, despite the fact that all visualizations inherently involve rhetorical choices and design decisions [41, 43, 48]. For example, a 'plain' chart may be perceived as objective, yet what feels like 'plain' design is often a form of visual rhetoric—one rooted in long-standing conventions that shape how we interpret and trust visual information.

This tendency for minimalist, default-style charts to be perceived as more credible aligns with broader discussions in visualization rhetoric, where established design conventions shape trust judgments rather than objective properties of the data itself [48]. The preference for familiar visualization styles represents a cognitive shortcut that may unnecessarily limit design exploration. Future work should investigate whether alternative forms of embellishments—such as subtle rather than exaggerated stylistic changes—can maintain high levels of credibility while enhancing engagement, memorability, and emotional connection with the underlying data. Additionally, research could explore how audiences might be educated about the rhetorical nature of all visualizations to promote more nuanced credibility assessments based on data quality rather than visual conventions.

Credibility Perception Is Multi-Dimensional: Our findings reveal that credibility perception is shaped by a complex interplay of factors, challenging the assumption that plain charts are always perceived as most credible. While most participants did rate traditional visualizations as highly credible, we were surprised to find that a small but meaningful subset (22 out of 160 participants) actually ranked plain charts as the least credible option. This variability highlights the role of personal preference [63], cognitive biases [24], and contextual factors such as aesthetic appeal and task relevance [14]. For example, viewers who prioritize aesthetics may find embellished visualizations more credible due to their engaging and detailed design. Credibility judgments go beyond the mere accuracy of facts, involving both emotional and cognitive aspects [67, 77], and highlighting the importance of exploring how these factors influence each other.

The Chartjunk Debate and Credibility: The "chartjunk" debate involves differing perspectives on visual embellishments in data visualization [2, 4, 8, 28, 47, 50, 62, 72]. Recent work has challenged the use of this term itself, arguing for more precise language that doesn't prejudge design elements [2]. While excessive decoration often reduces credibility, our results suggest that tasteful and contextually appropriate embellishments, such as carefully curated colors, do not compromise credibility. For instance, image-like charts were rated as credible as plain charts due to their professional and detailed design [58, 59]. These findings challenge absolutist positions in the chartjunk debate and suggest a more nuanced approach to embellishment is warranted.

Design Implications: Our results offer three key implications for visualization designers seeking to balance engagement with credibility: First, certain embellishments can be incorporated without sacrificing perceived credibility. Image-like visualizations maintained credibility comparable to plain charts, suggesting that representational elements can be used strategically when they reinforce the data's meaning. For example, using contextually relevant images as bars (like country flag icons for Olympic data) may enhance memorability while preserving trustworthiness. This aligns with the work by Windhager et al. [73], which suggests that instead of always striving for simplicity, designers can intentionally incorporate complexity into their work to achieve more nuanced, expressive, and meaningful outcomes [52].

Second, among the design elements we studied, font style had a notable impact on credibility—visualizations using hand-drawn fonts were consistently rated less credible. Meanwhile, color surprisingly enhanced credibility perceptions, challenging assumptions about formal grayscale presentations. The positive effect of color on credibility aligns with research suggesting that color creates more engaging and emotionally resonant viewer experiences [46]. These findings suggest designers can incorporate deliberate, systematic color schemes to improve data discrimination while maintaining credibility, provided they pair them with conventional, professional fonts.

Third, audience and context should guide embellishment decisions. For scientific or high-stakes communications, minimizing certain embellishments—particularly hand-drawn fonts and cartoon-style elements—would be prudent. For educational or public-facing visualizations where communication is equally important, judicious use of image bars and color can achieve both communication goals and credibility.

8 Limitations & Future Work

Our study has limitations that present opportunities for future research. We focused only on bar charts with two specific embellishment styles, limiting generalizability. We tested Mona Chalabi's comic-style visualizations but didn't account for individual differences in perception of "hand-drawn" elements. Investigating a continuum of styles—from rough sketches to polished designs—while considering personal preferences would enhance generalizability. Additionally, our measurement of credibility as a single construct may have overlooked nuanced aspects of trust.

As with many studies using online participants, our results may reflect characteristics of crowdsourced samples, including varied visualization literacy or task motivation. While platforms like these provide diverse and scalable audiences, future work could examine whether our findings generalize to expert users or domain-specific audiences in more ecologically valid settings [10].

A key direction for future research is developing clearer metrics and frameworks for the visual embellishment design space. While Chen et al. [20] have begun exploring this area, there remains a need to categorize the variety of infographic styles that integrate charts, icons, and illustrations into complex layouts. Expanding such frameworks could offer valuable guidance to designers, helping them create visualizations that balance communication with credibility. Future research should examine more chart types, diverse embellishment approaches, and provide evidence-based recommendations for using embellishments effectively across different visualization types to align with specific communication goals.

9 Conclusion

Our work studied how visualization design choices influence perceived message credibility. Through our studies, we examined how design elements such as embellishments, fonts, bar styles, and color impact viewers' perceptions. We found that comic-style visualizations lowered credibility due to their informal appearance, while image-like visualizations retained credibility. Plain charts, especially those with color, were consistently seen as the most credible. These results advance our understanding of how visual design affects perceived credibility, challenging oversimplified views of embellishments as universally harmful. By identifying which design elements most strongly influence credibility judgments, our work provides designers with evidence-based guidance for creating effective visualizations that maintain credibility for viewers.

Supplemental Materials

Supplementary materials include: (1) survey examples used in both experiments, (2) Excel files containing the experimental data, and (3) visualization stimuli used in the study with visualizations of study results.

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