How We Evaluate the Accessibility of an Infographic: A Pilot Study Through SUS Questionnaire

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Abstract. The present study aims to evaluate the accessibility of infographics by using the System Usability Scale (SUS) questionnaire, as well as to underline the necessity of new curricula on infographic literacy. The study was conducted on a sample of 200 participants [100 Visual Designer Graduate – 100 Other Disciplines Graduated]. The participants were given a set of infographics to evaluate based on their usability and understandability. The results showed that there were significant differences in the scores based on the level of education of the participants, with higher design education levels leading to better scores. The study also highlighted the importance of developing new curricula on infographic literacy, as the current educational system does not provide enough opportunities for students to learn about infographics and their proper use. This is especially important given the increasing prevalence of infographics in various fields, from journalism to science communication. Without proper education on infographic literacy, individuals may struggle to fully understand and utilize the information presented in infographics, leading to potential misinterpretations or misunderstandings. The findings of this study have important implications for educators and practitioners alike. Educators should prioritize the development of new curricula on infographic literacy to better prepare students for the increasing prevalence of infographics in various fields. Practitioners, on the other hand, should strive to make their infographics more accessible and user-friendly, especially for individuals with lower educational backgrounds.

Keyword: Infographic · Evaluation · Information Design

1 Introduction

Infographics are increasingly prevalent in our daily lives, appearing in various contexts ranging from news media to scientific publications. They are often used to convey complex information in a visually appealing and easy-to-understand manner. Nevertheless, despite their growing popularity, there is still much to be understood about how individuals perceive and understand infographics.

Previous studies [1] have focused on the usability and effectiveness of infographics, often using quantitative measures such as the System Usability Scale (SUS) to assess

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their overall accessibility. While these studies have provided valuable insights into the usability of infographics, they have not fully explored the cognitive processes involved in perceiving and understanding these visual representations of information.

The present paper aims to enrich the scientific context surrounding the issue of perceiving and understanding infographics by providing a framework for understanding the cognitive processes involved. We argue that understanding the cognitive mechanisms involved in processing infographics is essential for improving their design and making them more accessible to a wider range of individuals. To achieve this goal, we draw on a range of literature from cognitive psychology and visual perception to provide a comprehensive framework for understanding the cognitive processes involved in perceiving and understanding infographics.

By examining these processes in the context of infographics, we aim to provide a better understanding of how individuals perceive, understand, and evaluate, these visual representations of information.

2 Infodemic and Data Visualization: The Context

2.1 Living in a Visual Environment

We live in a visual environment and in a data-driven world [2] whose information is ubiquitous and of crucial importance for understanding different fields of knowledge [3] because what we see is what we know [4]. However, in the current post-pandemic scenario from COVID-19, the practices of mass mis and disinformation have re-emerged and have originated new terms, such as ‘infodemic’ and ‘disinfodemic’ [5] i.e., the uncontrolled production and dissemination of information whose degeneration is caused by fake news [6]. Contemporary society is facing a continuous evolution of habits, processes, and tools in the field of communication and information, because of the advancement of technologies and the massive amount of interaction inputs [7]. The production of data increases year by year, intentionally or unintentionally to our actions [8], and the Orwellian society does not seem to be so far away.

In fact, we are in the condition where we have a higher availability of information than our mind can handle usefully: information overload. The same people, through their activities - smartphones, home automation and ICT systems - produce incredible amounts of Small and Big Data, the stratification of which - without a method of selection, organisation, and interpretation - is just a “disorderly collection of information” [9], which leads mankind into a condition of chaos caused by the constant and simultaneous use of all communication possibilities, whether out of haste or ignorance. On the one hand, due to the haste to instantly do something that others might do to our disadvantage and to immediately acquire control of a medium of communication in any way, and on the other hand, due to ignorance of all the possibilities that the rush does not give us a way to know [10]. However, this rapid spread is not surprising, given the vast number of people who use the Internet to communicate, socialise, consume, and share information [11].

The terms ‘disinformation’, ‘misinformation’ and ‘propaganda’ are sometimes used interchangeably, and their definitions are shifting and overlapping [12]. All three involve false or misleading messages spread in the form of information content, whether in the form of mainstream communication, online messages, advertisements, or published articles. These forms can be generically grouped under the terminology of information disorder [13]. However, it is important to distinguish genuine from malicious messages and those that are designed, produced, or distributed by 'agents' who intend to cause harm from those that are not. Information disorder can appear in the form of text, image, infographics, video and audio, or a combination of these, and be both created or manipulated by humans - as is the case with 'deepfakes' - or synthetically generated by artificial intelligence-enabled tools [11].

In relation to the above scenario, the communicative artefacts derived from Data Journalism are not exempt from information disorder, and in fact are well suited to being manipulated and distorted for political purposes [14]. As Huff [15] states, a well-packaged statistic performs better than a big lie. A first issue in terms of errors that needs to be addressed is what Jones [11] refers to as the epistemological error. Data, in fact, never represent a fact in the objective sense [17] but rather a description of an event or phenomenon, thus forming a virtual model of reality that by its very nature is subject to errors and fallacies [18]. This is because scientific models of the visual-figurative type have always been virtual, and their novelty is to be found in the fact that they are the most real virtual models ever conceived. More real models in the sense of more formally, structurally, and functionally resembling - the objects depicted [15].

2.2 Encoding Visual Artifacts

In an infodemic, the citizen needs to process information quickly, using automated thinking parameters - bias and pattern - favouring interpretations that require minimal cognitive effort and primarily reflecting prior knowledge. Today's population needs to analyse information that is interconnected with society and the environment and that is continuously transmitted, remixed, and shared [20].

This mix and match of multimedia content that makes use of text, images, and data in several formats, shapes the way we perceive reality through visual communication, feeding the reinforcement of biases due to a substantial illiteracy towards a conscious consumption and production of communicative artefacts. The key role within the process of information disorder is played by the receiver of communication, who can transform from consumer to producer through the tools offered by digital technologies [21].

Therefore, the correct coding and critical encoding of the communication artefact is the cornerstone in which the decision is made as to whether information is to be considered reliable. However, this process is particularly tricky.

In fact, the activity of understanding and interpreting is strongly influenced by a series of biases that blend social, cognitive, and perceptual components, opening the question of a critical literacy in the consumption and creation of communicative-infographic artefacts, as because of technological democratisation everyone can design graphics, but only a few know how [2].

But we understand graphs can lie, either intentionally or unintentionally [22]. Huff [15], Tufte [23], Cairo [18] and Jones [16] present several examples of published graphs that are designed in such a manner as to produce misleading interpretations of the data. Furthermore, the same "seductive language of data" [15] is often used to sensationalise, inflate, confuse, and oversimplify. In fact, Meyer, Shinar & Leiser [24] state that the relative effectiveness of a visualisation may depend in part on the characteristics of the user population, while Carpenter & Shah [25] point out that individual differences in graphical knowledge may play as significant a role in the comprehension process as variation in the properties of the graph itself. Cleveland & McGill [26] provide a list of the most relevant perceptual features in reading graphs. These include, in order of precision: (i) Position along a common scale; (ii) Positions along unaligned scales; (iii) Length, direction, angle; (iv) Area; (v) Volume, curvature; (vi) Shading, colour saturation. While Freedman & Shah [27], identify three determining factors in the successful comprehension of visualisation, such as: (i) the visual properties of the representation; (ii) prior knowledge in reading graphs; and (iii) prior knowledge regarding the content of the visualisation. Therefore, the success or failure of comprehension could be due to an interrelationship of several factors, which, according to Glazer [28], Friel, Curcio & Bright [29], Shah & Hoeffner [30], would involve: (i) the domain of prior knowledge; (ii) the constant enjoyment of infographic content; (iii) the design of the graphic itself; (iv) the context of the artefact's appearance, and (v) cognitive and social models. It is from these premises that the cognitive, social mechanisms underlying the spread of information disorder that are inevitably influenced by perceptual bias should be studied.

3 The Accessibility Issue of Data Visualization

3.1 The False Myth of the Universal [Visual] Language

We owe the first systematic theorisation of visual language to the Bauhaus. Lupton [31] argues that particularly in the writings of Kandinsky, Klee, Moholy-Nagy and others, information graphics - i.e., what would later take the denomination of Data Visualisation - served as a model for a new aesthetic between didactics and poetics. Scientific grids, graphs, and diagrams were seen as the basis of an anti-illusionistic but universally comprehensible visual script, a graphic language, which goes beyond the conventions of perspectival realism but is objectively related to material facts [31]. In fact, Kandinskij and Klee were not solely interested in the expressive possibilities of the graphic sign but focused their pedagogical efforts on normalising their knowledge through the definition of universal principles of visual forms [32]. Earlier attempts can be found in the works of Superville, Jones, Blanc and Crane [32]. Similarly, Neurath, through the Buildstatistik, committed himself to the construction, on the one hand of a code of unified science [33] i.e., a new hieroglyphic script, which contemplates the immediate comprehensibility of iconic images, with a set of rules for their textual composition.

Later, Moholy-Nagy [34] identifies the basic principles of visual representation based on compositional variables such as dynamism and stasis. Kepes [35] subdivides visual language - defined as the language of vision - into plastic organisation and visual representation. Bertin [36] constructs a narrative around the topic of visual language applied to statistics - offering a refined analysis of the visual variables of data processing, its organisation, value, and purpose - by reinterpreting it under the lens of semiotics. Dondis [4] describes in detail the primitive elements of visual language, the rules of syntax and perception, even introducing the term Visual Literacy.

Historically, it was Balchin and Coleman [37] who coined the term Graphicacy referring to the skills of orientation, understanding and use of cartography for educational purposes, i.e., it represents a competence that combines mathematical, textual, media, technological and graphic skills. Graphicacy is, therefore, to be understood as the competence relating to infographic language skills. A graphically literate citizen therefore can read and write through the language of graphs, mastering its grammar and using it critically to form and shape. This interaction is also referred to as the 'language of design' by Schön [38]. In this regard, a study conducted by Culbertson & Powers [39] examined various types of graphs and tried to detect the effectiveness of correlations between Graphicacy and other skills, such as verbal skills. Therefore, can we refer to innate competence?

Several studies have investigated the population's difficulties in perceiving graphics, arguing that comprehension and aspects beyond the most obvious proportional relationships can cause extreme difficulties [40, 41, 42, 43]. This is because in order for a visualisation to be correctly processed, the receiver applies two evaluation dimensions [44]:

- Technical Mapping. Represents the methods by which the visualisation was created: (i) Direct, when the user can deduce the underlying data, (ii) and Indirect, when the user is unable to deduce the underlying data.
- Data Focus. Represents what is communicated by the graphic: (i) Intrinsic, if the image facilitates the intuition of data by cognitively effective means, or Extrinsic, if the image facilitates the communication of the meaning implied by the data.

This is because the definition of a visual language considers that there is not only an exchange between code and message but also a transformation from message to code. The use of signs requires an interpretation on the part of the performer, even if they are available in their semantic and cognitive form [45], as a polysemic nature is present in the diagram [36]. In fact, the difference between verbal and visual language lies in the arbitrariness of the verbal sign that has no natural relationship with the concept it represents [31] and that can be influenced by cultural differences and dictates missing in the understanding and interpretation of a photograph, symbol, or diagram [46].

3.2 The Aesthetic Bias

Messages resulting from communicative-infographic artefacts are sent and received on three levels [4]: representational, astrational and symbolic. The former refers to how we see and recognise elements from context and through experience. The latter, to kinaesthetic properties and the reduction of visual components into basic elements. The third level, to the codified sign system. The proper knowledge and understanding of these levels define a visually literate subject [4]. Despite this, the high level of visual wrapping of data into potentially false news reduces the assessment of information awareness and correctness to a mere aesthetic matter [47] as we seem disposed to suspend our critical judgement when looking at data visualisation [32]: if it appears visually pleasing, then it will probably also be trustworthy, this because in visual design the boundary between seducing and informing is not so strict [48]. Furthermore, even with the proliferation of studies on information clutter and the observation that we live in a 'visual' society, there are minimal studies on the relationship between visual images and information disorder [49]. According to Hemsley & Snyder [48] the credibility of a fact - and the knowledge it generates - depends on experience, perception, and social norms. As Fontana [50] argues, when people are faced with news, they apply a way of thinking based on cognitive fusion and belief systems, in other words, they simplify information, leading to a partial and incomplete interpretation, which leads to complete misrepresentation [48].

The basic requirement for understanding communicative-infographic artefacts is that understanding processes should take place to build inner representations. With respect to the consumption of infographics, it is possible to see how the visualisation of complex phenomena - considering the understanding/knowledge value of the Latin term video [7] - is the result of actions of encoding and decoding - using a language - of the message by an emitter and a receiver [51].

They - being a communicative tool for conveying information - necessarily require a reception phase of the visual message and therefore a perception phase to be understood as a process through which the information gathered by the sensory organs is arranged into objects, events or scenes equipped with meaning for the subject. This process is anything but purely objective and direct, as it is not limited to transferring the distal stimulus - i.e., the communicative-infographic artefact - into a proximal stimulus - the image imprinted on our retina - and consequently into a percept - i.e., the mental processing of it - without any need for integration or elaboration by our intellect. These comprehension processes are influenced by individual characteristics, such as domain content knowledge or visual-spatial skills of Graphicacy [29, 36, 52, 53] and the features of the stimulus, i.e., graphic, purpose and contense. Bertin [36] himself, with reference to graphic comprehension, identifies three levels of interaction - or questioning - that have an impact on the level of reading comprehension and that tie in with Curcio's [52] theory of comprehension:

- the level of the graphic system: to be understood as the canvas from which information is extracted, which generates an elementary reading.
- the level of internal processing: to be considered as the process of reduction - influenced by Gestalt theory - of the elements of the composition that pushes the subject to read new information through an intermediate reading.
- the level of external processing: which is configured as a general reading of the information in the graphic system, and therefore, a global reading.

More specifically, regarding the phase of the perception process of communicative-infographic artefacts, we can try to apply the Bayesian model of perception - an evolution of von Helmoltz's approach and unconscious inference - which, in adding up past experiences and stimuli, introduces a probabilistic constant whereby we tend to process the stimuli and produce a specific result on the basis of a mathematical model that may lead us to consider the information as correct or 'plausibly' more accurate. All this can lead to cognitive errors, the reason for which, according to Gillies & Giorello [54], lies in the fact that when faced with a general question or situation, the 'correct' answer cannot be found within a short period of time. For this reason, we tend to use a limited set of basic concepts and a suboptimal inferential mechanism to obtain the solution we consider to be optimal with respect to a balance between answer and process time, but not in an absolute sense: a compromise solution. Furthermore, being able to consider the communicative-infographic artefacts of sensory representations, as they are processed through sight, we should consider the resistance to informational errors - such as illusions of optimality - which persist despite recognising their illusory nature and which in Data Visualization risk being misleading. In fact, as Neurath [33] explains, diagrams, while being of undoubted explanatory value, even though they are immediately comprehensible by numbers, they generate a sense of partial strangeness in observers without special skills and foment a feeling of not fully understanding.

In addition, the features of the message, such as consistency and shapes of representation, can induce people's trust in the information visualised. The (potential) intuitiveness of any communicative-infographic artefact is to be found in the visual nature of its language - strongly emphasised using iconographic elements - which generates a perception of simplicity, effectiveness and credibility that is superior even to written text [47]. A misunderstanding of the relationship with Data Visualisation is to assume that it - being based on scientific rigour, data and numbers - has unquestionable credibility, mapping a phenomenon in an unambiguous manner. However, any graphic is a representation of reality and can reveal as much as it can conceal [18] and the passage from data to information is a succession of actions and processes [55], which each gate can correspond to mistranslations - voluntary or not - that affect the entire final product.

A good communicative-infographic artefact - aesthetically speaking - decreases the levels of guarding and critical attitude. The interpretation and perception of different types of data are strongly influenced by the language and composition used in the visualisation. In visual information elaboration, this process can also be influenced by pre-attentive processing - which takes place in the sensory memory - that processes visual attributes such as colour, positioning, and shapes almost instantaneously, without the intervention of awareness [56]. The appearance of an infographic can attract or repel the reader's attention [36], which can distort their interpretation by emphasising misleading content and generating a distorted sense of credibility [49]; if they are neutralised by this emotion, they will be more likely to pay attention to what is shown on the representation. The confirmation bias should be read in this sense. According to Nickerson [57], this bias can occur when a person consciously or unconsciously restricts the field of analysis to observations only, i.e., data and information that are favourable to the confirmation of his or her beliefs, hypotheses, and expectations, disregarding and not examining any other alternative information that might disprove the acquired position. This condition appears to be common in individuals with information disorder [58]. In addition, Rajsic, Wilson and Pratt [59] suggest that people, when faced with the need for a simple visual analysis of an artefact, tend to apply this form of bias, which can be identified in two types of bias: the first form - active - aims to seek confirmation - the second - passive - to evade contradictory information. In fact, a person can actively or passively select information from his or her digital environment [60]: when a user actively seeks to identify and process only information that confirms his or her idea, he or she can be said to suffer from the active form of confirmation bias. On the other hand, if a person is passive, information that contradicts his or her idea of the world will be rejected and therefore not confirmed. In this case, one can say that one suffers from the passive form of confirmation bias. Faced with the risk of information overload, humans will tend to choose the simplest solution and with respect to a novelty - such as a piece of information - they will be inclined to uncritically choose that which most satisfies their prior knowledge and does not lead to any disruption of their general coherence with the fact [61]. In a double study conducted by the University of Washington, Wobbrock et al. [62] it was found that articles with an average number of images of around three to seven were more credible than articles with very few or very many images. A weighted use of images to support discourse is therefore considered an element of credibility, which the authors refer to as the Goldilocks zone, a zone of balance between graphic and textual elements.

Finally, context plays an important role. As expressed by Bertin [36], a graph is not 'drawn' once and for all; it is 'constructed' and reconstructed until it reveals all the relationships formed by the interaction of the data. To make a useful graphic, we need to know what has gone before and what will follow'. According to this approach, therefore, the understanding does not lie in exclusively decoding the representation itself as a static object, but in comprehending the social actions through which the graphic was originally constructed [63]. In fact, the reader confusion is to be expected if it is not clear why a certain type of cut on reality has been made (problem data, visual scenario, complex theory, etc.) [64]. It is only by understanding the contexts for in which infographics are to be designed and how the data were obtained that a more complete understanding of graphics will be achieved. Therefore, understand the process of making the visual representation. The question is not about the specific type or quality of data, but how it will be presented, which can introduce errors and lead to wrong conclusions [23].

4 Data Visualization and Accessibility: A Pilot Studio

4.1 Methods and Design of the Research

The study conducted examines the accessibility of information that is conveyed through infographics and specifically in five Data Journalism products. The perception and interpretation of users in the use of such content is analysed. It is therefore investigated whether the basic knowledge offered by educational curricula or mere previous experience is sufficient to obtain a good level of access to information. Therefore, the investigation focused on the following questions:

- Q1. Is infographic language understandable by all?
- Q2. Is there a correlation between the accessibility of infographics and the degree of representativeness?
- Q3. Is infographic literacy innate?
- Q4. Is training in design a determining factor in skill?

The infographics - selected according to the degree of iconicity of the representation, applying Anceschi's [65] depiction scale (see Figs. 1 and 2) - were evaluated by a homogeneous sample of 200 graduates [M = 100 – F = 100 – average age 22], divided into two groups according to the criterion of certified competence. Namely:

- Group A. Graduates in other disciplines.
- Group B. Graduates in Visual & Graphic Design and related disciplines.

Infogr. 1 | Nobles, no degree.
G. Lupi in The Reading,
Il Correre della Sera

Iconicity GRADE: 7 lv.

Infogr. 2 | Noise Pollution.
F. Fragapane in The Reading,
Il Correre della Sera

Iconicity GRADE: 6 lv.

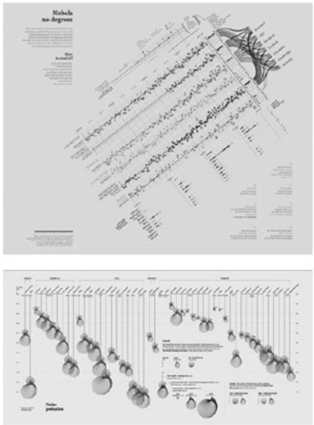


Fig. 1. Selected Infographics and related Iconicity Grade. Disclaimer: Fair use of images for research purpose [1].

From a methodological point of view, the usability test was individually conducted by an on-line form, anonymously and guaranteeing all privacy and data protection regulations in compliance with GDPR. The study applied a three-variable correlation design: two independent variables (i) the System Usability Scale (SUS) and (ii) the degree of iconicity of the representation; and one di-pendant variable, namely the amount of information extracted from the infographic. The SUS scores were calculated based on Brooke's [66] scale and the Lewis-Sauro model [67]. For the ratings related to the amount of information extracted, the proportion of information each participant extracted was evaluated on a scale from 0 to 5. For degrees of iconicity, the 7-point scale remained the same.

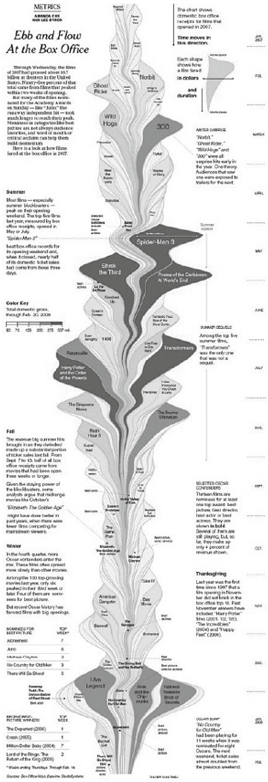
4.2 Preliminary Results

Tables 1 and 2 present the mean, standard deviation and skewness values for the SUS questionnaire ratings, and the number of information extracted from all infographics, divided by the two samples. In general, both samples revealed a usability of the assessed infographics in terms of the degree of iconicity of their representation. In Group A, not a single infographic crosses the minimum threshold of 68 average points - indicative according to the SUS scale of an artefact at the limit of usability. In Group B, this threshold is instead overcome only by infographic No. 4 and No. 5.

The ratings of the two groups studied show a linear progressive trend as the submitted infographic becomes less and less iconic. In specific terms, Group B - Design graduates - score, on average, 38% higher than Group A - graduates from other disciplines, leading to the assumption that prior knowledge is crucial in terms of perceiving and comprehending the displayed information as argued by Kosslin [68] and Cairo [69]. Nevertheless, when analysing the results of the individual infographics in more detail, some interesting findings arise to answer the research questions at the start.

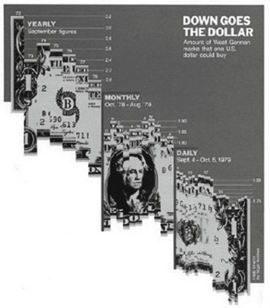
Infogr. 3 | Ebb and Flow at the Box Office. A. Cox in The New York Times

Iconicity GRADE: 5 lv.



Infogr. 4 | Down Goes the Dollar. N. Holmes in The New York Times

Iconicity GRADE: 5 lv.



Infogr. 5 | Turn the World Around. F. Franchi in IL, Il Sole 24ore

Iconicity GRADE: 4 lv.

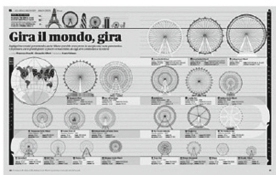


Fig. 2. Selected Infographics and related Iconicity Grade. Disclaimer: Fair use of images for research purpose [1].

Table 1. Sus Questionnaire Results – Group A [1].

	Mean	*Std. D.*	*Asym.*	*Grade*	*Ico-Lv*
Infogr. 1	37,78	16,71	−0,39	F	7
Extracted info	1,71	1,35	0,39		
Infogr.2	45,17	21,33	1,47	F	6
Extracted info	2,72	1,02	−0,2		
Infogr.3	46,45	20,66	−0,28	F	5
Extracted info	2,43	1,38	0,12		
Infogr.4	55,68	20,8	1,59	D	4
Extracted info	2,61	−0,15	−0,43		
Infogr.5	58,02	23,97	−0,23	D	3
Extracted info	2,87	1,66	−0,13		

Table 2. Sus Questionnaire Results – Group B [1].

	Mean	*Std. D.*	*Asym.*	*Grade*	*Ico-Lv*
Infogr. 1	60,62	23,63	−0,52	D	7
Extracted info	2,95	1,61	−0,18		
Infogr.2	65,32	20,80	−1,22	C	6
Extracted info	4,33	1,38	−2,10		
Infogr.3	65,9	20,64	−1,12	C	5
Extracted info	3,76	1,33	−0,87		
Infogr.4	69,4	18,17	−0,77	C	4
Extracted info	3,63	1,41	−0,50		
Infogr.5	74,65	15.39	−1,09	B	3
Extracted info	3,75	1,32	−0,74		

Consider the iconicity grade 7 infographic and the iconicity grade 3 one (see Table 3). The infographic No. 1 achieves a SUS score in Group A of 37.78 (Grade F), in contrast to a 60.30 (Grade D) in Group B, showing a variation of 60.8% between the two results. In the infographic No. 2, the SUS value scored by the first sample is 58.02 (Grade D), compared to an average value of 74.65 (Grade C) in the second one, scoring a positive variance of 28.7%. The proportion of increase between the two sets of samples is a remarkable fact in that there is a progressive drop in the performance gap, the higher the degree of iconicity tends to value of less than 5. In fact, as can be seen in Table 3, the SUS values of Group B go from virtually sustained increases of + 60.5% (Infographic No. 1), to values of + 41.9% (Infographic No. 3), and the lowest increase value is + 24.7% (Infographic No. 4). Adding to this, Table 4 highlights that in both Group A and B, the

Table 3. Group A and B - Differences between SUS results compared [1].

	Iconicity grade	*SUS* | *Mean*	*SUS Grade*	
Infogr. 1	7			
Group A		37,78	F	–
Group B		60,92	D	+60,5%
Infogr. 2	6			
Group A		45,17	F	–
Group B		65,32	C	+44,6%
Infogr. 3	5			
Group A		46,45	F	–
Group B		65,90	C	+41,9%
Infogr. 4	4			
Group A		55,68	D	–
Group B		69,40	C	+24,7%
Infogr. 5	3			
Group A		58,02	D	–
Group B		74,65	B	+28,7%

average usability performance and the number of information extracted in the individual infographics follows a significant positive progression ($r12$) with values between 0.61 and 0.79.

In Table 5, two highly significant data emerge.

The first is the negative correlation between SUS and Iconicity ($r13$), a signal of an inversely proportional relationship between the abstraction of the representation and its ease of use. The second one, related to the first, demonstrates that the trend to retrieve information from the infographic tends to be favoured by its iconicity ($r23$). If in the former case we observe an extremely close correlation - with a value of -0.97 in both groups - in the later, the range of values expands, moving between -0.77 in Group A and 0.28 in Group B.

About question Q1, namely whether infographics are accessible, the results of the SUS show that the infographics submitted for the test - with the exclusion of the infographic No. 4 and No. 5 evaluated by Group B - do not pass, as an average score, the minimum levels of accessibility even though they are in potential to be very effective visual artefacts. Nevertheless, if we were to conduct a combined average of ratings between Group A and Group B - more likely to reflect the reality - none of the infographics would achieve the minimum rating of 68 (the highest value would be set at 66.3 of the infographic of iconicity grade 3). The individual ratings of the two groups in relation to the single infographic reveal how the accessibility of information is particularly variable within the same sample (see Fig. 3). Infographic No. 1 - iconicity grade 7 - scores above 68 pts by 47% of Group B and only 1% of Group A. Infographic No. 2, on the other hand,

Table 4. Correlation between Sus Questionnaire Results and extracted information [1].

	r 12 ǀ SUS and Extracted Information
Infogr. 1	
Group A	0,66
Group B	0,73
Infogr. 2	
Group A	0,69
Group B	0,61
Infogr. 3	
Group A	0,64
Group B	0,64
Infogr. 4	
Group A	0,69
Group B	0,79
Infogr. 5	
Group A	0,70
Group B	0,63

Table 5. Correlation between Sus Questionnaire Results, extracted information and grade of iconicity [1].

	r12	*r13*	*r23*
Group A + B	0,87	−0,53	−0,29
Group A	0,82	−0,97	−0,77
Group B	0,27	0,97	−0,28

13% (A), 51% (B). Infographic No. 3, 10% (A), 59% (B). Infographic No. 4, 30% (A), 59% (B). Ultimately, infographic No. 5, 33% (A), 75% (B). This fluctuation suggests - answering question Q1 and Q3 - that the skill of reading visual artefacts cannot be considered an innate attribute and that infographics themselves are not so easily accessible in terms of information retrieval.

Reflecting on question Q2, namely whether iconicity of representation influences the usability of infographics, we can assume that in both samples, there is an increase in SUS ratings as the degree of iconicity leans towards the figurative as against the abstract. Group A increases by 53.6%, Group B by 23.2%. The greater growth in the first group may be because ‘non-design-literate’ subjects have greater problems in terms of processing abstract graphics, and in contrast, ‘design-literate’ subjects have less difficulty and for that reason, a more consistent performance. Keeping these values in mind,

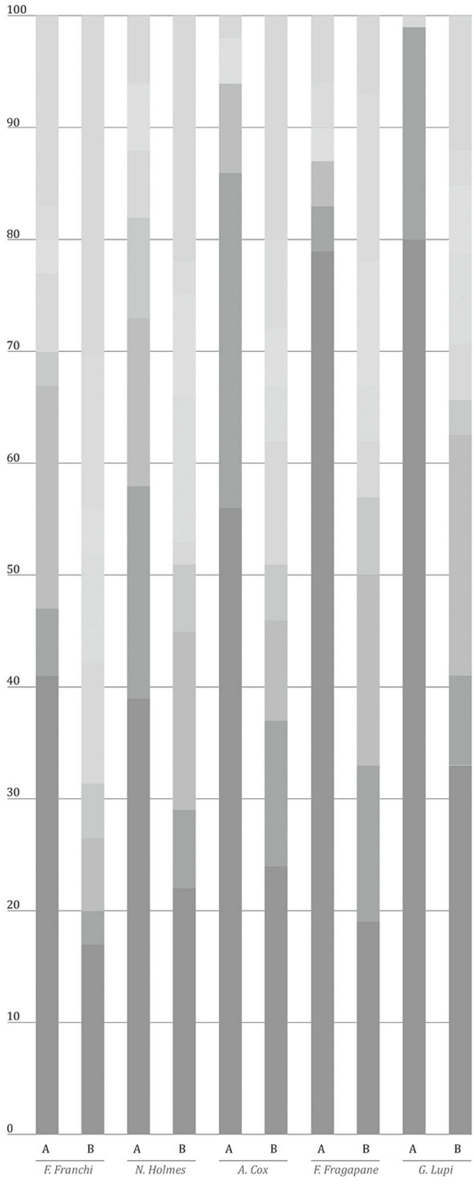


Fig. 3. SUS scores distributed among all the two samples.

we can nevertheless consider the fact that the performance gap also tends to narrow according to the degree of iconicity, revealing a possible relationship between basic graphic competence and infographic reading ability. On the other hand, grade 6 and 7 infographics make use of a complete visual alphabet whose grammar is not intuitive, as is underlined by the large gap between the values of 60.5%. In contrast, grade 3 infographics, apart from being generally better evaluated by both samples, show a smaller delta between the different performances.

Last, respect to question Q4, prior knowledge in the discipline of Visual Design seems to favour greater reading skill than the performance obtained by Group A. Basic competence in Graphic Design seems to be a crucial factor in the encoding process specifically in visual representations that lead towards hypotheticals or pure abstraction (see No. 1 and 2 infographics). Nevertheless, it does not appear - now - to be a transversally acquired skill that is decisive in accessing the higher levels of information offered by data visualisation.

5 Conclusion

In summary, the contribution - starting from the evidence contained in the literature - focused on the issue of usability, i.e., the accessibility of information when represented through Information Design languages. In particular, the results obtained, and the correlations made confirm the trends found in the literature on the need for visual literacy for a correct decoding and perception of the information displayed. In general, almost all the infographics studied did not reach the minimum threshold of usability, thus opening the reflection to two questions, in terms of competence and design. The data at hand lead us to hypothesise that Graphicacy - which tends to be more developed in Designers, aided by the Designerly component - is decisive in achieving higher, though not excellent, levels of usability of communication-infographic artefacts. This points to the need for a democratisation of these skills not from a professionalising perspective but from a cultural and access perspective. Finally, the low level of usability achieved by the communicative-infographic artefacts raises questions in terms of design and the correct use of high levels of iconicity of data representation.

Today, people need to analyse information that is interconnected with society and the environment and that is continuously transmitted, remixed, and conditioned [20]. The visual translation of data into information makes use of a language with a specific grammar of signs and channels [36, 70]. However, reading images is far from intuitive as understanding the message can only take place if one is aware of the codes - such as the use of fonts, the iconographic choices, and the use of colour, as well as the arrangement of the pieces of a table, distilled over millennia of figurative and scriptural conventions [48]. If the correct encoding and decoding [18, 71] does not take place, communication fails [3]. The issue thus described fits into the international debate that has developed in recent years on the centrality of policy investment in digital literacy and digital skills to provide citizens with adequate cognitive tools to decode and encode information from data [72]. The difficulties are due - first - to a low level of what Balchin and Coleman [37] define as Graphicacy and which plays a key role in the cognitive learning process [73] and in Data Literacy.

From the preliminary analysis of the data, it emerges that the ability to read is necessary today and that studies on the skills necessary for correct decoding are more necessary than ever. Graphicacy and Basic Design alone do not appear to be so decisive in favouring this cognitive process. The test conducted raises issues in terms of both reading and production training. Finally, the low level of usability achieved by the communicative-infographic artefacts raises questions in terms of Design and the correct use of high levels of iconicity in data representation. Even though the sample had an undergraduate level of education, the data and existing literature confirms that Graphicacy has been totally neglected in comparison to its ‘big brothers’ Literacy, Numeracy and Articulacy. This points to the need for a democratisation of these skills, not from a professional perspective but from a cultural and access perspective.

With the ever-increasing spread of information clutter, digital communication and the rise of data infrastructures, it is now more imperative than ever to incorporate teaching methodologies aimed at conscious production that takes into account the political, economic and social impacts - i.e., the economic and social impacts of the digital economy, economic and social impacts - i.e. an ethical dimension of the project - and, on the other hand, to an evaluation of the communicative-infographic artefacts with which we are confronted on a daily basis [74] by developing a critical attitude that avoids enthusiasm for uncritical data or dataisms [75] as it is necessary to learn how to read a graph before understanding it [18], since the veracity of the information contained in a data display is never absolute, but must be critically contextualised according to the objectives of those who want to use the initial data.

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