CHAPTER 2:

MAKING MEANING OUT OF BIG DATA IN HEALTHCARE: VISUAL DESIGNERS' PERSPECTIVE

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INTRODUCTION

Designing is a procedural activity that can be practised from diverse perspectives; it involves making plans to create a needed solution. Visually, a design is meant to be specific in the end result and that differentiates it from 'art' which often tilts toward more aesthetics. This simply does not mean a design cannot be beautiful; in essence, the crux of a design is both 'function' and 'aesthetics'. A design meant for the sight is visual, this has to do with functional art that can be seen, felt or touched; Such design adopts graphics strategically to create, refine or advance a solution. It is exemplified in package design, branding, information/ book design, prints, advert campaigns, television montages, web design and development, interface design, user experience design, multimedia authoring, industrial art and product design among others. Additionally, it (i.e. visual arts/ design) is a branch of creative arts, sectioned into Fine Arts and Applied Arts (see Fig. 1). As a result, it is about creativity which defines the feel and uniqueness of every result. Creativity is the ability to use clear imagination in the development of new and original ideas or things, especially in the realm of art (Bravolol, 2022). Apart from the skills of the designer which also matters, if a visual design will be outstanding, creativity must not be trivialised. The examples listed above apply to virtually all walks of life including the health sector. Print and online materials are used in healthcare while health practitioners make use of essential multimedia applications in daily

medical practices. Many products are developed innovatively, incorporating visual design. They are relevant medically and non-medically for both the patient and the healthcare giver. This is notably exemplified in digital products that store and retrieve health-related data in many folds. The data are so numerous that they are classified as 'big data' – non-organised, semi-structured or structured information.

Ordinarily, the health institutions: clinics or large hospitals rely on patients' records or health data to cater for their patients' treatment. Care for a patient can take many forms but can be facilitated when quality data are available. Health facilities in Nigeria are not faring badly but in practice, they are yet to fully key into health digitisation. Photius (2019) recorded that health in Nigeria was rated fourth worst in the world, while this is not good, it calls for improvement. The record was later amplified in 2023 in the expression of Schmale Matthias, UN Resident and Humanitarian Coordinator, captured by Habib (2023). The Coordinator lamented that Nigeria lags in the realisation of the Sustainable Development Goals (SDG 3 inclusive). The highlight of goal 3 by the UN is that there should be good health and well-being for all. Regrettably, achieving Sustainable Development Goals in Nigeria remains a fantasy without a more inclusive, multi-dimensional approach (Alozie, 2020). This shows that all hands must be on deck for concrete results in the area of health; but the Visual designer is only a creative personnel, does that mean such an expert cannot make an impact health-wise? Thus, it is worthy of exploration to determine how such a professional can use visuals to promote care especially from the point of meaningful data storytelling, hence this discourse.

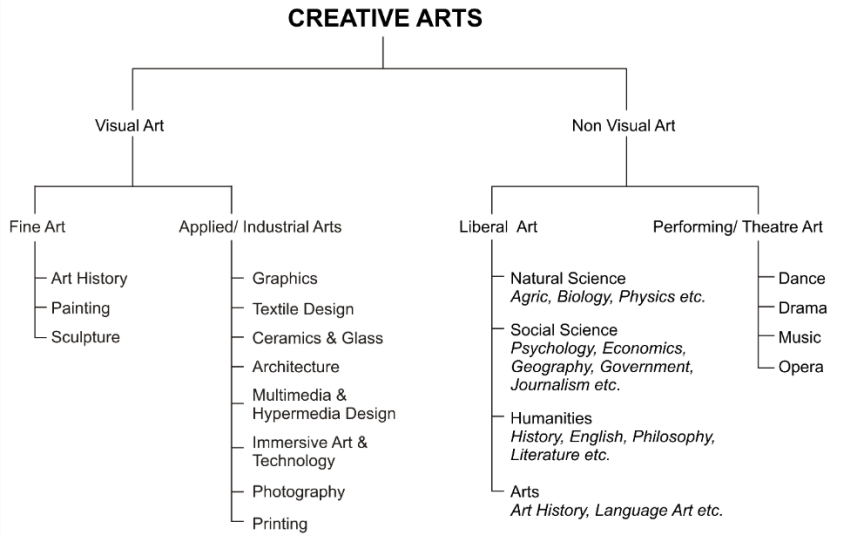


Figure 1: Branches of Visual Art/ Design under Creative Arts in the 21st Century. **Source:** Afolabi et al (2023); *https://doi.org/10.33093/ijcm.2023.4.1.1*

The Visual Designer: Skilled or Talented?

The goal of visual design is either to: promote, persuade or influence the people (i.e. public) through creative work; due to this, the designer is expected to be well-equipped for the task. For the sake of clarity, a Visual Designer uses media elements to create artistically pleasing designs. The principles of design are further used in structuring every visual element adopted for a particular creative work. Graphics, pictures, colours, shapes, typography, lines etc. form the contents, and together with the principles, are used to improve user experience. The role of a visual designer is also to create a layout and solidify brand identity. He or she specialises in the design, look and feel of digital assets such as websites and applications. A Visual Designer understands clearly the contents therefore in agreement to General Assembly (n. d), an online platform on education, the knowledge of visual design is a

powerful extension to a variety of professional backgrounds. As a result, visual creators also understand the ideologies behind 'visual' as an entity. Notable visual concepts that empower the Designer which are equally germane in art and design practises include: visual literacy, visual representation, visual properties, visual elements, visual grammar and metaphor, visual perception, visual display and visual culture among others.

Thus, from the foregoing, the qualities of Visual Designers are enormous. However, as core attributes, they must possess eyes for details, be well-educated, patient and also have a good sense of communication. Afolabi (2022) maintained that multimedia Specialists should embrace empathy and in so doing develop contents for therapeutic purposes. Logically, from inference, empathy is a good quality for a designer but should not be practised by a segment of Designers but rather by all Visual Designers. When this attribute is put into practice, the Visual Designer will design from the perspective of the client or user of the design work. In all, the answer to the question that a visual designer is perhaps skilled or talented boils down to the fact that talent without the right artistic skills will not yield the right creative results especially as the duo (skill and talent) are entirely different sets of qualities. However, while talent is innate (natural), skill is learnt; but the fact is, points discussed above that are involved in visual arts and design practices are certainly beyond solely talent, they must simply be learnt. A Visual Designer who is talented and simultaneously equipped with essential 21st-century design and technological skills will perform excellently in any field of art and design. Interestingly, if a Designer lacks artistic talent but is amply filled with the necessary skills, then such an expert is reclining on a solid foundation. Therefore, it is not just about talent or skill that matters, rather, the mean to a result (of effective and creative visual solution) which equally speaks volumes. They are the yardsticks or parameters that define a Visual Designer.

Healthcare in Nigeria: An Overview

Among the (social) institutions that make up society is the healthcare system which is structured into Primary, Secondary and Tertiary healthcare delivery models. Basic health centres and Comprehensive health facilities make up the Primary Healthcare System while the various General Hospitals are classified as Secondary. The tertiary health institutions are Federal Medical Centres/ National Hospitals, University Teaching and Specialist Hospitals. The basic healthcare system caters for the health needs of the grassroots community in rural settings; any health challenge or case that cannot be treated at this level is referred to the secondary level and in turn, the tertiary facilities. The CMD (Chief Medical Director) heads the health facility especially at the Secondary and Tertiary level while the Officer in Charge (OIC) oversees the day-to-day affairs of the Basic/ Comprehensive health centres. Common wards in a health facility in Nigeria include: Maternity, Neonate division, Paediatrics, Dentistry, Surgery, Emergency wards, Guidance and Counselling unit, Intensive Care Unit, General Medicine ward, Psychiatric, Oncology, and Outpatient Services among others. Hence, different healthcare/ medical experts in different areas of specialisation are engaged to practice professionally and solve all manner of health issues, thereby promoting healthy lifestyle.

From the foregoing, healthcare as a setup regulated by the federal and state government through assigned agencies/ ministries is not an institution that gulps low funds for running its operations and maintenance. Synchronously, irrespective of the Wards or Units in any of the delivery models, they all rely on data i.e. health information to appropriately discharge their duties and give out care. Sadly enough, healthcare in Nigeria is poorly funded (Nwachukwu, 2021; Olomola, 2009; & USAID, n.d) while the electronic record system is not well integrated and in some cases, non-existent (Teniola, 2023, Afolabi, 2021 & Farouk et al, 2023). Little wonder, a World Health Organisation survey conducted in

the year 2000 classified Nigeria's healthcare system as the fourth worst in the world by ranking it- 187th globally (Photius, 2019 & WHO, 2000). However, in a report by Muanya and Ozioma (2021), Oladigbolu, National Chairman, the Association of Community Pharmacists of Nigeria (ACPN) claimed Nigeria has improved by moving from 187th to 163rd. However, the progress still calls for serious improvement, because the 163 simply depicts the 28th worst health care system in the world. This point is out of the 191 countries in the world that were assessed in the level of compliance with the Universal Health Coverage.

The Concept of Big Data

This is the era of IoT (Internet of Things), as a result, big data which is all about concrete information tilts toward more digital trends; but that does not mean information cannot be experienced in the conventional settings i.e. non-digital mode. Information is crucial and entails the act of collecting facts about a specific subject; the facts are accessible data. They are essential in making facts known and for the advancement of knowledge. *"Big data is the fuel that delivers real-time analytics"* (Moore, n.d.) because it is about *"collecting and analysing large amounts of data; to generate actionable insights that an organisation uses to enhance its different aspects"* (AnalytixLabs, 2021). Hence, the idea behind big data is projected in: Volume, Velocity and Variety. These are the three basic characteristics of big data (InterviewBit, 2023). The loads of information trooping in on data-driven applications: web, mobile, social media feeds etc. are always plenty (i.e. in volumes); with a dynamic speed. Resultantly, the rate at which information is gathered and processed is the velocity and this is for information (i.e. data) which could be in varieties: structured and semi-structured (or both) or unstructured i.e. completely disorganised set of information. Basically, conventional data are always structured and fit easily into a relational database; whereas with the advent of big data as an innovation, information became more of new

unstructured data (InterviewBit, 2023). For clarity, examples of structured data are information stored in the form of tables and spreadsheets. They are processed by organising them; stored and retrieved in a fixed format. Unstructured data have no 'known' structure and are heterogeneous information from search engines, webpages, videos, images, texts, audio etc. Semi-structured data is both structured and unstructured such as web content (with unstructured log files, transaction history files etc.) and a table definition in a relational Database Management System. The table has no classification into a definite database but is tagged for element distinctiveness (AnalytixLabs, 2021 and Adilin, 2021). However, *"unstructured and semi-structured data types including video, text, and audio need extra pre-processing to determine meaning and support metadata, the context around the data itself".* (InterviewBit, 2023)

Other salient features of big data (see Fig. 2) include veracity (i.e. inconsistencies witnessed in data variations), variability, visualisation (or visual representation) and value (Moore, n.d). It is to be noted that raw data are meaningless unless processed for tangible and meaningful information; thus 'value' as a feature of big data is the most important (InterviewBit, 2023). Logically, apart from other means, value can also be achieved in two ways, and that is technologically and creatively. Many technological tools are readily available for processing big data and good examples of these advanced tools among others are: 'Tableau' and 'DataWrapper'. They both support big data analysis via creative approaches such as visualisation; a core area of expertise attributed to the Visual designer. Notably, while 'Tableau' is proprietary, acquired by 'Salesforce' in 2019 (Nat, 2019), 'DataWrapper' the other hand, is freeware, common among program developers and News journalists. It is also meant for design experts. The advent of big data can be likened to innovation spurred by technology in phases. It was conceived as a concept many decades ago and subsequently put into practice which

evolved into a systematic approach till today. Despite many versions of report about the realisation of big data, one common trait in its development is that the rise in big data started in the 90s – the period of Computer age (Dekate, 2022). Also, *"from the early 2000s, the internet and corresponding web applications started to generate tremendous amounts of data"* (BigData Framework, n.d). Currently, the rapid acceptability of mobile technology and devices, also aided the embrace and advancement of big data.

Figure 2: Characteristics of Big Data, including Visualisation practised by Visual Designer. **Source:** Afolabi's Compilation (2022)

The essence of big data is that it will allow businesses, firms and organisations, including healthcare to utilise voluminous information effectively. Trends, patterns, and behavioural acts in a given situation are easily identified with big data analytics which would ordinarily be difficult to detect in conventional data processing means. It is thus easy to sum up that results from big data operations will foster decision-making in any organisation. Investing appropriately will be easy when big data solutions have been adopted by organisations that transact based on heavy information such as healthcare. Interestingly, when data are processed, storing such comprehensible information becomes easy as the space needed would be minimal when compared to storing

raw data which often are bulky. 'Big data analytics' is important because it applies to virtually all walks of life especially healthcare. Summarily, *"big data includes multiple processes: including data mining, data analysis, data storage, data visualization, etc. The term 'big data' refers to collecting these processes and all the tools that we use…"* (AnalytixLabs, 2021).

Nature of Big Data in Healthcare

Data interpretation could become a complex activity, especially with the vast amount of information involved in big data. At the same time, data can become valueless when it makes no meaning, importantly when difficult to interpret. This is the crux of visualisation, to simplify the logical (mental) process, create meaning and form part of the communication and data dissemination channel. Data record in healthcare employs either the traditional means using manual registers or electronic mediums. Data itself includes: patients' health details, vaccine distribution logs such as during the COVID-19 pandemic, community immunisation records, disbursement logs of intervention funds for health ministries, agencies/ parastatals in a country, records of epidemic and several other diseases, birth records among others. All the manually recorded different information (varieties) are usually piled up or in some cases sourced/ collated from a large population. Hence, they are plenty (i.e. voluminous) – these are attributes of 'big data'. Digitally, smart devices such as mobiles and wearables generate lots of health data that may be difficult to comprehend; such data are meant for tracking and diagnosis. Interviews and Surveys, structured or unstructured, captured manually or electronically also make up big data in healthcare; importantly, if they are experienced on a large scale.

sVisual Designer and Data Mining for Health Infographics: Methods cum Benefits

In big data operations, the Visual Designer would be concerned with visualisation since that is part of the core areas where his/ her expertise will be felt among the 7 Vs (See fig. 2). This professional is expected to 'mine' the data by creating information graphics: charts, lines, tables, illustrative pictures among other visual aids that best interpret and present the raw/ processed dataset. The objectives of visualisation in practice entail: 1. comprehension, 2. retention and 3. appeal (see fig. 3); especially to communicate information in the most comprehensible form. The order is not fixed but can be altered at will by the Designer, based on the purpose of creating the information graphics (Lankow, Ritchie & Crooks, 2012). *"A graphic created with a commercial interest in mind will have many different priorities… the order of priorities of the commercial marketing graphic would be appeal, retention and then comprehension. Publishers that create editorial infographics have a slightly different mix: appeal, comprehension and retention"* (Lankow, Ritchie & Crooks, 2012, p. 38-39). In healthcare, relying on Baruah (2020), the focus of the visualisation would rather suggest a mix that prioritises first, comprehension, retention and then appeal. Baruah (2020) listed criteria for visualising (data) information that, the source of data should not be instantly visible; perhaps abstraction. This is because information visualisation transforms non-visual to visual; more reason image is generated from the entire process. Lastly and importantly, data must be comprehensible and readable. The last criteria is the main reason for the mix as regards health. However, creative solution has no boundary, hence, some practical cases (e.g. health awareness/ sensitisation development) would rather warrant that appeal should be treated as most important then comprehension and retention.

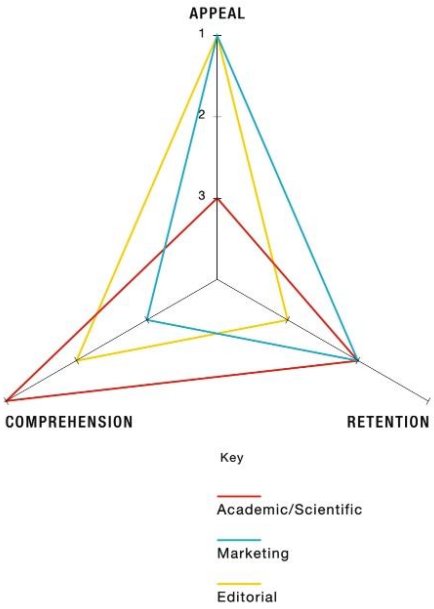


Figure 3: Objectives of visualisation
Source: Lankow, Ritchie & Crooks (2012)

The view of Baruah on data readability is also based on clear reasoning that unnecessary details should be avoided which is in line with Knaflic (2015) who also opined that de-cluttering is essential to achieving a meaningful data visualisation. *"Communication is most effective when you say neither more nor less than what is relevant to your message. Don't make people wade through meaningless visual content in your display to find what matters"* (Few, 2006, p. 6). The zig-zag method has also been suggested as a solution, notably in the area of visual design. The eyes scan through contents or across the screen in a zigzag motion (i.e. Z): Top Left – Top Right – Across – Down Left – Down Right. Hence, important elements or visuals must be placed from the 'Top Left' to the 'Top Right' first (Knaflic, 2015). Interestingly, designing creative visual content is also believed to be both

systematic and strategic. The former, in the words of Baruah (2020) means a definition of a problem such as identifying the need/ preference of the end users as regards information/ data visualisation. The next is to define the data set (for visual representation) which could be: ordinal, categorical, interval, continuous, nominal and discrete (Lankow, Ritchie & Crooks, 2012). They are to be in the right category for mapping. Thirdly, the definition of attributes and dimensions that would depict the data matters. Attributes are the variables which could be in multiples, single or double and after that is the sorting out of data structure: linearly, in tabular or hierarchical form etc. (see Fig. 4).

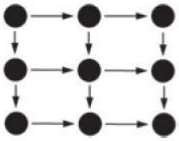
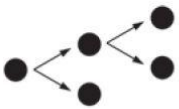
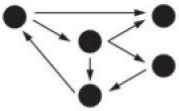
Model	Diagram	Common graphics
Linear		List, single-variable plot
Tabular		Spreadsheet, multicolumn list, Sortable Table, Radial Table, Multi-Y Graph, other multivariable plots
Hierarchical		Tree, Cascading Lists, Tree Table, Treemap, Radial Table, directed graph
Network of interconnections		Directed graph, flowchart, Radial Table
Geographic (or spatial)		Map, schematic, scatter plot
Textual		Word cloud, directed graph
Other		Plots of various sorts, such as parallel coordinate plots, Treemaps, etc.

Figure 4: Types of Data Structure/ Organisation
Source: Tidwell (2011)

Lastly, the determination of the amount of interaction preferred by the user and likewise the right format for the visual content. Lankow, Ritchie & Crooks (2012) tagged the format as a vehicle comprising: static, motion and interactive models. Strategically, *"when you use cutting-edge tools and technologies to stitch together different metrics (i.e. data) and reveal the relationships between them, you are virtually building an entire world of narratives".* (Rodriguez, 2022). This is known as data story telling (Knaflic, 2015); the idea behind this approach is to allow the data to narrate its own story to derive meaning (see Fig. 5) while visuals are embedded to further enrich essential details. This kind of information visualisation, according to Dykes (2016) is persuasive, engagement oriented and aids memorability. Concurrently, persuasion is a core attribute needed in healthcare. It therefore approaches fitting for healthcare (big) data simplification. Positive persuasion is needed to make patients believe in the treatment being administered or for the public to adjust and respond to a tailored health campaign. Government and Stakeholders, in some cases, would need to be persuaded as well to rise to health matters and make impactful contributions. Originally, the strategy was postulated for business enterprises but by operation, it can also be applied to healthcare. It should be marked that, though 'health' is about care and patients, yet, it can also be seen from the lens of a business. However, irrespective of the motive, whether patient-oriented or business inclined, the strategy fits perfectly into big data in healthcare.

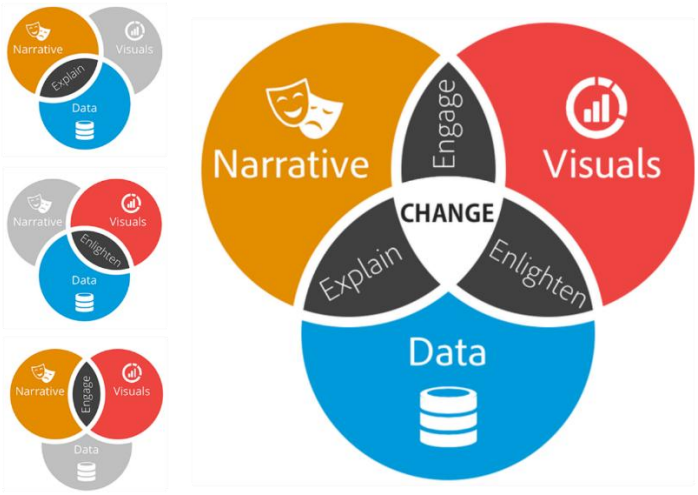


Figure 5: Strategic Development of Information Visualisation via Storytelling Approach. **Source:** Dykes (2016)

By operation, Rodriguez (2022) maintained that to achieve the right approach, firstly, a plotline with a clear objective is to be developed, which is the foundation for a good data story. The second is to create a narrative that holds attention while the data tell the story. Fourthly, the recipients of the information visuals are to be categorised by their level of understanding of the data story and finally, incorporation/ integration of the right visuals. The last bit is to be observed relying on pre-attentive attributes (see Fig. 6) and Gestalt principles. The data structure used (see Fig. 4) signals to the user, subconsciously, a lot about the nature of the data. It is very easy for the brain to quickly process pre-attentive features. Therefore, variables with similar attributes must be weaved or placed together. Irrespective of the big data, they simply convey the information at once, even before the viewer pays conscious attention (Tidwell, 2011; Lankow, Ritchie & Crooks, 2012). Pre-attentive attribute and Gestalt principle of visual perception (see Fig. 7) are about similarity, enclosure, proximity, continuity, enclosure and closure (Knaflic, 2015). These together with other

visual elements: especially colours/ white space, to draw attention (Knaflic, 2015; Tidwell, 2011; Lankow, J., Ritchie J. & Crooks, R., 2012) are needed for orderliness and solution-based visual design for data communication.

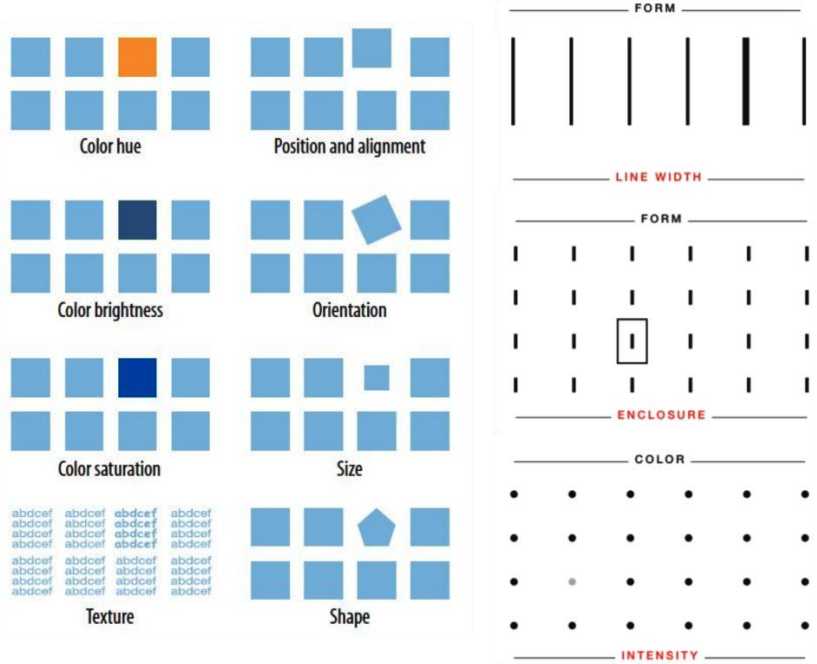


Fig. 6: Pre-attentive attributes guiding placement of visuals to make meaning out of big data. **Source:** Tidwell (2011); Lankow, Ritchie & Crooks (2012)

In the same vein, the logic to achieving a catchy, compelling and engaging narrative is to allow the audience to choose the story they see and by using Exploratory Data Analysis (EDA) with interactive visuals, audiences would be involved in the visual message. Also, the data can dictate the narrative story solely by being truthful, with no manipulation of data. Visuals that combine well with the data should be adopted while standardised units be considered; precisely when comparisons are involved in the (big) data story (Rodriguez, 2022).

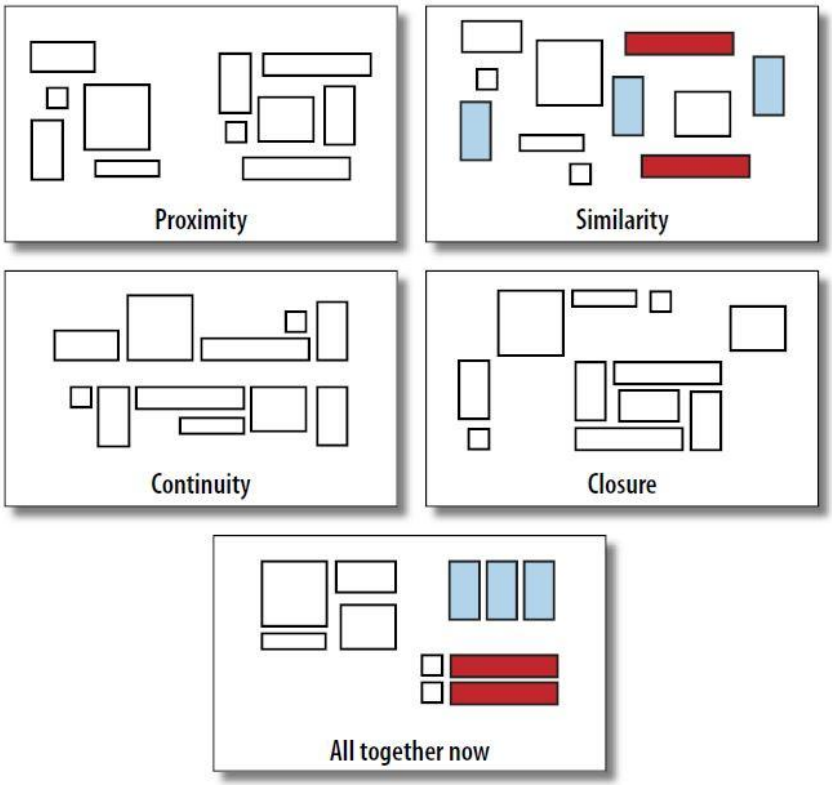


Fig. 7: Four Gestalt principles for manipulation of layout for content/ visual display. **Source:** Tidwell (2011)

The actual focus of the big data production will also influence the narrative for visualisation. Basically, 'big data analytics' is either: descriptive, diagnostic, predictive or prescriptive; they are simply four in that hierarchical order. The last analytic *"has good use in the healthcare industry. It can be used to enhance the process of drug development, finding the right patients for clinical trials etc."* (Pathak, 2021). The strategy described above for visualising big data will then have to be executed through the lens of either of the four analytics, important as the case may be. This must be

creatively put into consideration, if not the Designer may run fowl of erroneously and unconsciously manipulating the result of the data analytics. In reality, this is a clear example of how one may not be truthful with data (either big or small). This must be watched to keep all the data intact, precise and truthful as much as possible.

Conclusion

"Medical records are tough to come by in so many developing countries. The few hospitals with medical records are challenged with incomplete, inaccessible, and inconsistent patient data" (Teniola, 2023). Deductively, this is simply that manual records (which can pile up to become 'big') still dominate the nation's health system (Nigeria precisely). It is a serious area of concern that calls for effective digitisation of healthcare. Quality healthcare also requires digitised records and *"practically impossible without efficient data to support an Electronic Health System"* (Teniola, 2023). Data, in any form, are an integral part of the operations of health institutions which aptly (in the digital sense), accumulate to make 'big data'. This is characterised by its volume, velocity, variety, variability, veracity, visualisation and value. Unfortunately, big data is valueless unless it can be presented in a simplified manner. This is the essence of visualisation which is important to achieving meaning in big data in healthcare. It is better to get health infographics (i.e. data visualisation) done systematically and strategically. By the former, it means a carefully mapped-out process towards creating data visualisation. The latter solidifies the (data mining) process in which one stage rolls in to another; dwelling on relevant visual elements and (Gestalt) principles of design. Visual (data) communication as a means to a result can therefore be integrated into any e-health platform for seamless operations, especially for meaningful big data. When data information is easily understood, it fosters the decision making process for the Government and health-reform stakeholders. Health institutions via refined data presented as infographics, will be able

to provide improved or personalised care experience for patients. Health facilities can increase their revenue and advance their care services through processed data that also dwells on visual communication. In all, as a Visual Designer, it is therefore important to understand the concept of 'big data' from the angle of communication design. By having sound knowledge, Visual Designers should then be able to provide better data communication and design solutions. This is necessary, especially at a time when there is also a call for investment in medical research (Edema, 2023); such research will equally rely on data that must be presented meaningfully, with the aid of data visualisation tools e.g. charts: pie, scatter plot, histogram, cartogram, dendrogram etc.

Question

1. What is big data visualisation?
2. Discuss the essence of information graphics in healthcare.
3. Explain the term 'visual design' and discuss the characteristics of a Visual Designer.

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