

**Juicy Visualizations:
Exploring the Impact of “Juiciness” on Interactive Infographics**

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A Thesis
in
The Individualized Program

Presented in Partial Fulfillment of the Requirements
for the Degree of
Doctor of Philosophy (Individualized Program in Fine Arts) at
Concordia University
Montréal, Québec, Canada

November 2025

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Abstract

Juicy Visualizations: Exploring the Impact of “Juiciness” on Interactive Infographics

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This thesis explores the integration of the concept of "juiciness"—defined as the incorporation of engaging visual and interactive elements—into interactive infographics, a medium that has evolved with technology to enhance user engagement and information retention. Traditional infographics have relied on static representations, but the rise of digital platforms has facilitated the incorporation of dynamic and interactive elements, making complex information more accessible. This research identifies a gap in existing literature, which has primarily focused on juiciness within game design, and proposes that the principles of juiciness can be applied to interactive infographics to foster a richer user experience. Through a comprehensive analysis involving the examination of 195 interactive infographics, interviews with practitioners, and comparative studies between juicy and non-juicy versions, the results indicate that while juiciness can enhance user engagement and retention of information, its implementation requires careful consideration to avoid overwhelming users. The findings suggest that strategic incorporation of juicy elements, including animation and audio feedback, can significantly improve the effectiveness of interactive infographics, but designers must balance these elements with the core message to ensure clarity and purpose. The thesis concludes by emphasizing the need for thoughtful application of juiciness in interactive visualizations, advocating for a methodological approach that considers audience, context, and design goals to optimize user interaction and experience.

*For Sophie.
Thank you for
making my life
simply juicier.*

Acknowledgements

I start by dedicating this work to the most important people of my life: my daughter Sophie and my wife Nathalie. This work is becoming a reality because of your support, patience, care and love that you share with me during every second of my existence. Thank you so much for giving me the opportunity and privilege to be a part of this amazing family. I LOVE YOU WITH ALL OF MY HEART!

I also thank my parents, Gessi and Isabel, for all the support, wisdom, care and love that was always provided. Thank you for always being there for me.

A special thanks to my younger brother Lucas who, despite the distance, always finds time to share a good song to listen to or a good video to laugh at.

I would also like to thank my parents-in-law, Simoni and Edson, and my brother-in-law João Victor, for all the support provided to our family whenever needed.

Thanks to my cat Shiny that was constantly in my lap during the composition of this work, also reminding me that it is important to stand up and stretch. And to her beloved sister Lua, that now watches for us as a beautiful star from the sky.

I can't forget to thank my therapist Rafael Barros, who served great purpose in the advancement of this research, this thesis and for contributing so much with my personal development.

A posthumous tribute to my professor, great teaching model and mentor, Dr. Murilo Scoz. The accomplishment of this work is also part of your continuous legacy.

To my supervisors Jonathan Lessard, Rilla Khaled and Christopher Moore for accepting me as a PhD student, providing me with the first opportunity to teach in Canada, and for bearing with me up to this point.

A great thanks to all of the participants that took part in this study, for both the interviews and user test sessions.

To all of my family and friends that always had supportive words to encourage my progress with the pursuing of this degree.

Table of Contents

List of Figures..... xii

List of Tables..... xiii

Chapter 1

Introduction..... 1

1.1 Problem Statement.....2

1.1.1 Research Questions.....3

1.2 Positionality..... 4

1.3 Methodology.....5

1.4 Contributions..... 6

1.5 Thesis Overview.....7

1.5.1 Chapter 1: Introduction.....7

1.5.2 Chapter 2: Related Work..... 7

1.5.3 Chapter 3: Assessing Juicy Elements In Interactive Infographics..... 7

1.5.4 Chapter 4: Juiciness and Interactive Infographics: An Ethnographic Perspective..... 8

1.5.5 Chapter 5: Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics..... 9

1.5.6 Chapter 6: Conclusions..... 9

Chapter 2

Related Work.....10

2.1 Interactive Infographics.....10

2.1.1 General Definitions..... 10

2.1.2 Interactive Characteristics.....12

2.1.3 Positive Aspects of Interactivity..... 14

2.1.4 Interactive Infographics and User Experience (UX)..... 14

2.1.5 Situating Interactive Infographics.....16

2.2 Juiciness.....	17
2.2.1 General Definitions.....	17
2.2.2 Beyond Visual Feedback.....	18
2.2.3 Juiciness and Engagement.....	19
2.2.4 Exploring Juiciness Besides Games.....	21
2.3 Microinteractions.....	22
2.3.1 Microinteractions and Data Visualization.....	24
2.4 Visual Embellishments.....	26
2.4.1 Visual Embellishments and Engagement.....	26
2.5 Chart Junk.....	27
2.5.1 Positive Perspectives Over Chart Junk.....	28
2.6 Conclusion.....	29
Chapter 3	
Assessing Juicy Elements In Interactive Infographics.....	32
3.1 Chapter Introduction.....	32
3.2 Juicy Elements.....	33
3.3 Methodology.....	37
3.4 Results.....	38
3.5 Discussion.....	43
3.5.1 Limitations and suggestions for future research.....	45
3.6 Conclusion.....	46
Chapter 4	
Juiciness and Interactive Infographics: An Ethnographic Perspective.....	49
4.1 Chapter Introduction.....	49
4.2 Methodology.....	50
4.2.1 Design Ethnography Approach.....	50
4.2.2 Participants.....	51

4.2.2.1 Rodolfo Almeida.....	52
4.2.2.2 Nadieh Bremer.....	52
4.2.2.3 Alberto Cairo.....	53
4.2.2.4 Vinicius Sueiro.....	53
4.2.2.5 Jan Willem Tulp.....	54
4.2.3 Data Collection and Analysis.....	54
4.2.4 Ethical Considerations.....	57
4.3 Findings.....	58
4.3.1 Familiarizing with the concept of "juiciness"	58
4.3.2 Perceptions of Juicy Design in Interactive Infographics.....	58
4.3.2.1 Do Juicy Elements Enhance User Experience?.....	59
4.3.2.2 Are Juicy Design Elements Distracting or Beneficial.....	59
4.3.3 Challenges in Applying "juiciness"	60
4.3.3.1 Technical Complexity.....	61
4.3.3.2 Cognitive Load.....	61
4.3.3.3 Measuring Infographic Success.....	62
4.3.3.4 Appropriateness of Juicy Design for Different Information and Audiences.....	62
4.3.4 Impact and Value of "juiciness" applied to Interactive Infographics.....	63
4.3.4.1 Contribution of Juicy Design to User Engagement and Information Retention.....	63
4.3.4.2 Balancing Aesthetic Appeal and Functional Clarity.....	64
4.3.5 Future of Juicy Design in Infographics.....	65
4.3.5.1 Future Prominence of Juicy Design in Infographics.....	65
4.3.5.2 Personal Exploration of Juicy Design in Future Projects.....	66
4.4 Discussion.....	67
4.4.1 Limitations.....	68

4.4.2 Suggestions for Future Research.....	68
4.5 Conclusion.....	69
Chapter 5	
Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics.....	70
5.1 Chapter Introduction.....	70
5.2 Literature Review.....	72
5.2.1 User Engagement within Interactive Infographics.....	72
5.2.2 Juiciness and User Experience.....	73
5.2.3 Information Retention and Interactive Visualizations.....	74
5.3 Methodology.....	75
5.3.1 Infographics Development Process.....	75
5.3.1.1 Infographic 1: The Daily Routines of Famous Creative People.....	76
5.3.1.2 Infographic 2: Burcalories.....	77
5.3.1.3 Infographic 3: The Main Chakras.....	78
5.3.2 Participants.....	80
5.3.3 Procedures.....	80
5.3.3.1 User Engagement Scale (UES).....	82
5.3.3.2 Short-Term Information Retention Questions.....	84
5.4 Results.....	86
5.4.1 User Engagement Scale results.....	86
5.4.2 Feedback and Takeaways.....	90
5.4.2.1 The Daily Routines of Famous Creative People.....	90
5.4.2.2 Burcalories.....	92
5.4.2.3 The Main Chakras.....	94
5.4.3 Information retention results.....	95
5.4.3.1 The Daily Routines of Famous Creative People.....	95

5.4.3.2 Burcalories.....	97
5.4.3.3 The Main Chakras.....	99
5.5 Discussion.....	100
5.6 Conclusion.....	102
Chapter 6	
Conclusions.....	103
6.1 Findings Overview.....	103
6.1.1 Assessing Juicy Elements In Interactive Infographics.....	103
6.1.2 Juiciness and Interactive Infographics: An Ethnographic Perspective.	104
6.1.3 Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics.....	106
6.2 Conclusions.....	107
6.2.1 Future Work.....	109
References.....	112
Appendix.....	121

List of Figures

Figure 2.1 - AVENGERS The ultimate infographic guide	11
Figure 2.2 - Can You Stop an Outbreak of a Contagious Disease?	12
Figure 2.3 - Positioning Interactive Infographics	16
Figure 2.4 - Visual example of Juiciness in the Candy Crush Saga game	18
Figure 2.5 - Example of Microinteraction: Airplane mode from iPhone	23
Figure 2.6 - Ultra Combo bar from the game Street Fighter IV	26
Figure 2.7 - “Diamonds” by Nigell Holmes	28
Figure 3.1 - Construct at mta.me	36
Figure 3.2 - Overview of Juicy Elements on Interactive Infographics	39
Figure 3.3 - Number of Juicy Elements Used Together	40
Figure 3.4 - Interactive Visualizations by Year of Publication	42
Figure 3.5 - Juicy Elements Over the Years	43
Figure 4.1 - The game Peggle Blast used as a visual reference of "juiciness"	56
Figure 5.1 - The Daily Routines of Famous Creative People - “Dry” version	76
Figure 5.2 - Burcalories - “Juicy” version	77
Figure 5.3 - The Main Chakras - “Juicy” version	79
Figure 5.4 - Participants distribution	81
Figure 5.5 - Recalling Chakra Locations - Screenshot from Notebook LM	85
Figure 5.6 - Chakra Infographic User Feedback - Screenshot from Notebook LM	86
Figure 5.7 - UES Overall Engagement results	87
Figure 5.8 - UES Overall Engagement results comparing infographics assigned to the same respondents group	88
Figure 5.9 - UES Subscales Total Average Scores	89
Figure 5.10 - Responses comparison from Burcalories infographics multiple choice question 1	97
Figure 5.11 - Responses comparison from Burcalories infographics multiple choice question 2	98

List of Tables

Table 2.1 - Comparison between Juiciness, Microinteractions, Visual Embellishments and Chart Junk concepts	30
Table 3.1 - Combination of Juicy Elements	41
Table 5.1 - Adaptation of the User Engagement Scale Short Form	83
Table 5.2 - The Daily Routines of Famous Creative People Infographic: Information Retention Comparison Dry x Juicy	96
Table 5.3 - The Main Chakras: Information Retention Comparison Dry x Juicy	99
Table 6.1 - Core Juicy Elements (What to Incorporate)	104
Table 6.2 - Strategic Application and Best Practices (How to Implement Juiciness)	105
Table 6.3 - Contextual Warnings and Limitations (What to Avoid)	107

Chapter 1

Introduction

With the evolution of technology over the years, available information has skyrocketed. Content transmission is made via multiple venues, taking many shapes and forms, in various modes of delivery. Among these, infographics - defined as tools for simplifying, clarifying, and communicating complex information through the thoughtful integration of visual and textual elements - have emerged as a way to facilitate the communication of complex information by organizing it visually. (see for example Smiciklas, 2012; Cairo, 2013; Krum, 2013).

Infographics have traditionally taken the form of static content but their migration to digital platforms have made them more dynamic and interactive. As digital technologies evolve, interactive visualizations integrated into news stories by prominent organizations allow users to freely explore visualized data and find specific data values of interest (Li *et al*, 2018).

According to Greussing and Boomgaarden (2021), interactive infographics are regarded as the cutting edge of information design in the 21st century. Compared to their static counterparts, interactive infographics can accommodate much more information and offer various applications open to user interaction, providing a richer and more engaging experience (Dur, 2014). The inclusion of interactive elements can make an argument more persuasive and attractive to readers, potentially fostering a deeper connection with the presented information (Burnett *et al*, 2019).

Another medium where engagement and visual aesthetics play an important role in stimulating better interactions are games. To do so, developers incorporate visual embellishment (VEs), which are design elements that do not affect system functionalities, but contribute to the overall user experience (Bateman *et al*, 2010). The

incorporation of feedback that would make use of an overabundant amount of VEs from a single player input can be described as the act to make a game “juicy” (Hicks, 2020).

“*Juiciness*” initially emerged as a term used in the game industry by Matt Kucic (2005), who described it as "constant and bountiful user feedback". The practitioner stated that a juicy game "feels alive and responds to everything you do – tons of cascading action and response for minimal user input" (Kucic, 2005). This makes the player feel powerful and in control, and coaches them through the rules by providing constant feedback (Kao *et al*, 2024).

Considering that the concepts of interactive infographics and Juiciness both aim to promote higher engagement through visual appeal, this thesis suggests to merge them, proposing the intentional incorporation of Juiciness into Interactive Infographics. This intention is motivated also by the opportunities for research to examine the concept of Juiciness when applied outside of game-based mediums, as suggested by previous work around the term (Hicks, 2020; Durmanova, 2022).

The following topics and chapters will further detail how this work has been methodologically planned and structured, presenting reviews from past and current studies. Results, findings and discussions obtained by the proposed research are also discussed.

1.1 Problem Statement

Past and current academic research that discusses Juiciness mainly focuses its applications into games (see for example Atanasov, 2013; Hicks, 2020; Kao, 2020; Durmanova, 2022). Some studies have been trying to be more specific regarding studying the presence of Juiciness within specific elements (i.e. haptic, audio and texts), but those are still related to game-based experiences (Hicks *et al*, 2024; Fabre *et al*, 2024; Spets & Spek, 2023; Singhal & Schneider, 2021). Therefore, there’s an opportunity - gap - to verify the presence and effects of Juiciness applied to other digital interactive experiences.

Amongst those, infographics could maybe benefit from integration of "juicy" patterns. Studies suggest current interactive infographics often rely on a limited set of interaction techniques, primarily clicking and basic navigation. (Greussing and Boomgaarden, 2021; Zwinger and Zeiller, 2016). Infographics could also further explore animated resources and integrate multiple media (text, static images, interactive visualizations, video, audio) in a more seamless and effective way for storytelling (Afify, 2018; Segel and Heer, 2010).

Considering the current expansion of digital content creation, highlighted by the growth of User Experience and User Interface Design fields in recent years, it is believed that this thesis can offer a newer perspective regarding the application of Juiciness beyond game-based experiences. Findings from this work might benefit academic researchers and professional practitioners, promoting a broader discussion regarding good practices that might increase user engagement with interactive digital content.

1.1.1 Research Questions

This thesis sets out to verify the presence, perceptions and impacts of Juiciness within Interactive Infographics. To do so, it addresses 3 main research questions:

Research Question 1: What is the current state of Juiciness presence within existing Interactive Infographics?

Based on concepts provided by past research, this question aims to respond if existing interactive infographics incorporate juicy elements within their designs. [Chapter 3](#) provides further details and findings.

Research Question 2: What are the perceptions and impressions of juiciness from designer's perspectives when applied to interactive infographics?

This question looks for understanding how and to what extent designers notice and would consider applying juiciness within interactive visualizations. Discussions and Findings are offered in [Chapter 4](#).

Research Question 3: How does the incorporation of juicy design elements in interactive infographics influence user engagement and information retention compared to dry/regular designs?

Considering the benefits identified in previous work, when juicy versions often returned more positive responses when compared to non-juicy counterparts, this question puts the concept to the test when applied to interactive infographics. Results and findings are further detailed in [Chapter 5](#).

1.2 Positionality

This research is informed by a professional and academic trajectory rooted in design education and practice. Since 2012, I have served as a university professor in the field of design, working across a variety of courses and disciplines. This diverse teaching experience has fostered a transdisciplinary perspective and a strong interest in how design can shape engagement, understanding, and user experience—particularly in digital environments.

Over the years, my career has become more focused on UI/UX and interaction design, areas in which the responsiveness, clarity, and emotional tone of user interfaces are of great importance. These concerns are directly reflected in this study, which explores how the concept of Juiciness, originally developed within game design, can be integrated into interactive infographics to enhance user engagement and information absorption.

This investigation is not solely academic in nature; it also emerges from an ongoing reflective teaching practice. In my role as an educator, I have consistently aimed to make my classes atmosphere more “juicy”. This pedagogical inclination aligns closely with the

attributes of juiciness explored in this research: immediacy of feedback, sensory richness, and playful interaction.

Furthermore, this study builds upon my earlier research undertaken in my master's dissertation, which focused on the use of infographics to increase accessibility to academic content. While that work emphasized clarity and information design, the current project extends that foundation by examining how aesthetic and interactive enhancements might contribute to a more affective and participatory user experience.

This positionality—bridging academic research, teaching practice, and professional design experience—might influence insights. Nevertheless, the study maintains a reflective stance throughout, applying structured analytical methods and grounding its insights in existing literature.

1.3 Methodology

This work follows the "manuscript-based thesis" model, meaning that it is a collection of three papers that all build towards a similar thesis project summarized here. The papers and the conferences where they were accepted are listed below:

- ***Assessing juicy elements in interactive infographics.***

Revista De Comunicación De La SEECI.

Campos, B. (January 2025)

- ***Juiciness and Interactive Infographics: An Ethnographic Perspective.***

11th International Conference on Information Management (ICIM2025)

Campos, B. (March, 2025)

- ***Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics.***

11 th International Conference on Signal and Image Processing (SIPRO 2025)

Campos, B. (May, 2025)

These manuscripts incorporate different research methods, such as literature reviews, ethnographic design interviews, research-creation and comparative user tests. These methods are further detailed and explained during the next chapters, presenting their rationales and modes of implementation.

The results are compiled in this thesis to provide an overview of the whole research. Redundant literature reviews from the original papers were modified or removed for reading efficiency.

1.4 Contributions

This thesis brings the following 4 main contributions:

1. It consists of the first academic study to examine the effects of Juiciness outside of game-based experiences, investigating its impacts when applied to interactive infographics.
2. It is the first work to search for Juicy Design elements within interactive infographics guided by previous work that established ground bases for concepts around Juiciness
3. It collected relevant input from professional interactive infographics designers, discussing their perceptions about Juiciness, its pros and cons with users and their own intentions of incorporating this technique within their own work.
4. It puts to the test the efficacy of juiciness when applied to interactive infographics in terms of user engagement and information retention

It is expected that this thesis will add more substance into the applications of Juiciness, more specifically to non-gaming experiences.

1.5 Thesis Overview

This topic presents how this thesis is structured, with a brief summary of contents from each chapter.

1.5.1 Chapter 1: Introduction

This chapter presents the structure of the thesis, introducing concepts of juiciness and interactive infographics, briefly discussing existing work in the area. It also presents a problem statement, informing the research questions that are answered throughout this thesis. Lastly this chapter highlights the contributions of the work.

1.5.2 Chapter 2: Related Work

This chapter is divided into two main topics: Juiciness and Interactive Infographics. The first one presents an overview of existing work that explores Juiciness, its existing and suggested applications, and how it impacts user engagement. The second topic of this chapter concentrates on research about infographics, providing an overview of its variations, with focus on interactive approaches, their development process, applications and impacts on users. Besides the above mentioned, related work from Microinteractions, Chart Junk and Visual Embellishments are also addressed, presenting their correlations with the main thesis subjects.

1.5.3 Chapter 3: Assessing Juicy Elements In Interactive Infographics

This chapter addresses a notable gap by investigating the presence of Juiciness and its potential within non-gaming interactive systems, specifically focusing on interactive infographics and data visualizations available online. The central aim of the chapter is to assess the extent to which "juicy elements" are currently incorporated into existing

online interactive infographics and data visualizations. To achieve this, the study identifies and focuses on five specific juicy elements: animation, particles, audio feedback, screen shake, and persistence. The research seeks to determine which of these elements, and in what combinations, are present in a sample of freely accessible online interactive visualizations. This initial exploratory investigation is motivated by the hypothesis that juiciness can indeed enhance engagement with infographics. By systematically examining the current landscape of interactive infographics, this research lays the groundwork for understanding the existing application of these techniques outside of gaming.

1.5.4 Chapter 4: Juiciness and Interactive Infographics: An Ethnographic Perspective

This chapter delves into the perceptions of design professionals regarding the application of "juicy design" principles to interactive infographics and data visualizations. The goal was to explore how interactive infographics/dataviz designers understand and consider the incorporation of "juiciness" in their work. To investigate this, the paper presents an ethnographic study employing semi-structured interviews with experienced professionals in interactive infographics and data visualization. The study explores the designers' familiarity with "juiciness", their perceptions of its potential benefits and drawbacks (such as enhanced engagement versus distraction), the challenges and limitations of implementing juicy design, and their speculation on the future role of "juiciness" in their field. The study ultimately aims to provide insights into the potential of "juiciness" to enhance user engagement, content understanding, and memorability in interactive infographics, while also considering practical approaches and potential negative impacts like overstimulation.

1.5.5 Chapter 5: Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics

This chapter investigates the impact of Juiciness within the context of interactive infographics. The goal is to understand how the incorporation of juicy design elements in interactive infographics influences user engagement and information retention when compared to their "dry" or regular counterparts. To address this, the research employed a comparative study involving the development and testing of three distinct interactive infographics, each presented in both a "dry" version with minimal feedback and a "juicy" version incorporating elements like animations and sound effects. The methodology involved participants who interacted with either the dry or juicy version of two different infographics. User engagement and short-term information retention were measured and evaluated through a combination of open-ended recall questions and multiple-choice questions administered immediately after interaction. The study collected data on user engagement scores and the accuracy of recalled information to compare the effectiveness of the two design approaches. Findings offer preliminary insights into the potential of "juiciness" to influence user engagement and information processing in interactive infographics, contributing to a better understanding of how design choices can impact user experience and learning outcomes in digital information environments.

1.5.6 Chapter 6: Conclusions

This final chapter provides a summary of the key findings of the thesis, outlining the main contributions and highlighting the results presented in each chapter. It then closes the thesis with a conclusion and suggestions for future works.

Chapter 2

Related Work

The present chapter provides an overview of work and research around the two main topics of this study: interactive infographics and juiciness. The subjects are organized into their own subcategories, which are broken down into separate parts that provide further details about each concept. Aside from that, three other topics that link infographics and juiciness are discussed: “Microinteractions”, “Visual Embellishments” and “Chart Junk” concepts.

2.1 Interactive Infographics

This topic presents definitions of Infographics and their interactive variants from previous research. At the same time, it discusses their potentialities related to interactivity.

2.1.1 General Definitions

Infographics, or information graphics, are an effective visual representation that explains information simply and quickly using a combination of text and graphical symbols (Huang & Lim Tan, 2007). They are traditionally viewed as visual elements such as charts, maps, or diagrams that aid comprehension of a given text-based content, being more than just a record of discovered information, also having the potential to discern new meaning and discover new knowledge (Rajamanickam, 2005; Costa Pinto, 2017).

Infographics combine graphics, image, and text to communicate information, data, or knowledge effectively using graphic visual representations. They are used to communicate complex topics efficiently and draw the attention of readers (Zwinger *et al*, 2017; Krum, 2014). Afify (2018) further elaborates on that, stating that infographics are

visual presentations in which graphic drawings (illustrations, symbols, maps, graphics, etc.) are combined with verbal language (Figure 2.1) to transform complex data and concepts into images and drawings that can be clearly and interestingly understood and assimilated.

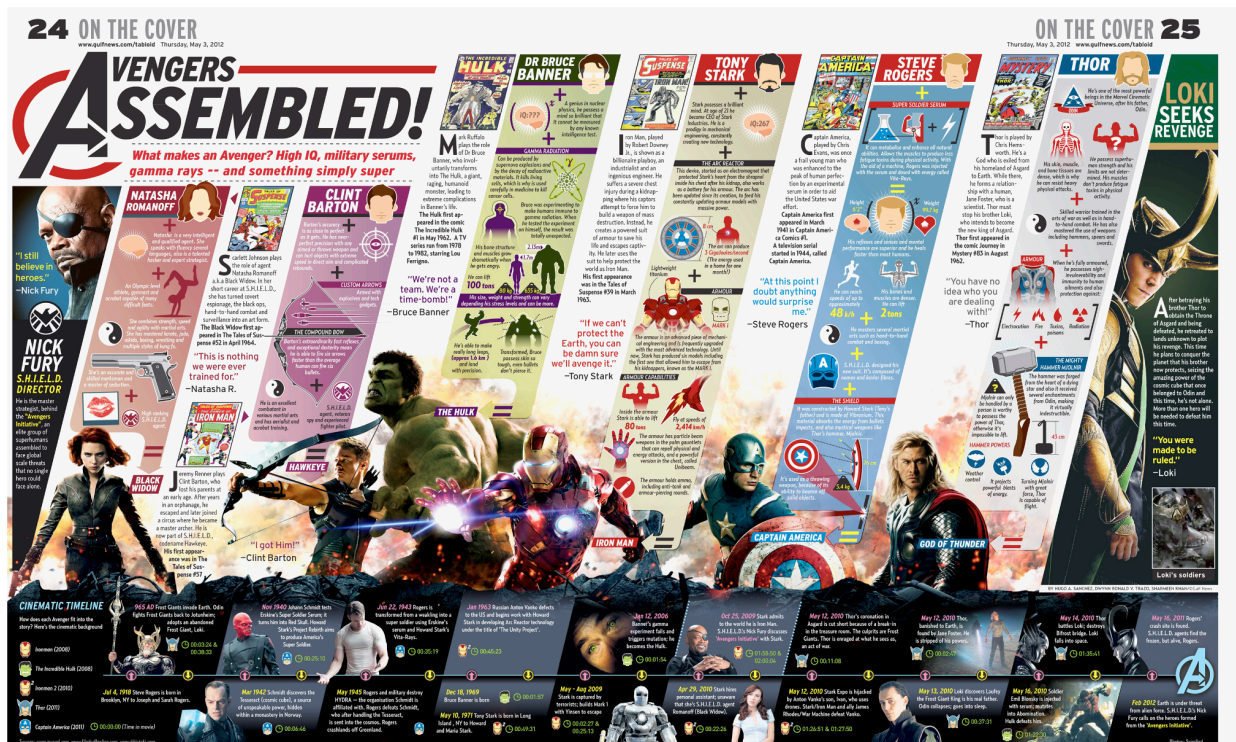


Figure 2.1 - AVENGERS | The ultimate infographic guide (Sánchez *et al*, 2012)

In terms of presentations, infographics can be developed and conceptualized in different formats. They can be **static**, consisting of fixed texts and non-dynamic visual components (Yildirim, 2017); **dynamic or animated**, designed for screen viewing, featuring elements in constant motion (Hassan, 2016); or yet **interactive**, offering users at least one option to modify the form or content in real time (Greussing & Boomgaarden, 2021). This last configuration is the one of main interest for this research.

2.1.2 Interactive Characteristics

Interactive infographics respond to user input in various ways. For example, The New York Times (2025) article “*Can You Stop an Outbreak of a Contagious Disease?*” (Figure 2.2) offers some visualizations where interactive sliders let the reader adjust vaccination rates to see how it changes the control of the spread.

How low can you set the vaccination rate to contain the outbreak?

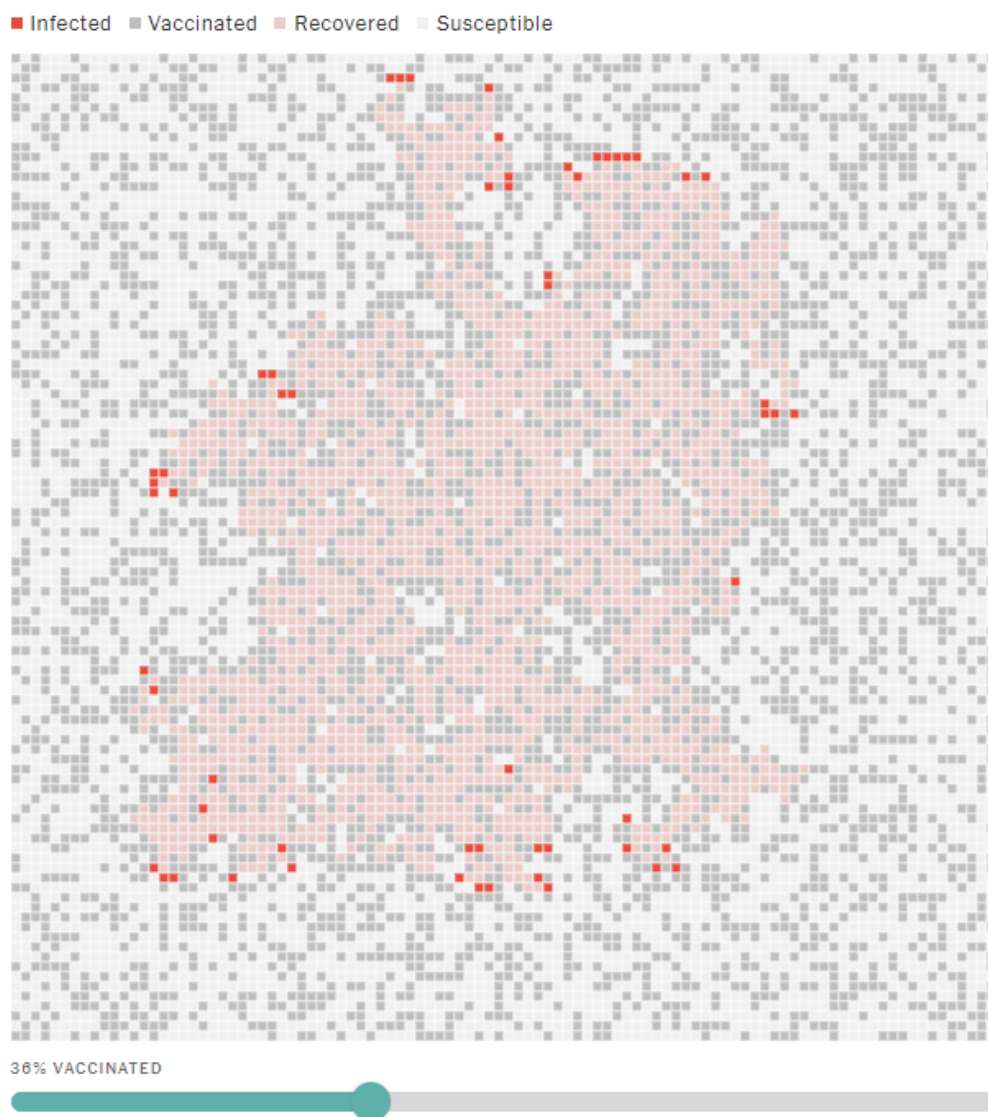


Figure 2.2 - Can You Stop an Outbreak of a Contagious Disease? (The New York Times, 2025)

To promote interactivity, this type of infographics include controls that allow readers to make changes on the data and visualizations. Examples of these include slide bars, play buttons, advanced controlling features, start or stop buttons, forward or backward buttons, menu items to select, timelines or time controllers, filter, data request or input boxes (Zwinger & Zeiller, 2016). At the same time, interactive infographics often supply information along with multimedia resources, which can include audio, video, and animated drawings (Dehghani *et al*, 2020).

Zwinger and Zeiller (2016) propose different levels of interactivity for infographics by their degree.

- **Low interactivity:** Allows users to navigate within the infographics and select content using internal links, zooming, mouseover effects, or next/start buttons without changing the infographics.
- **Medium interactivity:** Enables users to manipulate the infographics, such as by using a timeline slider or menu items, thus applying changes and comparing information.
- **High interactivity:** Allows users to explore the infographics and to interact with data and information through inputs, filtering, or data retrieval.

The same authors also propose different activity models, based on the way users can interact with content:

- **Linear:** Users move through a predetermined linear sequence defined by the author.
- **Nonlinear:** Offers a large variety of possibilities to individually explore and test the infographics.
- **Linear-nonlinear:** Combines aspects of both, often seen as the most convenient type for users.

The interactive characteristics highlighted in this topic demonstrate the many possibilities interactive infographics might carry along, offering room for further exploration.

2.1.3 Positive Aspects of Interactivity

According to research, interactive infographics have the potential to significantly enhance user engagement through their novelty, aesthetic appeal, provision of user control, and ability to convey information in an engaging manner. The ability to interact in a playful way can catch users' attention, inviting for the novelty and aesthetic appeal of the digital environment (Greussing & Boomgaarden, 2021).

Interactive infographics are perceived as having a higher information quality compared to static versions, possibly because the active engagement makes the experience more interesting and cognitively pleasant (Locoro *et al*, 2017). They can also offer functional expressions that improve functionality by adding or accentuating information, and emotional expressions that entertain users (Won, 2018).

Research also indicates that interactivity can result in a positive assessment of the interface, followed by cognitive engagement with the associated content, including absorption and elaboration (Greussing & Boomgaarden, 2021).

The benefits of interaction identified within interactive infographics directly resonate with the other main topic of this thesis - Juiciness - which is further discussed in [topic 2.2](#).

2.1.4 Interactive Infographics and User Experience (UX)

In their interactive form, infographics promote a medium of user experience for their readers. The term User Experience - UX - was coined by Don Norman (2013), who describes it as encompassing all aspects of the user's interaction with a company, its services, and its products. Norman states that UX extends beyond usability, including emotional responses, aesthetics, and overall satisfaction. According to the author, the goal is to create systems that are both functional and pleasurable to use.

Interactive infographics designs are increasingly influenced by user experience thinking to improve audience reading efficiency and the user experience when browsing and

understanding them (Zou & Qi, 2020). In that context, UX is affected by factors like demanded cognitive load, and selective visual attention can decrease extraneous load by focusing attention on specific information (Allewijn, 2020).

According to Siricharoen (2013), interactive infographics can help enhance the user experience because their evaluation criteria are similar to those of UX evaluation. By providing a matching interactive environment, they form a good interactive experience and promote the interactive value among information, media, and the audience (Zou & Qi, 2020)

The works by Siricharoen (2013), Zou and Qi (2020) and Allewijn (2020) describe that key aspects often considered when evaluating the user experience of interactive infographics include:

- **Aesthetics:** The visual design, look, and feel.
- **Dependability:** Feeling in control of interactions and perceiving them as predictable.
- **Efficiency:** The accuracy and completeness of goal achievement relative to resources expended, often measured by task completion time. Interactive infographics may require greater mental effort due to complexity.
- **Intuitive use:** The ability for users to rely on intuition to easily use the product without extensive training. This minimizes extraneous cognitive load.
- **Stimulation:** The enjoyable and motivational factor for using the product. Interactive elements can make infographics more interesting, engaging, and cognitively pleasant.
- **Trustworthiness of content:** The user's belief in the legitimacy, accuracy, and relevance of the information provided.

The same authors state that user experience is a critical aspect of modern infographic design, extending beyond traditional usability to encompass aspects like enjoyment, engagement, aesthetics, and emotional fulfillment. These facets are also explored within the concept of Juiciness, which is introduced in topic 2.2.

2.1.5 Situating Interactive Infographics

Ambiguities exist regarding the boundaries and relationships between interactive infographics and other forms of interactive visual representations. According to Alberto Cairo (2012), information graphics are the broader category, with data visualization being a subset that specifically displays data (while other info-graphics may rely on pictorial illustrations). He emphasizes using visual tools to see stories embedded in numbers.

Following Cairo's perspective, interactive infographics could be floating around the bigger circle of information design (Figure 2.3). If it displays graphs and data, then it would touch the information graphics and data visualization zones - which would be most likely to happen considering that stories constantly make use of quantifiable data and visual graphs to be told.

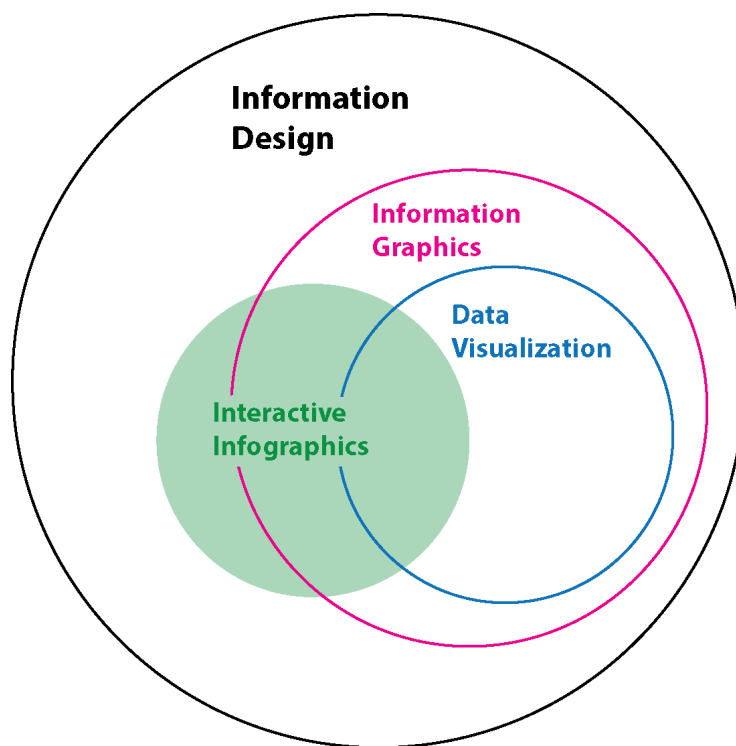


Figure 2.3 - Positioning Interactive Infographics

Interactive infographics are then interpreted as independent pieces that can be used to support other forms of interactive approaches (e.g. game-based experiences could make

use of interactive infographics as part of their whole, but the game itself is not an interactive infographic), assuming their own role as a support for visual information.

2.2 Juiciness

This topic introduces more definitions to the concept of Juiciness, presenting information of when it was first coined and used, and how research has explored it until current times. Apart from that, some information about its applications and impacts on user feedback, obtained from previous research, are also listed.

2.2.1 General Definitions

In the context of games, the term “*juiciness*” first appeared around 2005, coined by Kucic (2005), when he wrote an article called “*How to Prototype a Game in Under 7 Days*”. The author explains:

‘Juice’ was our wet little term for constant and bountiful user feedback. A juicy game element will bounce and wiggle and squirt and make a little noise when you touch it. A juicy game feels alive and responds to everything you do – tons of cascading action and response for minimal user input. It makes the player feel powerful and in control of the world, and it coaches them through the rules of the game by constantly letting them know on a per-interaction basis how they are doing.

Since then, the term has been further explored in academic contexts. Juul and Begy (2016) describe juiciness as “excessive positive feedback” (Figure 2.4) that gives the player an immediate, pleasurable experience beyond simply communicating information or making the game easier to use. Hicks (2020, p.46), based on his study findings, further elaborates and proposes the following definition:

Juiciness is a term that describes a game experience that contains a coherent design of game mechanics and visuals, while providing feedback to the player with both direct feedback that is confirmatory, relevant and explicit, but also offering superfluous feedback

that helps to inform players about the game state, and contribute to the game being perceived as a coherent whole.



Figure 2.4 - Visual example of Juiciness in the Candy Crush Saga game (King, 2012)

Swink (2008) argues that both negative and positive feedback contribute to juiciness, emphasizing the immediacy and abundance of feedback as core aspects. He hypothesized that juiciness can contribute to perceived player competence and overall player experience, leading to increased player engagement.

2.2.2 Beyond Visual Feedback

The definitions above mentioned provide a strong relationship between Juiciness and visual stimulation. Nonetheless, studies have been exploring the concept from other types of feedback, such as audio, haptic (tactile) and textual.

A study by Smets and Spek (2021) empirically explored juicy audio by creating non-juicy and juicy versions of sound effects through techniques like distortion, pitch alteration, added reverb, layering, and longer duration. Their findings indicated that participants experienced "significantly greater immersion and sensory fidelity" in the game version with juicy audio.

Hicks's (*et al*, 2024) research explores how audio designers in the game industry interpret and implement juiciness in sound design. Interviews conducted by the authors with game designers found that attributes of juicy design identified in visual contexts are also reflected in auditory contexts.

In a study about juicy haptic design, Singhal and Schneider (2021) explore the added value of juicy haptics on player experience in the context of short animation clips, with findings indicating that juicy haptics, described by the authors as excessive positive haptic feedback (i.e. tactile sensations through vibrations, forces or motions) with the intention of improving user experience in games and other interactive media, can enhance the experience in terms of enjoyment, aesthetics and immersion.

Finally, Fabre (*et al*, 2024) conducted a study about Juicy text and its effects for juicy player experience. It investigates how text effects like onomatopoeia and even regular/ordinary text can be "juiced up" with the addition of animation, particle effects and sound effects, displayed simultaneously to improve player experience and engagement. The authors concluded by mentioning that "Text effects have merits in conveying information and contributing to stylistic choices, but do not surpass particle effects in PX." (Fabre et al, 2024, p. 8)

These studies demonstrate that while visual feedback has been a central focus in discussions of juiciness, researchers and designers have also explored and recognized the importance of other forms of feedback, such as audio and haptics. These works indicate the potential to explore Juiciness in various contexts.

2.2.3 Juiciness and Engagement

At this point, it is feasible to say that the impact of juicy design on user experience is a multifaceted topic with evidence suggesting positive contributions. Juicy design can enhance the player's gameplay experience by inciting feelings like excitement, curiosity, immersion, and competence (Luz *et al*, 2024).

According to Hicks (2020), juiciness can add visual interest that contributes to a player's desire to explore a virtual world and leading to more immersive experiences. These immersive experiences can be leveraged to increase engagement or pique initial interest.

As stated by Juul (2009), design principles such as positive fictions, high usability, interruptibility, and lenient punishments for failure are used alongside Juiciness in casual games. The author states that Juiciness in casual games is often nondiegetic, meaning the excessive feedback addresses the player directly via the screen space, outside of any simulated 3-D game world. This type of feedback is highly valuable in small-screen environments like mobile devices, ensuring the player feels rewarded immediately for their actions. The Casual Revolution observed by Juul (2009), driven by designs that prioritize player accessibility, time flexibility, and immediate gratification, has enabled game mechanics like matching tile games (Bejeweled) to become ubiquitous on mobile devices and other non-traditional gaming platforms. Juiciness is the aesthetic and functional design component that facilitates this enjoyable, immediate, and rewarding experience across these platforms.

Regarding engagement, the studies from Marshall McLuhan (1994) about “hot” and “cool” media provide a perspective that can link to juiciness and interactive infographics. In his work *“Understanding Media: The Extensions of Man”* (1994), the author offers a framework for analyzing how different media engage audiences. McLuhan characterizes media along a spectrum based on their level of sensory detail and the degree of audience participation they require:

- **Hot Media:** high-definition media that provide abundant information, engaging a single sense intensively and requiring minimal audience participation. Examples include print (books, newspapers), radio, film, lectures and photographs.
- **Cool Media:** low-definition media that offer less sensory information and thus demand greater audience involvement to fill in the gaps. Examples include: TV, cartoons, telephone, seminars and comics.

Following previous definitions of Juiciness consisting of immediate, satisfying feedback users receive from their interactions (i.e. animations, sounds or other audiovisual effects that respond to user input), it aligns closely with McLuhan's idea of cool media: by incorporating juicy elements, interactive infographics transform from static, hot media into dynamic, cool media. They require users to participate actively, interpret feedback, and engage multiple senses, thereby enhancing the overall user experience.

Nevertheless, some studies warn about nuances and potential negative impacts of juiciness on user engagement. Luz (*et al*, 2024) suggests that too much or too little juicy design can negatively affect attention and, subsequently, reduce engagement with a visual stimulus. Research conducted by Kao (2020) demonstrates that medium and high juiciness conditions outperformed low and extreme juiciness across measures including interest/enjoyment and playtime. Durmanova (2022) presented similar research findings, where participants found extreme levels of Juiciness to be less-relaxing for the proposed interactive experience.

The above mentioned studies demonstrate that, while juiciness has the potential to significantly enhance user engagement by creating more appealing, responsive, and immersive experiences, its impact is not always uniformly positive. The level and type of juiciness need to be carefully considered, as excessive or poorly implemented juicy elements can be detrimental to attention, motivation, and overall engagement.

2.2.4 Exploring Juiciness Besides Games

Very few examples of academic studies have been found where Juiciness is explored outside of game-based mediums.

A blog post by Heraghty (2015) suggests practices and benefits of designing for a “Juicier Web”. Luz (*et al*, 2024, p.2) proposed a study “to examine the effect of level of juicy design on attention”. Another work by Singhal and Schneider (2021) measured the added value of what they call “*juicy haptics*” into player experience. Authors Hicks

(2020) and Durmanova (2022) suggested that Juiciness should be explored in other interactive mediums.

That poses an opportunity for this study, expanding the exploration of Juiciness within mediums and contexts beyond games.

2.3 Microinteractions

Similarly to how Juiciness is incorporated into game-based experiences, UX designers often incorporate small, often overlooked design elements that can significantly impact the user's experience by adding clarity, feedback, or delight to interactions. These are called Microinteractions (or Micro-interactions), which according to Dan Saffer (2013), are defined as contained product moments that revolve around a single use case—designed to accomplish one task or provide a single piece of feedback.

For example, when using an iPhone, if the user turns the airplane mode ON (Figure 2.5), they will see a little icon of an airplane sliding and fading in from the left side of the screen, slowing down and staying in position, indicating that the task is complete. When turning it OFF, the airplane icon quickly moves to the right, fading out. But actions of turning the airplane mode ON and OFF provide this single piece of feedback to accomplish one task, making reference to an airplane that arrives (ON) and take-off (OFF). The visual presence of the airplane icon indicating that the airplane mode was turned ON, along with the animation of the moving plane, are not necessary for it to function. Still, they support user feedback and might delight the user if noticed.

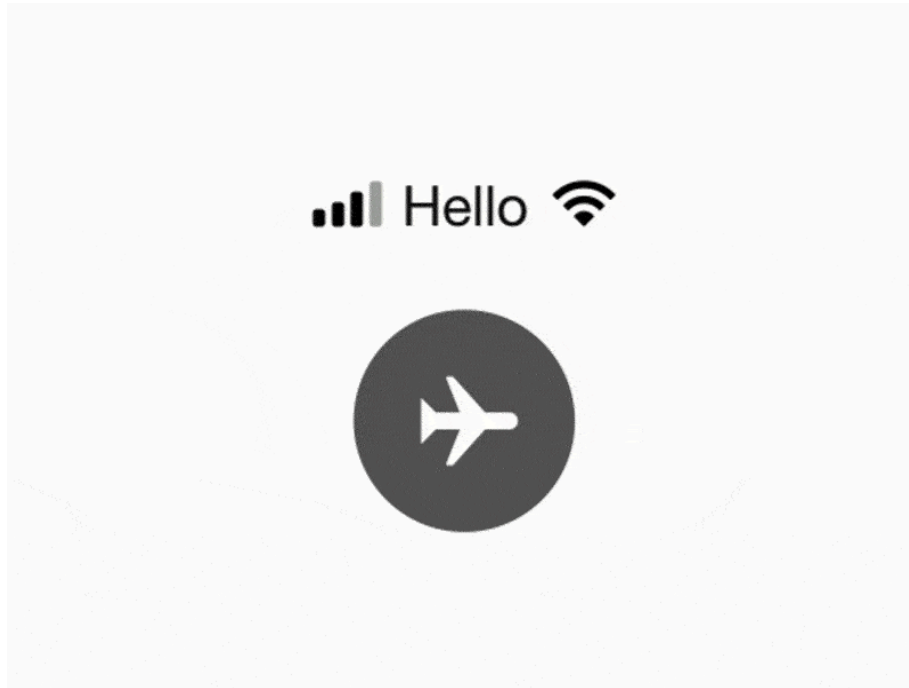


Figure 2.5 - Example of Microinteraction: Airplane mode from iPhone ([Lee, 2018](#))

Shwany (*et al*, 2024) mentions that microinteractions are considered an essential part of Human-Computer Interaction (HCI), where their purpose includes providing feedback, enhancing interactions, creating engaging experiences, and giving users a sense of control. Expanding on feedback, Betz and Hall (2015) state it is a fundamental component of microinteractions, which flows from the application or interface back to the user. The authors sustain that feedback can take various forms, including visual (like a color change on hover or confirmation messages), auditory, or haptic, though visual feedback is most common.

Microinteractions can directly impact user engagement, satisfaction and attention. A study from Shwany (*et al*, 2024) found that most participants agreed that micro-interactions are engaging in enhancing their user experience, with 69% of respondents agreeing on this point. The same authors mention that user-friendly digital interfaces that incorporate micro-interactions have been found to lead to an improved overall user experience.

Microinteractions can also be used to guide user experience (UX) and user interface (UI) design practices. The book “*Laws of UX*” by Jon Yablonski (2024) consists of a guide that explains how key principles of psychology can be applied to build products and experiences that are more human-centered and intuitive. Some of the principles can make use of microinteractions concepts to reinforce their uses:

- **The Peak-End Rule** states users judge an experience largely based on how they felt at its peak and at its end, rather than the total sum or average of every moment of the experience. The author suggests identifying the moments when the product is most helpful, valuable, or entertaining and design to delight the end user. This entertainment can be made with animated elements, for instance.
- **The Zeigarnik Effect** states that users remember uncompleted or interrupted tasks better than completed tasks. It is suggested that providing a clear indication of progress might help motivate users to complete tasks. That can be achieved with the use of badges, which are common to game-like experiences, and can be juiced-up to promote visual engagement.

2.3.1 Microinteractions and Data Visualization

When it comes to infographics, limited research sources were found that relate microinteraction with the broader field of data visualization.

In a study called “*Data Feel: Exploring Visual Effects in Video Games to Support Sensemaking Tasks*”, Zhou and Forbes (2022) propose the application of visual effects common in video games to data visualization and visual analytics tools, aiming to create more engaging interactive visualizations, contrasting with traditional aesthetics in data visualization. Incorporating elements from video game design into data visualization is referred to as “data feel”. According to the authors, these applications aim to facilitate sensemaking, improve selective attention, and enable designers to embed additional interactive functionality, creating new kinds of user experiences in data visualization tools.

In an online article by Chakraborty (2024) named “*How to Use Micro-Interactions for Data Visualization*”, the author writes:

Micro-interactions are subtle, often unnoticed design elements that guide users, provide feedback, and make the interaction with digital content more intuitive and engaging. When applied to data visualization, micro-interactions can significantly enhance the user’s experience by making complex data easier to understand, interact with, and explore. From highlighting important trends to providing detailed insights on hover, micro-interactions can transform static charts and graphs into dynamic, interactive experiences.

The same author says that micro-interactions serve as the bridge between static information and user engagement, making data more accessible and enhancing the user’s ability to draw meaningful insights (Chakraborty, 2024). She lists the following benefits of incorporating micro-interactions:

- Enhancing User Engagement
- Improving Data Clarity
- Guiding User Focus
- Facilitating Data Exploration
- Reinforcing Data Storytelling

These benefits parallels with previously mentioned positive effects related to the application of Juiciness within game-based experiences.

The information provided above demonstrates strong correlations between the concepts of Microinteractions and Juiciness, especially in terms of feedback and user engagement. Where they seem to differ though is in terms of frequency and intensity of use. While Microinteractions affect feedback with subtle layers of audiovisual additions, Juiciness does not skimp on employing intense and for times exaggerated amounts of those same audiovisual effects to stimulate players. The intention here is to verify if this enormous quantity of rewarding feedback finds a fruitful environment within interactive infographics.

2.4 Visual Embellishments

One of the links that exist between infographics and juicy design is the eventual incorporation of Visual Embellishments (VEs). According to Hicks (*et al*, 2019), Visual Embellishments are defined as design elements that have no effect on system functionality but are thought to contribute to the overall user experience. They primarily consist of visual information that engages the user (e.g. adding an aesthetic theme to a bar graph to engage and highlight key points - see Figure 2.6).



Figure 2.6 - Ultra Combo bar from the game Street Fighter IV (Capcom, 2008)

In the context of information visualization, embellishments are features commonly used in everyday visualisations which are demonstrated to enhance assimilation and memorability. They can be icons, pictographs, images, and others used to attract readers' attention to visualisations in the news media (Alebri *et al*, 2023). Similarly in the realm of charts, embellishments are deviations from a baseline chart, including changes to the shape of the bars, added components, or bars with an altered set of data encodings. Data visualization designers add VEs to charts to catch the eye of readers (Skau, 2016).

2.4.1 Visual Embellishments and Engagement

In terms of engagement, the works from Andry (*et al*, 2021) and Alebri (*et al*, 2023) have identified positive and negative aspects related to Visual Embellishments applied to infographics and data visualizations. Embellished visualizations are generally found more beautiful and are liked more than standard ones. This beauty-emotion link can arouse positive emotions, a key goal for designers using embellishment to make visualizations aesthetically pleasing. Embellishments can increase interest and

engagement by reducing the perceived effort needed to read the data and by engaging the reader with the visualization topic. Their studies also suggest that embellishments, such as icons and background images, can aid memorization and recall. Features like recognizable objects and high visual density can also increase memorization.

On the negative spectrum, findings from previous studies (Alebri *et al*, 2023) indicate that certain embellishment types, particularly salient ones (e.g., large-sized icons on their own or combined with other elements), can make viewers feel underestimated, childish, or patronized. Some individuals felt those embellishments gave a sense of lack of autonomy, which can lead to disengagement. Highly embellished visualizations can sometimes be perceived as less objective and trustworthy compared to plain or subtly embellished ones, especially if they are associated with less credible sources like tabloids. (Andry *et al*, 2021)

Embellishments can be a valuable tool for engaging users and enhancing the aesthetic appeal and memorability of infographics, yet designers must exercise caution: excessive or poorly chosen embellishments, or those that distort the data representation, can hinder clarity, reduce accuracy, and even lead to negative user experiences (Andry *et al*, 2021).

For interactive infographics, the effectiveness of embellishments is a balance that needs to consider their saliency, the context of use, the target audience, and the wide goal of clear and accurate communication. For game-based experiences, the overuse of visual embellishments might be the initial step to create a juicy experience.

2.5 Chart Junk

The terms "chart junk" and "visual embellishments" are closely related in the field of data visualization, with "chart junk" often considered a specific type or subset of "visual embellishments" that is viewed negatively (Bateman *et al*, 2010). Chart junk was coined by Edward Tufte in his book *The Visual Display of Quantitative Information*, from 1983. As a strong proponent of minimalist design in data visualization, Tufte considered

chart junk to be "graphical decoration" that is erasable and provides no additional information, believing it made interpretation more difficult and distracted readers from the data (Haque Syeda *et al*, 2019; Akbaba *et al*, 2021). One of the pieces that Tufte famously criticized was a chart entitled “*Diamonds*” by Nigel Holmes (Figure 2.7), who was the first visualization specialist at *Time Magazine*. Tufte labeled this piece as “chart junk” filled with clichés and stereotypes, presenting a focus on beautifying data over statistical integrity (Akbaba *et al*, 2019; Few, 2011).

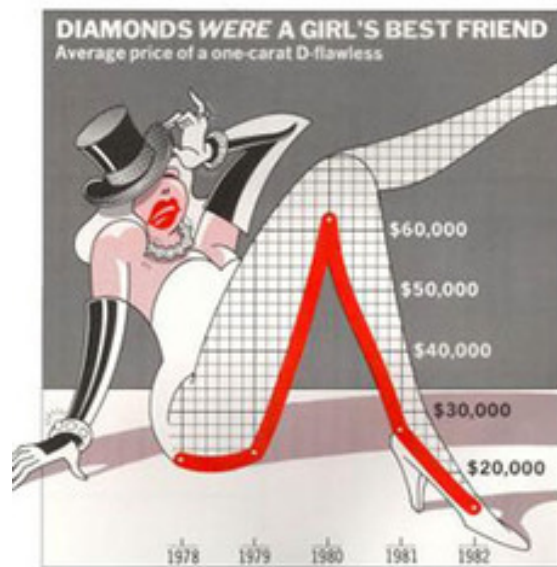


Figure 2.7 - “*Diamonds*” by Nigell Holmes (Tufte, 1990)

2.5.1 Positive Perspectives Over Chart Junk

While Tufte asserted that chart junk was harmful without empirical evidence, some past research suggested that minor decoration might not hinder interpretation (Akbaba *et al*, 2019; Bateman *et al*, 2010). Steven Few (2011) proposed that embellishments could sometimes represent information redundantly in useful ways or support the display of informative content. According to Parsons and Shukla (2020) more recent research has empirically investigated the effects of visual embellishments, with findings suggesting chart junk can be appropriate to increase memorability or engagement. Some research

suggests that certain visual embellishments can have benefits, such as making charts more memorable, engaging, and even potentially conveying a value message more effectively (Li & Moacdieh, 2014). A key study by Bateman et al. (2010) compared embellished and plain charts, finding that embellished charts did not hinder interpretation accuracy and led to significantly better long-term recall.

In essence, while Tufte originally defined chart junk as any non-essential visual element, considering it detrimental, the concept of visual embellishment is broader. Modern perspectives and research suggest that some visual embellishments might serve useful purposes beyond just presenting the raw data, such as enhancing memorability or engagement, and therefore might not always be accurately described as "junk". The effectiveness of visual embellishments often depends on the context, the type of embellishment, and the goals of the visualization.

2.6 Conclusion

This chapter presented findings from research on the topics of Interactive Infographics and Juiciness, making some correlations with UX, Microinteractions, Visual Embellishments and Chart Junk.

The background presented offers possibilities for strong connections between Interactive Infographics and Juiciness. It also brings up questions in terms of whether Visual Embellishments and Juicy Elements should be meaningfully thought to be incorporated into infographics without becoming pure Chart Junk.

Juiciness, Microinteractions, Visual Embellishments, and Chart Junk are related design concepts that describe how aesthetic and interactive elements are used in interfaces, particularly in data visualization and interactive media, to influence user experience and engagement. The following chart (Table 2.1) provides a brief and concise comparison of Juiciness, Microinteractions, Visual Embellishments, and Chart Junk, focusing on their core definitions, intensity, and relationship to the functional content or data.

	Juiciness	Microinteractions	Visual Embellishments	Chart Junk
Core Definition / Focus	Use of visually and interactively rich feedback, characterized by excessive positive feedback. Elements often "bounce and wiggle and squirt".	Small, often overlooked design elements that can significantly impact the user's experience by adding clarity, feedback, or delight to interactions.	Design elements that do not affect system functionalities, such as icons, pictographs, or aesthetic themes.	Graphical decoration that is erasable and provides no additional information. A subset of visual embellishments.
Intensity / Scale	High; employs constant, intense, and exaggerated audiovisual effects. Provides "tons of cascading action".	Low; uses subtle layers of audiovisual additions designed to guide users through a small task.	Variable; deviations from baseline charts used to attract attention.	Variable; non-informative decoration
Primary Goal	To create an immediate, pleasurable experience, making the user feel powerful and in control and fostering satisfaction.	To provide specific feedback, enhance single interactions, and make digital content intuitive and engaging.	Contribute to the overall user experience (UX), enhance memorability, and arouse positive emotions.	(Original View) Beautify data. (Modern View) Increase memorability or engagement.
Risk / Downside	Overuse is overwhelming and can lead users to disregard the main content.	None explicitly specified; must remain intuitive to avoid frustration.	If excessive, VEs can hinder clarity/accuracy or lead to negative perceptions.	Makes data interpretation difficult and distracts readers from the data.

Table 2.1 Comparison between Juiciness, Microinteractions, Visual Embellishments and Chart Junk concepts

This thesis is interested in juiciness as applied to interactive infographics. It is needed to distinguish interactive infographics from other visual approaches that also focus on supporting information, such as serious games and dataviz (although data visualization is often part of infographics), among others. It is equally important to differentiate juiciness from visual embellishments and microinteractions. Therefore, the following

working definitions for Interactive Infographics and Juicy Design are proposed, which will apply for the rest of the thesis:

Interactive infographics are dynamic visual representations of information and data that aim to facilitate quick and clear comprehension and communication of a subject, by enabling users to modify and explore content in real time through various interactive tools.

Juiciness/Juicy Design refers to the use of visually and interactively rich feedback to enhance user engagement, satisfaction, and responsiveness, employing elements like animations, sounds, and transitions to create rewarding and immersive interactions.

The next 3 chapters offer more detailed perspectives in terms of the presence - or not - of Juicy Elements within Interactive Infographics ([Chapter 3](#)), a professional perspective about juiciness applied to interactive infographics ([Chapter 4](#)) and finally a test that compares juicy and dry (non-juicy) infographics and their effects on user engagement and information retention ([Chapter 5](#)).

Chapter 3

Assessing Juicy Elements In Interactive Infographics

Related Work¹: Campos, B. (2025). Assessing juicy elements in interactive infographics. Revista De Comunicación De La SEECI.

3.1 Chapter Introduction

The first step in this research is to assess the state of affairs when it comes to juiciness in interactive infographics: How prevalent is it? And in which form?

This chapter investigates the presence of juicy elements in interactive infographics and data visualizations that are freely accessible online. We believe our research will contribute to both academic and industry contexts.

Academically, this study may bridge the gap in the exploration of juiciness in non-game design projects (e.g., mobile apps, websites, digital publications), as it is the first to examine its application outside gaming environments. For the industry, this study findings could be valuable to interactive and graphic designers seeking to incorporate juiciness deliberately and meaningfully in the development of interactive infographics and data visualizations. Juiciness also presents a relatively low-cost way to enhance user engagement in existing interactive applications.

It is hypothesized that juiciness can enhance engagement in infographics. To examine this potential, the first step proposed in this research is to assess whether current infographics incorporate juiciness elements and to what extent. The following research question is posed to guide this investigation:

¹ Changes and adaptations were made from the original piece, mainly in terms of literature review, to support reading flow and efficiency by reducing duplication of quotes and references.

RQ: Which, and how many, of the following juicy elements—animation, particles, audio feedback, screen shake, and persistence—are present individually or in combination in existing online interactive visualizations?

This chapter presents a review of the literature on the concept of Juicy Elements, followed by a description of the Methods employed, then presenting the Results and a Discussion of the findings, with attention to Limitations and Suggestions for Future Research. A conclusion of the work conducted is presented at the end of the chapter.

3.2 Juicy Elements

The interaction between users and systems usually involves back-and-forth actions: the user makes an input action, that is then received by the system which will interpret it, and return an information to the user, ideally based on the input previously made. This returned information is called Feedback and might affect what the user might be able to do next (Schell, 2008). In the book *The Design of Everyday Things*, Don Norman (2013) defines feedback as the communication of the results of an action to the user, enabling them to understand whether the intended effect has been achieved. According to the author, feedback is essential for guiding users, reducing uncertainty, and ensuring a seamless interaction with systems or products.

The amount – and maybe quality – of feedback provided to the user might affect the experience they will have with a system. Norman (2013) emphasizes that effective feedback should be immediate, informative, and proportional to the action, enhancing usability without overwhelming the user.

In games, if too little feedback is provided, an interface might be described as “dry”. Juicy systems, on the other hand, will provide the player with a lot of feedback that feels very rewarding. On a talk titled “Juice It or Lose It”, Martin Johansen and Petri Purho (2003) provide some basic examples on how a game can be converted from “dry” to “juicy”, by sampling adding some effects such as particles, screen shakes, explosions, bass tone sounds and others.

Overall, research about Juiciness, mostly related to the context of game design, supports it has positive aspects whenever applied. Schell (2008, p. 233) proposes “The Lens of Juiciness”, where juicy interfaces will provide the player with lots of powerful, interesting, and continuous feedback in form of rewards. The author states that, to promote a fun and positive experience to the player, the juicier, the better. Kucic (2005) states that juicy games feel alive, with elements that bounce, wiggle and squirt, making little noises, responding to every minimal player action.

When examining different levels of juiciness, aiming to convey “juicy design” as a term to be used in academic contexts, Atanasov (2013) concluded that “the quality of Juiciness defines conditions that foster a positive emotional response, a feeling of reward and satisfaction and an overall enjoyment of being within the game world.”, demonstrating that Juiciness can positively affect player experiences with games.

Still, some research also suggests that Juiciness should be carefully thought out before their implementations (Hicks, 2020). If minimal or extreme, Juiciness can have negative impacts on player experience (Kao, 2020).

These quotes pose an important aspect to be considered when designing a juicy experience, even more so if the target audience is not primarily made of video game players.

To achieve a "juicy" experience, game designers incorporate various elements and techniques into their projects. According to Kucic (2005) “A juicy game element will bounce and wiggle and squirt and make a little noise when you touch it.” These elements may be applied individually or in combination to enhance the sense of juiciness experienced by users when interacting with an interactive visualization or game. Building on prior research and identified occurrences (Hicks, 2020; Kao, 2020; Durmanova, 2022), the following Juicy Elements were selected for investigation:

Animation: Animation refers to dynamic or moving elements within a layout, utilizing frame transitions to create the illusion of motion from a sequence of static images. In the context of juiciness, animation is applied to a variety of objects within a scene, employing diverse movement types, including rotations, size variations, multi-axis

movement, and distortions, among others.

Particles: Particles are elements or objects that respond to events within a scene. They consist of small units—often single pixels or groups—that appear before, during, or after events such as collisions, friction, or explosions. Particles are animated and behave according to specific system settings, including physics, quantity, and speed. In interactive infographics, particles may represent data values or quantities, as seen in *Histogramphy* (Stauber, 2015), where tiny, animated dots behave like particles in response to user inputs.

Audio Feedback: Audio feedback includes sounds played during the interactive experience, encompassing both music and sound effects that respond to events, such as a “crash” sound upon object collision. An example is *Listen to Wikipedia* by Stephen LaPorte and Mahmoud Hashemi (2015), which uses sound effects to signify recent Wikipedia edits. Here, “bells indicate additions, and string plucks indicate subtractions, with pitch variations based on edit size; larger edits produce deeper notes” (LaPorte and Hashemi, 2015).

Screen Shake: Screen shake is an effect involving the movement of the entire screen and its visual elements, serving as an additional layer of user feedback in response to events such as collisions, explosions, or sounds. This technique is explored in *Optikamer* (Team Optikamer, 2016), where subtle screen shakes occur when the user-controlled object jumps or lands.

Persistence: Persistence refers to visual traces left by events that occur during interaction. These traces can be either permanent or temporary, and include both instant effects, such as footprints, and lasting changes, like a wall crack resulting from user input. An example of persistence can be observed in the interactive infographic *Construct* (Figure 3.1), which “transforms the New York subway system into an interactive string instrument” (Chen, 2011). Here, the lines representing subway paths remain visible temporarily, gradually fading out.

The exploration of juiciness highlights its potential to enhance user interaction by adding dynamic and engaging elements to digital experiences. While many of the juicy

elements identified are commonly associated with games, their application in other interactive formats, such as infographics, also offers significant opportunities. As we shift focus to interactive infographics, it is important to consider how these elements might be integrated into visualizations designed to communicate complex information, enhancing both the engagement and the clarity of the message being conveyed.

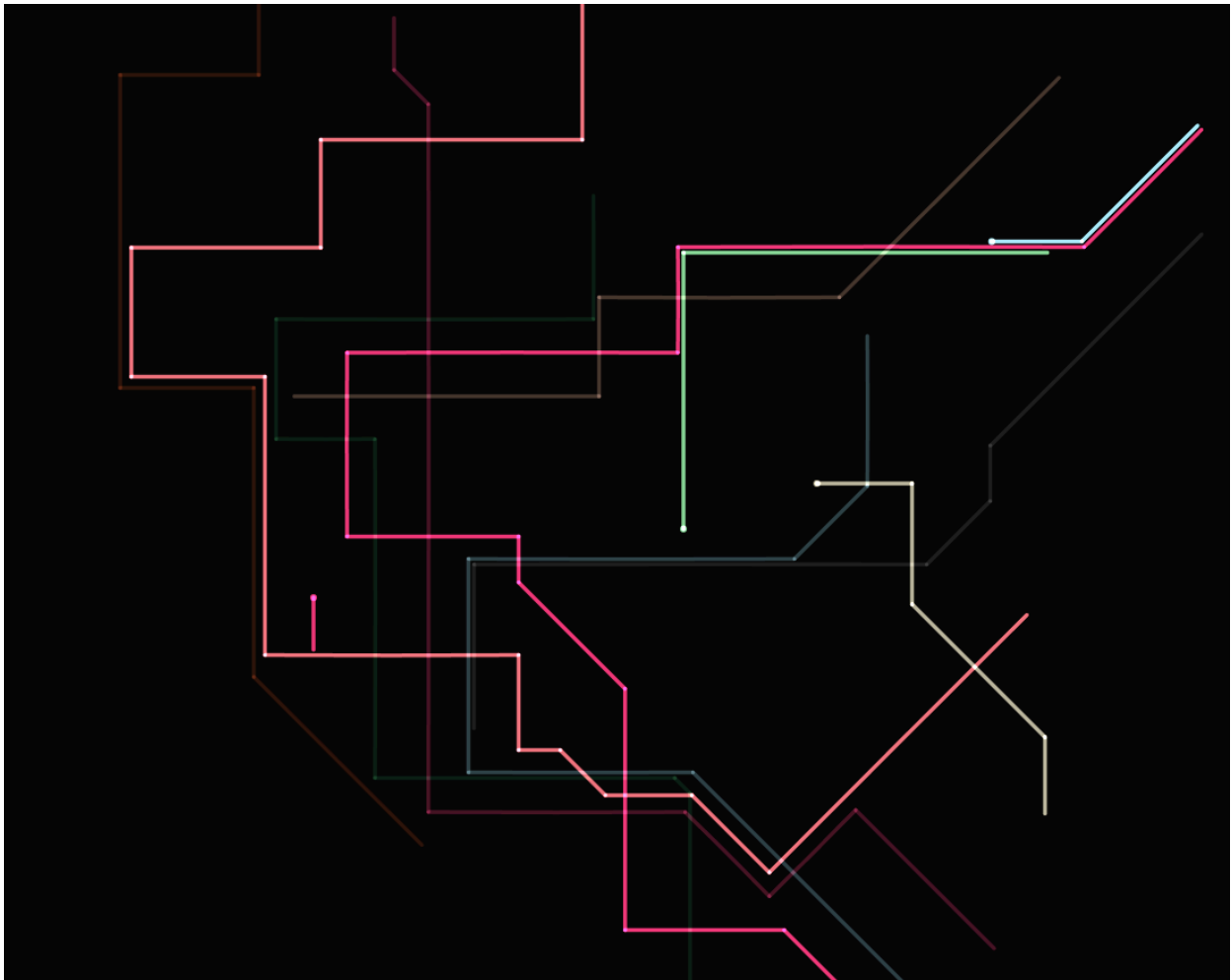


Figure 3.1 - Construct at mta.me. (Chen, 2021)

3.3 Methodology

For this research, a list of interactive infographics and data visualizations was examined. The collection process began with Google searches using prompts such as “best interactive infographics,” “top interactive infographics,” “best interactive data visualizations,” “top interactive data visualizations,” “best interactive data viz,” and “top interactive data viz.” Specific years were appended to these search terms to expand the date range. Despite using various search terms, considerable overlap was observed, leading to several websites that curated what their staff considered the best examples of interactive infographics and data visualizations. Among these, four sources were the most significant and comprehensive based on the quantity of links provided: “101 Visually Stunning Interactive Infographics to Inspire You” compiled by Katy French (2019) from Column Five Media; “The 100 Best Infographics [Interactive]” curated by Ross Hudgens (2021) from Siege Media; the Information is Beautiful Awards website; and annual “best-of-the-year” lists from the Flowing Data website.

The lists from Siege Media and Flowing Data included both interactive and non-interactive infographics, so only those categorized as interactive were considered. For the Information is Beautiful Awards website, results were filtered using the “interactives” tag, yielding 12 pages of interactive visualizations. Although the exact number of projects could not be determined due to randomized content refreshes, an estimated 200+ projects were identified. Across these primary sources, repeated visualizations were also mapped. Additionally, a few other examples were gathered from various online sources, including developers’ and companies’ websites featuring interactive visualizations.

A total of 195 accessible and functional links remained after reviewing each individual entry. While the initial list was expected to be larger, numerous broken links and unavailable visualizations reduced the count. Certain technologies used to create older infographics—such as Adobe Flash—are no longer supported by modern browsers, and some domains are no longer maintained.

The criteria for including an infographic in the final list were as follows: each infographic

had to be accessible online at no cost (i.e., without paid subscriptions or donations), and it had to be categorized by either the list organizer or creator as an interactive infographic, interactive data visualization, or interactive visualization (such as interactive maps). Visualizations with incomplete access, such as missing images, static samples, or video demonstrations, were excluded.

The final set of visualizations was then cataloged in a spreadsheet recording the following information for each entry: title, author(s), publication year, and the presence of five types of juicy elements—animation, particles, audio feedback, screen shake, and persistence. The publication date was included to allow for trend observation over time regarding juiciness in interactive visualizations. In cases where the publication date was not immediately available, the Wayback Machine was utilized to approximate the original publication period.

Each link was revisited to assess the presence of juicy elements, which were classified using a binary (YES or NO) system without quantifying intensity or frequency. Interaction with available interactive elements such as buttons, sliders, links, draggers, hover effects, and input fields was conducted using mouse or keyboard inputs. Notably, while all interactions took place on a computer, it is acknowledged that some visualizations may also be compatible with mobile devices. The findings are presented in the following section.

3.4 Results

Overall, the findings indicate that juicy elements are present in certain interactive visualizations, though not universally across all examples. Figure 3.2 illustrates the percentage distribution for each element.

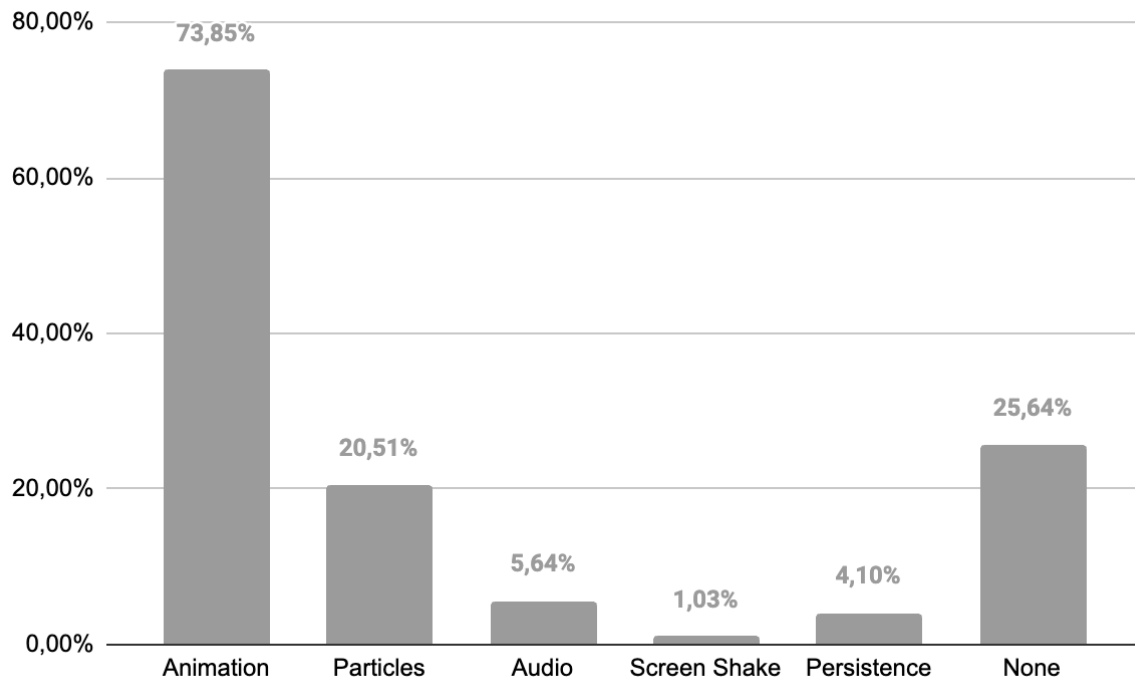


Figure 3.2 Overview of Juicy Elements on Interactive Infographics

All juicy elements were identified across multiple instances within the analyzed visualizations. The data presented in the graphic indicate that animation appeared most frequently, with an occurrence rate of 73.85%, followed by particles (20.51%), audio feedback (5.64%), persistence (4.1%), and screen shake (1.03%). Furthermore, 25.64% of the visualizations contained no juicy elements. The lower percentages of the elements, apart from animation, can be expected given the concept of Juiciness comes from games - where all of these effects are commonplace.

It is believed that it is important to verify the amount and types of juicy elements used together along different samples. By performing that analysis, it is possible to identify the dominance of a single element and what elements are most used in combinations in different occurrences. For that analysis, visualizations were categorized based on the number of juicy elements each contained, as depicted in Figure 3.3. Additionally, efforts were made to determine which elements were commonly used together and the

frequency of these combinations, as outlined in Table 3.1.

Number of Juicy Elements Used

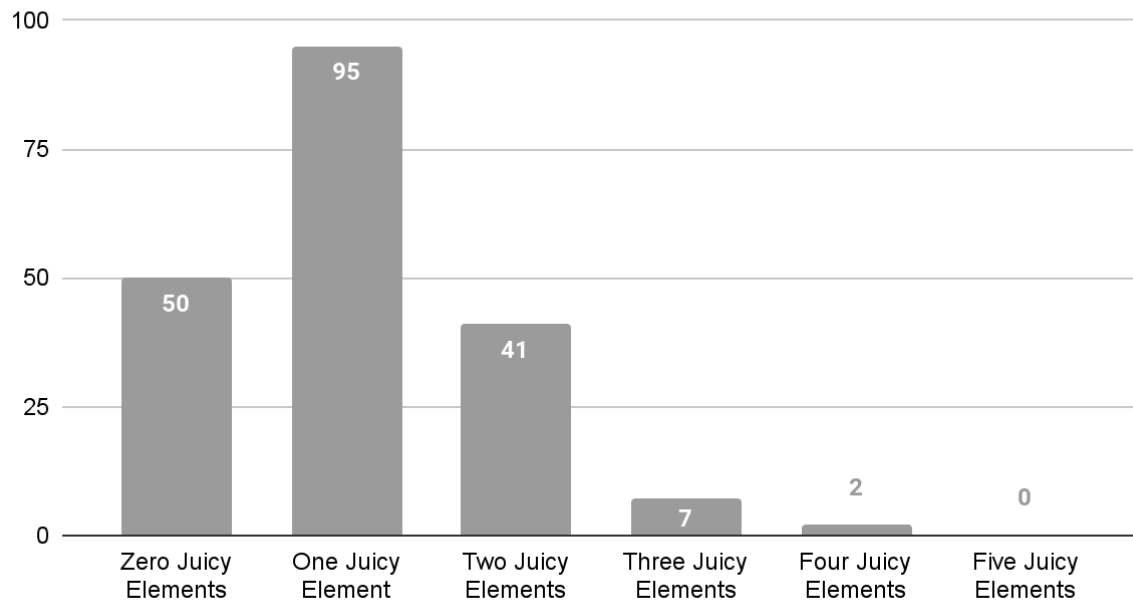


Figure 3.3 Number of Juicy Elements Used Together

0 Juicy Elements	50
1 Juicy Element Only	95
Animation	94
Particles	0
Audio	1
Screen Shake	0
Persistence	0
2 Juicy Elements Only	41
Animation + Particles	34

Animation + Audio Feedback	4
Animation + Screen Shake	1
Animation + Persistence	2
3 Juicy Elements Only	7
Animation + Particles + Audio Feedback	2
Animation + Particles + Persistence	3
Animation + Audio Feedback + Persistence	2
4 Juicy Elements Only	2
Animation + Particles + Audio Feedback + Screen Shake	1
Animation + Particles + Audio Feedback + Persistence	1
5 Juicy Elements	0

Table 3.1 Combination of Juicy Elements

Animation is the most frequently used element in isolation, appearing as the sole juicy element in 94 visualizations. In contrast, only one visualization featured audio feedback as the sole juicy element. When two or more juicy elements were combined, animation was always present. This is particularly true for the particle element, which logically appears alongside animation, as particles are typically animated.

In terms of the timeline, we analyzed interactive visualizations created between 2010 and 2024. Figure 3.4 displays the distribution of occurrences over the years:

Number of Visualizations by Year of Publication

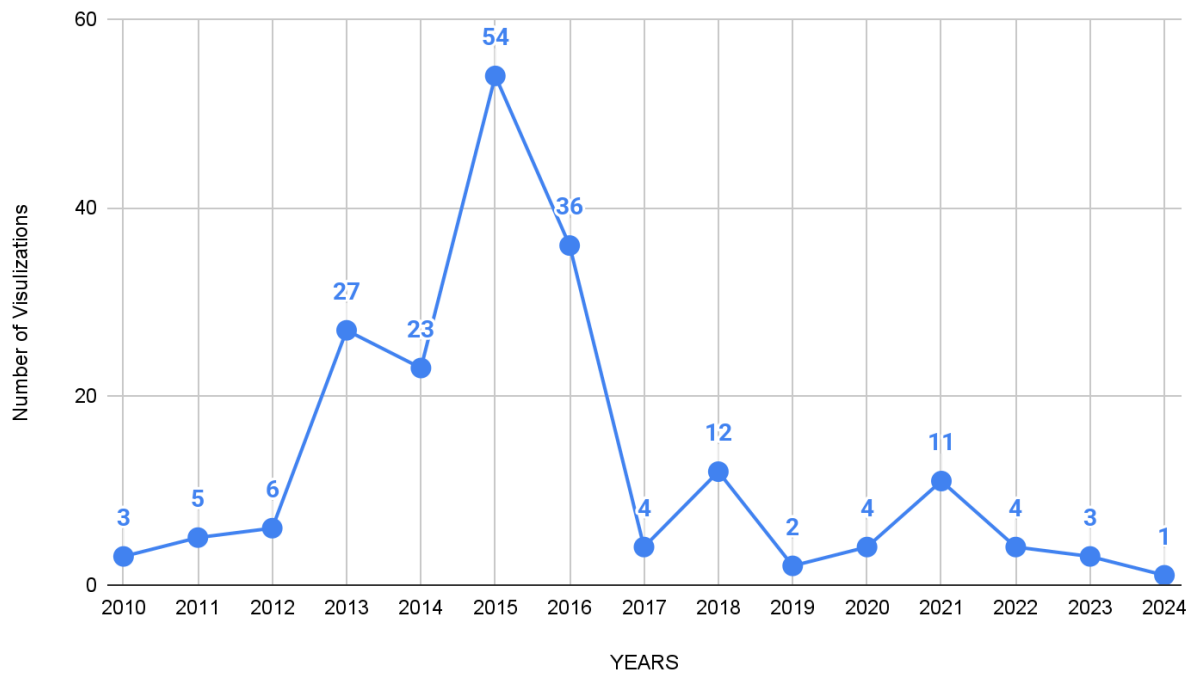


Figure 3.4 Interactive Visualizations by Year of Publication

It was then investigated the occurrence of Juicy Elements over the years. Figure 3.5 shows how many times they appeared on interactive visualizations for each year.

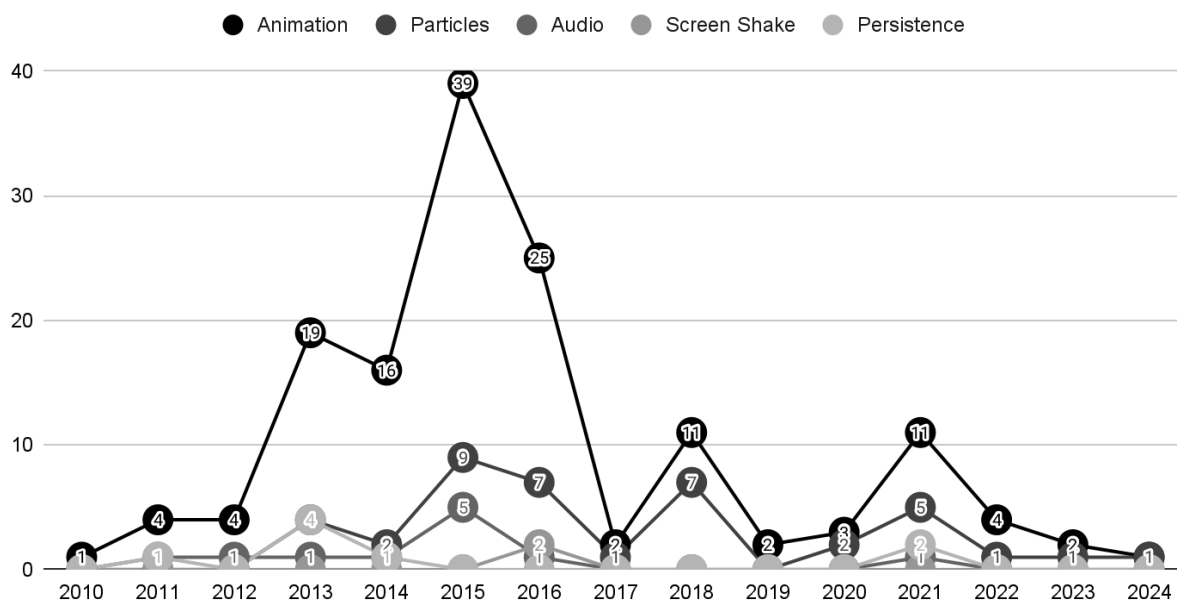


Figure 3.5 Juicy Elements Over the Years

The animation trend shown in Figure 5 mirrors the overall pattern of interactive visualizations per year as displayed in Figure 2. This confirms that animation is the most widely explored juicy element in the analyzed visualizations. Both figures show a notable increase in the use of animations, particles, and audio between 2014 and 2016. One possible explanation for this growth is that by this time, support for CSS animations—introduced in 2009 with CSS3—had become well-established across major browsers. As a result, visual designers and programmers were likely actively exploring the potential of these new animation capabilities.

3.5 Discussion

The findings from the analysis reveal that juicy elements are present in a significant number of interactive visualizations, but none of the visualizations analyzed incorporated all five juicy elements simultaneously. This suggests that while individual

elements, such as animation and particles, are frequently used, achieving a comprehensive experience that includes all juicy elements remains uncommon. Notably, two visualizations—Optikammer by Team Optikammer (2016) and Seeing CO₂ by Extraordinary Facility (2021)—were identified as incorporating four juicy elements. Optikammer lacked the element of persistence, while Seeing CO₂ did not feature screen shake. Both visualizations provide real-time controls, allowing users to interact with the content using keyboard inputs, further enhancing the immersive nature of these examples. These real-time interactions, which are akin to a gameplay experience, suggest that they are particularly successful examples of integrating juiciness within interactive infographics.

However, it is important to note that despite the presence of some juicy elements, not a single visualization captured the full essence of juicy design, which ideally offers a high level of feedback from minimal user input. This raises an important question regarding the effectiveness of juiciness in interactive infographics: Is it necessary to include all juicy elements for a visualization to be considered "juicy," or can the integration of a few carefully selected elements still significantly enhance user experience? The analysis indicates that the success of juiciness may be less dependent on the quantity of elements and more on their thoughtful integration within the design. According to Pichlmair and Johansen (2021, p. 147), "Juiciness requires exact timing of particle emissions, freeze frames, audio cues, perspective changes, and potentially many more parts of the game." The way these elements are executed and aligned with the visualization's goals plays a crucial role in shaping the overall user experience.

Furthermore, the study revealed that a substantial portion of interactive infographics included at least one juicy element, with animation emerging as the most prevalent. This finding is consistent with the growing trend of using animations in digital design, where the incorporation of motion serves to capture attention and guide users through content. While animation alone can make an infographic engaging, combining it with other juicy elements like particles, audio feedback, and persistence could amplify the interactive experience, creating a more dynamic and compelling interaction.

Interestingly, the analysis of combinations of juicy elements also highlights certain

patterns. For example, animation was always present when other elements, such as particles, audio feedback, or persistence, were included. This suggests that animation is a central component in interactive infographics, often serving as the foundation upon which other elements are added. The frequent pairing of animation and particles is particularly notable, as particles are often animated to enhance the visual experience. This combination exemplifies the potential of using juiciness to create a more immersive and visually appealing interaction with data.

Another key insight from the study is the trend over time. The distribution of interactive visualizations analyzed across the years (2010–2024) reveals a steady increase in the use of animation, particles, and audio feedback starting around 2014. This coincides with the widespread adoption of CSS3, which enabled more sophisticated animations across web browsers. The increased support for these technologies likely encouraged designers to experiment with and explore new possibilities for animated interactions, leading to the greater integration of juicy elements. As interactive design continues to evolve, it is expected that the use of such elements will expand, offering even richer and more engaging user experiences.

3.5.1 Limitations and suggestions for future research

The variability in the level of interactivity within the visualizations examined also raises important questions about how we define and measure interactivity in this context. Some of the visualizations analyzed were labeled "interactive" based solely on the inclusion of basic scroll functionality - which can still become more engaging when incorporating "scrollytelling" techniques, which blend scrolling with multimedia content (Seyser and Zeiller, 2018) - while others offered more complex interactions, including real-time data manipulation and multimedia content.

This variability underscores the need for a closer examination of the minimum criteria required to classify a visualization as interactive: Should scrolling alone suffice? Is there an upper boundary for interactivity? Further research could aim to assess user

perceptions of juiciness in interactive visualizations by inviting participants to engage with them and offer feedback on their juiciness experience.

Identifying specific sources that list interactive visualizations (such as infographics and data visualizations) proved challenging, suggesting an opportunity to gather and consolidate these interactive approaches within a single repository.

The focus of this research on freely accessible online infographics limited access to those funded through paid initiatives or projects. Projects with dedicated funding may have greater resources and development time to employ advanced technologies, which could support the inclusion of more juicy elements. Future studies could gain valuable insights by investigating interactive infographics available through paid subscriptions offered by major news outlets such as The New York Times, The Washington Post, The Guardian, and similar publications.

A language constraint was also encountered, with most analyzed visualizations being in English, alongside some examples in Spanish, French, German, Portuguese, and Russian. Future studies may find it beneficial to analyze infographics in other languages, including Japanese, Cantonese, Mandarin, Arabic, and others, to determine whether language-specific visualizations yield differing results.

3.6 Conclusion

This study aimed to explore the application of juicy elements within interactive infographics and data visualizations, specifically focusing on how these elements contribute to user engagement and overall interaction experience. By analyzing 195 interactive visualizations, the research confirmed that juicy elements, such as animation, particles, audio feedback, persistence, and screen shake, are widely used.

The analysis revealed that the integration of juicy elements varies significantly across visualizations. While no single visualization incorporated all five juicy elements, combinations of up to four were observed, suggesting that juiciness does not require a

uniform or exhaustive application of all elements. Instead, the strategic integration of a few well-designed elements can create a highly engaging experience for users. This aligns with the idea that juiciness, much like other design principles, is about the thoughtful application of elements rather than their mere presence.

Furthermore, the study highlighted that animation is by far the most prominent juicy element, both in isolation and in combination with others, particularly particles. This suggests that animation has become a key tool for enhancing interactivity in modern data visualizations, perhaps driven by advances in web technologies like CSS3 and JavaScript. These trends emphasize how the evolving technical capabilities of the web influence the ways in which designers apply juiciness in their work.

The research also raised important questions about the definition of interactivity in visualizations. The variety of interactive features—ranging from simple scrolling to real-time user input—illustrates the fluidity of what can be considered interactive. This underscores the need for further exploration into the criteria that define an "interactive" infographic and how different levels of interactivity might impact user perception and engagement. Additionally, the study focused on freely accessible online infographics, which, while useful, may not represent the full range of possibilities in interactive design. Paid sources with more resources could potentially offer more complex and richly designed examples that may further develop the concept of juiciness.

This study contributes to the growing body of work on the intersection of interactive design and user engagement, emphasizing that juiciness is a valuable tool in creating more engaging and emotionally resonant visualizations. However, it also demonstrates that juiciness is not the only factor influencing the effectiveness of an interactive experience. Instead, it is one component of a larger design strategy aimed at fostering engagement, enhancing comprehension, and improving the overall user experience. Future studies could explore how juiciness can be integrated with other key design principles, such as accessibility, clarity, and usability, to create more effective and inclusive interactive infographics. Additionally, further research could investigate the impact of juiciness on user behavior, learning outcomes, and information retention, providing deeper insights into its practical applications in fields such as education,

journalism, and data analysis.

In conclusion, this study provides a detailed examination of the presence of juicy elements in interactive infographics and data visualizations. It not only contributes valuable insights into current design practices but also sets the stage for further research into the broader implications of juiciness in digital design. As the field of interactive design continues to evolve, the potential for juiciness to enhance user engagement and learning will undoubtedly remain a critical area of exploration.

Chapter 4

Juiciness and Interactive Infographics: An Ethnographic Perspective

Related Work²: Campos, B. (2025). Juiciness and Interactive Infographics: An Ethnographic Perspective. 11th International Conference on Information Management (ICIM2025).

4.1 Chapter Introduction

It has been observed that the concept of juiciness is not widely present in existing infographics. Understanding the reasons for this limited prevalence could be an important next step, including exploring how contemporary designers perceive this approach, their level of interest, and the factors that may discourage its implementation.

This chapter presents an ethnographic exploration of how "juiciness" is perceived and how it might be applied to interactive infographics. To achieve this, semi-structured interviews were conducted with design professionals, gathering their perceptions of "juiciness" and their insights regarding its potential incorporation into infographics. The study examines the benefits and drawbacks of this approach from the perspectives of audience reception and development processes.

The chapter is structured as follows: Section 4.2 details the Methods employed, while section 4.3 presents the Results of the interviews. Section 4.4 discusses the findings,

² Changes and adaptations were made from the original piece, mainly in terms of literature review, to support reading flow and efficiency by reducing duplication of quotes and references.

addressing Limitations and offering Suggestions for Future Research, followed by the final section 4.5 Conclusion.

4.2 Methodology

This section outlines the methods employed in this research, providing a rationale for the use of ethnography and detailing the processes of participant recruitment, data collection, and analysis. Additionally, it addresses the ethical considerations undertaken to ensure the integrity and validity of the study.

4.2.1 Design Ethnography Approach

Design ethnography is a qualitative research method that employs ethnographic techniques to study design practices and subjective experiences. It extends beyond merely observing actions to understanding how individuals perceive their world, the meanings they ascribe to it, and how these perceptions influence their design processes (Rapp, 2021; Müller, 2020). This approach highlights the importance of grasping the subjective experiences of both designers and users to create designs that resonate meaningfully with both groups. Furthermore, design ethnography facilitates a deeper understanding of how design practices are influenced by subjective impressions, cultural contexts, and the materiality of design elements. These insights can inform the development of more meaningful, engaging, and user-centered products and systems.

Ethnographic interviews, a key component of design ethnography, rely on open-ended questions to explore a diverse range of perspectives and experiences from the interviewees' standpoint (Rapp, 2021; Müller, 2020). This method is particularly relevant to the present study, as it encourages designers to share their personal insights and distinctive approaches to "juiciness," thereby enabling a more nuanced and comprehensive understanding of the concept. Moreover, delving into the motivations and rationales behind designers' choices can illuminate their underlying values,

aesthetic preferences, and perceptions of how "juiciness" influences user engagement and comprehension.

The overarching objective of this research is to explore the concept of "juiciness" with the aim of applying it to a domain beyond games. To achieve this, the study draws on data from experienced practitioners. Design ethnography, a research approach that integrates ethnographic methods with design practices, is employed to understand individuals' behaviors, needs, and the contexts in which they operate, thereby informing the design of new products, services, and systems (Pink et al., 2022).

This method facilitates the collection of qualitative data, offering valuable insights into how designers engage with the concept of "juiciness" in their practice. Additionally, participants are encouraged to identify examples of other works where "juiciness" is evident in interactive visualizations, even if the terminology is not explicitly used to describe the technique.

4.2.2 Participants

The participant recruitment process focused on individuals whose professional work involved the design of interactive visualizations, including infographics and data visualizations. Video game designers were excluded, as the study aimed to explore the application of "juiciness" outside the realm of gaming. Potential candidates were identified based on their publicly available visual works, accessed through personal websites or online portfolios. Designers meeting these criteria were contacted via email and invited to participate in an interview regarding the application of Juicy Design to interactive visualizations, with full disclosure that their participation would contribute to academic research. Out of 22 professionals invited, 5 responded positively and agreed to participate in the study. A summary of their profiles is presented in the following topics.

4.2.2.1 Rodolfo Almeida

Rodolfo Almeida has a background in journalism, having studied at the Catholic Pontifical University in S. Paulo. He developed an interest in design while involved in publishing and taught himself design.

His career in interactive infographics and data visualization began in 2014 when he joined Nexus Journal as an infographics artist, despite having no prior experience in the field. This period was highly formative, as he worked intensely, publishing three infographics per week (mostly static) alongside a data scientist for three and a half years. Subsequently, he gained programming skills, data analysis, and Flourish while at Vortex Media. Almeida then co-founded Nuclear Journalism, an outlet focusing on big tech, AI, and social media.

Currently, he works part-time as a visual journalism editor at Nucleo journal, and as a freelance information designer and data journalism editor, which has allowed him to sharpen his skills in interactivity and pursue projects he desires.

4.2.2.2 Nadieh Bremer

Nadieh Bremer is a best-selling author and multi-award-winning data visualization designer and artist, living and working from a lovely house in the woods in the Netherlands. She has a background in astronomy and worked as a data scientist starting in 2011. After four years, she realized her passion lay elsewhere and was inspired to specialize in data visualization. In 2015, Bremer transitioned to a role as a data visualization designer, creating dashboards using D3JS.

Since 2017, the same year she started freelancing, focusing on custom data visualization solutions, she has been the founder and owner of [Visual Cinnamon](#). With a background in astronomy and a career that began as a data scientist, her analytical skills enable her to quickly understand and manage complex datasets. Her publications are

practitioner-focused books, reflecting her hands-on approach in the field for almost eight years of freelancing.

She has been immersed in this field for almost a decade, and my enthusiasm for it continues to grow.

4.2.2.3 Alberto Cairo

Dr. Alberto Cairo started his career in journalism in 1997, initially focusing on visual explanations using illustrations for print newspapers. His entry into interactive graphics began in 1999 at El Mundo, a national newspaper in Spain, where he became the head of interactive graphics and used technologies like Flash. He developed a specific interest in data visualization around 2008 or 2009, at which point he began seriously studying statistics and data visualization. Cairo transitioned into academia, moving to the United States, then Brazil (where he headed graphics for Editora Globo/Epica), before becoming a professor at the University of Miami in 2012. Alongside his teaching, he maintains an active side career as a consultant and art director, continuing to produce visualizations and provide training for organizations. He has been making interactive graphics for 25 years as of the interview.

Dr. Cairo is also the author of several books about infographics and data visualization, such as ***The Functional Art*** (2013), ***The Truthful Art*** (2016), ***How Charts Lie*** (2019), and ***The Art of Insight*** (2023).

4.2.2.4 Vinicius Sueiro

Vinicius Sueiro began his bachelor's in design in 2012 and started working with infographics and data visualization in 2014 at a major Brazilian newspaper, Estadão. Initially, he focused on translating print content to digital, but later led a team to create original, award-winning projects. After five years in the newsroom, he worked as an

experience designer for a Brazilian consultancy, focusing on UX/UI design and user research, before deciding to freelance.

As a freelancer, he collaborated with organizations like Google News Initiative and The Washington Post, notably on the Epicenter project during the COVID-19 pandemic. He pursued a master's in interaction design, with his projects often geared towards interactive data physicalizations.

Since 2021, he has taught at graduate programs in Brazil and, in 2022, joined the University of Miami as a faculty member, teaching interaction design, web development, infographics, and data visualization.

4.2.2.5 Jan Willem Tulp

Jan Willem Tulp studied interaction design and initially worked as a software engineer before discovering data visualization. He dedicated a year to preparation and then transitioned into freelancing, which he has been doing ever since.

Tulp specializes in a wide range of custom-designed, web-based data visualization projects, some appearing in magazines or online, with a few involving animation. He writes his own code, primarily using HTML, CSS, JavaScript, and frameworks like D3 and Svelte. While he often works independently from start to finish, he also takes on roles as part of larger teams, such as his current projects for the World Bank.

His work, which can be seen in his personal website tulpinteractive.com, emphasizes bespoke solutions over standard software packages, and he consistently aims to create visually appealing designs that also serve a functional purpose.

4.2.3 Data Collection and Analysis

The data collection process was carried out through semi-structured interviews. These interviews were conducted online and synchronously via Google Meet, with audio and

video recordings as well as text transcripts generated to support subsequent qualitative analysis. The interviews were initially scheduled to last between 45 and 60 minutes, although some sessions extended beyond the planned duration, enabling more detailed and in-depth discussions on the topics under consideration.

The semi-structured interviews (Appendix A) were organized into six main topics. To begin, participants were invited to provide a (1) personal introduction, discussing their careers as interactive visualization designers. They explained how they entered the field and offered an overview of their experiences creating interactive infographics and data visualizations.

Following this, participants were asked about their (2) familiarity with "juiciness". For those unfamiliar with the concept, a definition of Juicy Design - introduced in Chapter 2 - was provided. This definition summarized key findings from the existing literature on the topic and served to establish a common understanding for the discussion.

"Juiciness/Juicy Design refers to the use of visually and interactively rich feedback to enhance user engagement, satisfaction, and responsiveness, employing elements like animations, sounds, and transitions to create rewarding and immersive interactions."

Simultaneously, participants were invited to complete the first level of the game Peggle Blast (Electronic Arts, 2018), which served as a visual and interactive reinforcement of the concept of "juiciness" (Figure 4.1). Following this introduction to the concepts, participants were asked to provide links to examples of interactive visualizations from their own portfolios, as well as works by other designers, where they perceived elements of "juiciness."



Figure 4.1 The game Peggle Blast used as a visual reference of "juiciness". (Electronic Arts, 2018)

The following section focused on (3) perceptions of Juicy Design in interactive infographics, with questions aimed at identifying respondents' opinions regarding the presence of "juiciness" in interactive infographics and data visualizations. The questions sought to explore the potential benefits, enhancements, and possible distractions associated with incorporating "juiciness" into these designs.

Next, participants were asked about (4) challenges and limitations in applying juicy elements to interactive designs. Questions in this section addressed methodological and technical difficulties, as well as the potential impacts on the usability and effectiveness of visualizations when "juiciness" is overused. One question also asked participants to identify specific types of information or audiences for which the application of "juiciness" would be particularly effective or ineffective.

Following this, the section on (5) impact and value inquired whether "juiciness" contributes to user engagement and improved information retention. Additionally,

participants were asked how designers balance aesthetic appeal with functional clarity in their interactive designs.

The final topic, (6) the future of Juicy Design in infographics, invited respondents to reflect on the potential role of "juiciness" in infographics and data visualizations, including its place in their own work practices. As the interviews progressed, questions were adjusted to maintain the flow of conversation and to allow for deeper exploration of topics that seemed to interest the interviewees the most.

During the interviews, participants were encouraged to share samples of their own work and related examples from other designers that they believed incorporated "juiciness" into their designs. This helped illustrate the discussion with visual examples, linking the concept of "juiciness" to existing interactive designs.

At the conclusion of each interview, participants were asked if they knew of any other designers who might be interested in being interviewed for the study.

Interviews were conducted between December 2024 and January 2025 via Google Meet. Both video recordings and transcripts were captured, following participant consent, allowing for a comprehensive analysis of the discussions.

The video recordings and transcripts were analyzed using qualitative data analysis tools. The specific tool employed for this analysis was NotebookLM (Google, 2023). Transcripts were uploaded into the application, which facilitated the search for patterns, trends, and key findings. The tool also identified frequently used terms and words, guided by the interview topics and questions. The results of this analysis will be further detailed in the Findings and Discussion sections.

4.2.4 Ethical Considerations

To ensure the ethical integrity of this research, all participants were required to complete and sign a digital Information and Consent Form. This document outlined the purpose,

procedures, potential risks and benefits, and the conditions of participation in the interview.

4.3 Findings

This section breaks down insights gained from answers provided by respondents. It is going to be divided into subtopics, providing quotes, common ground and different opinions obtained during the interviews.

4.3.1 Familiarizing with the concept of "juiciness"

All the five interviewees were not initially familiar with a common ground of the term "juiciness" or the variant "Juicy elements" when asked about them. After being introduced to a definition and experiencing a visual example that incorporates elements considered juicy, they all agreed to have gained a better understanding of what "juiciness" means in the proposed context. When asked to provide some examples, both from their own work or other designers' projects, they all promptly provided a couple of links with interactive visualizations where they believed some "juiciness" was incorporated. Interestingly, when providing works from other designers, they didn't mention each other's work and not a single interactive infographic was mentioned by two or more different interviewees. These projects would make use of Juicy elements, such as sound effects and transitions, but animation was by far the most used technique they would relate to the idea of "juiciness".

4.3.2 Perceptions of Juicy Design in Interactive Infographics

The interviewees generally agreed that juicy design elements could enhance user experience, but also acknowledged the potential for these elements to be distracting.

4.3.2.1 Do Juicy Elements Enhance User Experience?

In general, interviewees' responses indicated they believe that the addition of "juiciness" can enhance user experience. Rodolfo Almeida thinks these elements communicate just as much as the main piece and the data itself. He also notes that animations can reduce friction and make data easier to understand, mentioning that as humans, we see things as "happening and morphing" and not static. Nadieh Bremer suggests that juicy elements can draw the reader in and help them understand the visualization, making them more inspiring to look at.

Alberto Cairo thinks that if a particular stylistic feature will enhance the reader's experience then it should be used. He prioritizes understanding, and asks, "Is this feature going to help the reader understand the information better?". Cairo also notes that animation can convey information, and that every element should serve a purpose. Vinicius Sueiro believes that juicy design aligns with his goal of using technology to "inform and delight humans." He emphasizes the need to make information "enticing" and "rewarding." Sueiro also believes that the message or content needs to be meaningful so that the user will enjoy consuming it.

Jan Willem Tulp agrees that juicy design elements can enhance user experience, because they can be fun to look at and play with. He also notes that they can be used to carry information, such as shaking the screen to reinforce the effect of something dropping.

4.3.2.2 Are Juicy Design Elements Distracting or Beneficial

Interviewees' responses indicate they believe that "juiciness" can bring benefits, but they should serve a purpose other than pure visual embellishment to reduce the chances of becoming a distraction to the readers. Rodolfo Almeida acknowledges that "juiciness" can be "weaponized" to keep readers engaged even when they don't want to be. He also states there can definitely be "too much 'juiciness'". Almeida says that some people may find it engaging while others may find it overwhelming. He also prioritizes simple

interactions such as scrolling because he doesn't want to overwhelm readers with too many things to do.

Nadieh Bremer states that the effectiveness of juicy elements depends on the context, stating "it depends". She also believes that doing it the same way as game design is "too over the top", and may cause people to click around just for fun and not focus on the content itself. Bremer thinks that a more nuanced approach is needed, especially for heavier topics. She thinks that as long as it's not a "loaded topic" then juicy design could help, but there is a balance that needs to be struck.

Cairo thinks that animation is beneficial when it enhances the sense of continuity and has a functional purpose. He notes that if a graphic fails at being understandable, then it fails entirely. He says that the more aesthetic elements of a graphic should work with the functional to enhance it.

There is also a belief that projects are planned and conceived according to distinguished aspects. Sueiro believes it is a case-by-case situation and mentions the idea that "juiciness" could be "interactive chart junk". He also adds that if something is more fun it might be more distracting. Tulp thinks that it depends on how things are designed. He says that the same thing could be beneficial if it is well designed and a distraction if it isn't well designed.

4.3.3 Challenges in Applying "juiciness"

Respondents had a lot to say regarding challenges in incorporating "juiciness" into interactive infographics, which range from technical aspects that imply in development time consumption, all the way other aspects to be considered such as appropriate topics and targeted audiences.

4.3.3.1 Technical Complexity

Interviewees mentioned that most of current interactive visualizations are designed through programming languages. Almeida noted that interactive visualizations require coding skills, more time, and testing on different devices. He also mentioned that each interactive element needs to be intentionally introduced, tested, and coded. On a similar path, Bremer pointed out that juicy design often involves more programming.

There is also the need for unique tools to create those visualizations. Tulp stated that juicy design is not supported out-of-the-box by standard software, requiring custom solutions, pointing out that a good designer is needed to make it work. That is specifically true within projects where the designer is working on their own to produce infographics instead of integrating a larger team of designers, a situation that is more common within game productions for instance.

4.3.3.2 Cognitive Load

There is a risk of staggering the user with too much interaction and feedback. Almeida stated that one of the challenges is not overwhelming the reader and that it's easy to make juicy elements that don't add to the main point. He also mentioned that some readers may find the interactions distracting and may prefer a plain text version. There is also a question related to making sure to send the intended message. On that, Tulp mentioned that overdoing juicy design elements could hide the information to be conveyed.

Distraction has also been brought up by some interviewees as becoming another aspect to be considered when overusing juicy elements. Almeida and Bremer expressed concern that users would eventually simply click around the visualization for fun, disregarding their initial intention and main focus with the infographic.

4.3.3.3 Measuring Infographic Success

All respondents agreed that measuring the effectiveness of an infographic is challenging, although mentioning different aspects that could help with getting feedback about an interactive infographic success. Almeida suggested that traditional metrics like shares and likes can be a measure of engagement but that measuring impact is more important. Bremer mentions that clients will usually apply the visualization with their own audiences, but feedback is not always provided to the designer. Cairo and Tulp noted that, although not usually done for journalistic projects, user testing is possible and can help determine effectiveness and memorability. Sueiro mentioned that time spent on the page is a metric that was used in newsrooms, and that projects with infographics had higher conversion rates, meaning that users who viewed the infographics were more likely to subscribe to the newspaper.

In the matter of the correlation between engagement and effectiveness, interviewees' comments revealed that, while engagement can be measured through metrics such as “likes” and “shares”, it does not always translate to effective information conveyance or retention. Almeida stated that they try to measure impact by tracking if the piece caused relevant individuals, such as authorities, to take action. Sueiro noted that higher conversion rates can be a metric of success, especially in journalistic contexts.

4.3.3.4 Appropriateness of Juicy Design for Different Information and Audiences

According to some responses, the effectiveness of juicy design depends on the context. Almeida stated that serious topics may need to "scream and shout" to get attention. He also added that it depends on the tone. On the other hand, Bremer and Cairo believed that topics such as war and death are less suited for juicy design, and that some subjects may need to be treated with a more serious tone.

In regards to suitability for different target audiences, responses went on a similar path. According to Almeida, some people may find "juiciness" engaging while others may find

it overwhelming. Sueiro and Tulp stated that visualizations created for experts or for daily uses, such as visual instructions or similar, may not need as much "juiciness" compared to visualizations for the general public. Regarding specific areas or subjects that could potentially appropriate Juicy Design as a beneficial technique for their development, Bremer suggests art, media, and culture.

4.3.4 Impact and Value of "juiciness" applied to Interactive Infographics

For this section, interviewees were inquired about their impressions on the impact and value of applying "juiciness" to their designs when creation, discussing user engagement, information retention and the balance between aesthetic appeal and functional clarity.

4.3.4.1 Contribution of Juicy Design to User Engagement and Information Retention

Interviewees comments and responses indicated that there is a general consensus that juicy design elements can enhance user engagement. Almeida and Bremer believe that "juiciness" can make data more engaging and interesting to users, especially in complex visualizations. Cairo notes that juicy elements could mimic what people see in video games and play a role in engagement. Sueiro adds to that stating that "juiciness" aligns with the idea of using technology to inform and delight users, making information more enticing and rewarding. With a similar approach, Tulp believed that even if the juicy elements do not carry information they can still be fun to look at or play with, which can be engaging.

While engagement is often seen as a positive outcome, the impact of juicy design on information retention is more complex and less clear. Bremer mentioned that if applied properly, "juiciness" can increase information retention because users are more engaged with the visualization. Sueiro stated that whenever we see an interaction that mimics the physical world, that experience can be more memorable because it activates more parts of our brain. Tulp pointed out that it can create memorability, with well-designed visualizations potentially being remembered longer.

Based on some comments, it's important to note that the effectiveness of juicy design in both engagement and information retention depends on the context and implementation. Almeida noted that there has to be some cohesion between the juicy elements and the message, for instance, sound effects should not be added just as an extra embellishment. Tulp stated that a well-designed visualization is critical for success in both engagement and retention. He also stated that the interpretation of a visualization always happens in the user's mind.

4.3.4.2 Balancing Aesthetic Appeal and Functional Clarity

The interviewees emphasized the need to see aesthetic appeal and functional clarity as interdependent rather than separate goals. Almeida believed that the visual form is not separate from the meaning of the data and that it carries the meaning itself. Cairo stated that the graphic should be both understandable and visually appealing. He also noted, in a similar opinion provided by Tulp, that a graphic that looks good will be more likely to attract a reader's attention. Sueiro believes that the functional aspect should come first, but the aesthetics should help with the storytelling. These responses indicate that it is not only a matter of making a good looking graphic, nor making it purely functional. There must have been some balance considered to make it more effective.

Responses from interviews about their design process also support what is mentioned above. It should prioritize the functional goal of the infographic, and the aesthetic considerations should support that goal. Bremer mentioned that she starts with the goal of the visualization and then focuses on making it visually appealing. She noted that the goal is not a visual design or "a rainbow". Cairo stated that every element should serve a purpose in making the graphic more understandable, unique, or attractive. Sueiro said that the design should follow the function, and that aesthetics should serve the message. Tulp noted that design principles like spacing, color use, contrast, and harmony are always in mind when creating a design.

In terms of context and requirements, the balance between aesthetic appeal and functional clarity can depend on the project's goals, target audience, and specific

requirements. Tulp mentioned that the goal of the project has a big impact on what he designs, pointing out that sometimes clients have different requirements in terms of how much design they need. Cairo also stated that there is a need to have a very clear understanding of what the reader should take away from the visualization.

In summary, according to the designers, juicy design has the potential to improve user engagement and information retention in interactive infographics, but it needs to be implemented carefully. Balancing aesthetic appeal and functional clarity is essential, with design processes that prioritize the communication goal while integrating visual elements effectively.

4.3.5 Future of Juicy Design in Infographics

The final block of the interview inquired about respondents' visions on if and how they would see "juiciness" being applied to interactive infographics, including the development of their own projects.

4.3.5.1 Future Prominence of Juicy Design in Infographics

Some interviewees' responses suggest that juicy design could become more prominent in the future of interactive infographics. Almeida anticipates that the lines between data visualization, graphic design, infographics, and game design will continue to blur, leading to more mixed approaches that incorporate elements of each. He also believes that interactive projects will continue to blend these fields. Sueiro thinks that "juiciness" could be a way to make data visualizations more enticing. He also thinks there are a lot of possibilities to think about "juiciness" in informal learning environments like interactive installations, such as museums. Tulp hopes there is more custom visualization design, as those projects tend to use juicy design elements, and that those elements can be a way to create engagement.

Respondents mentioned that factors such as engagement, memorability, differentiation and technological advancements might drive a potential growth in the use of "juiciness" within interactive infographics. At the same time, other aspects could be seen as limitants. Regarding cost and time, implementing juicy design can be more time-consuming and costly than creating standard charts. Bremer noted that it may not be feasible for all projects, as clients will not pay for this "nice-to-have" feature. Tulp points out that creating custom solutions for juicy design can be technically challenging. He also mentions there is a lack of standardized guidelines and best practices for using juicy design, making it difficult for designers to know when and how to apply these elements effectively.

4.3.5.2 Personal Exploration of Juicy Design in Future Projects

Interviewees expressed an interest in exploring and incorporating more juicy design elements in their future projects. Almeida plans to employ more juicy elements, but with the intent of serving the story and the data. Sueiro wants to explore 2D or 3D physics or game engines to create interesting things that blend entertainment and information. Tulp noted that the juicy design can be a way to distinguish his work from AI, and that he is interested in finding tools that make it easier to implement those.

Respondents' driving factors for incorporating "juiciness" are motivated by aspects such as enhancing engagement amongst users, serving the story and the data, balancing information and delight, and taking into consideration clients needs and project goals if it is not a personal work. On that, there is an emphasis on using juicy design intentionally, rather than just adding it for its own sake. Almeida believes that the elements have to work cohesively, not just added as an embellishment. Sueiro does not intend to start a project thinking about "juiciness", but as a polishing layer to an existing design.

4.4 Discussion

The present study aims to explore the concept of "juiciness" outside its traditional and most prevalent context—game design. The findings derived from participants' responses align with the related work discussed in the Literature Review section of this study. The discussion on the application and efficacy of "juiciness," which has previously been explored in the context of games, reveals that "juiciness" can be beneficial to the user experience if applied thoughtfully and in moderation (Durmanova, 2022; Kao, 2020). Interviewees in this research agreed that juicy design elements can enhance user experience in interactive infographics; however, they emphasized the importance of balancing these elements to avoid overwhelming the core message of the infographic.

The participants also acknowledged that the application of "juiciness" presents a range of challenges, particularly regarding the risk of overuse, which can diminish the effectiveness of the visualization. The context, target audience, and goals of the visualization must be carefully considered to ensure these elements are used appropriately. Moreover, measuring the success of such designs is complex and requires an equilibrium between engagement metrics and information retention.

The most commonly perceived and used juicy element, both in the participants' own work and the examples they provided, was animation. This observation supports previous research, which also identified animation as one of the most frequently employed techniques in interactive infographics (Campos, 2025).

While it was initially hypothesized that "juiciness" might function as a mere engagement booster, the interviewees acknowledged that juicy elements could indeed contribute to higher levels of user engagement and acceptability. However, they also highlighted that the process of incorporating "juiciness" into their interactive infographic designs can be time-consuming and is not always suitable for all types of audiences or clients. This is particularly true for designers who often rely on coding skills to implement these elements, as the creation of juicy components can be complex, especially when they are unique and tailored to specific visualizations with distinct subject matter. Nonetheless,

all respondents expressed a willingness to incorporate juicy elements into their designs, recognizing their potential benefits.

This study hopes to pave the way for further research into "juiciness" within infographics, data visualizations, and interactive media. Future research could explore specific genres, subjects, mediums, or target audiences, thereby yielding more granular insights. This would enable researchers and practitioners to track the evolution of "juiciness" and interactive infographics alongside technological advancements and the development of new methodologies for their creation.

4.4.1 Limitations

The main limitation of this research lies in the sample size. The participant profile was somewhat specific, focusing on designers who incorporated interactive infographics and/or data visualizations into their practices. When searching for terms like "interactive infographic designers," the results often yielded professionals with interactive design pieces in their portfolios that were not necessarily infographics or data visualizations. A positive strategy was to ask interviewees for recommendations from their own professional networks. However, as mentioned earlier, only 5 out of the 22 professionals contacted responded to the invitation, and all agreed to participate in the interview. A larger sample size could have provided a broader range of responses and impressions.

4.4.2 Suggestions for Future Research

In terms of ethnographic approaches, including interviews or group discussions, future research should aim to engage a larger number of participants, potentially offering compensation to encourage participation. One of the interviewees also suggested conducting a comparative study to assess the impact of incorporating juicy elements, with and without them. This type of testing could provide valuable insights into the effects of "juiciness" on interactive visualizations.

4.5 Conclusion

The responses gathered from the interviews provide key insights into the application of "juiciness" within interactive infographics. According to the interviewees, potential benefits include enhanced engagement, improved content comprehension, and increased memorability. However, drawbacks such as distractions, overstimulation, and an inappropriate tone were also noted.

Applying juicy design presents various challenges, with overuse potentially diminishing the effectiveness of an infographic. It is essential to consider the context, target audience, and goals of the visualization to ensure these elements are used appropriately. Measuring success is complex and requires a balance between engagement and information retention metrics.

While juicy design presents many exciting possibilities for enhancing interactive infographics and data visualizations, it is crucial to approach it thoughtfully and with balance. By carefully considering the context, audience, and purpose of a visualization, designers can use juicy elements to improve user engagement, understanding, and memorability without sacrificing clarity or effectiveness.

In conclusion, while there is optimism that juicy design will become more prominent, its growth will be influenced by practical considerations such as cost, time, and technical complexity. Designers are generally interested in exploring juicy design, but they prefer to do so intentionally and in alignment with the overall goals of their projects. The future of juicy design is likely to involve more frequent use, but with careful consideration and thoughtful integration.

Chapter 5

Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics

Related Work³: Campos, B. (2025). Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics. 11 th International Conference on Signal and Image Processing (SIPRO 2025)

5.1 Chapter Introduction

As seen in the previous chapter, current designers perceive juicy elements as costly and complex to implement. Nevertheless, the incorporation of those elements might be considered if they meaningfully support content transmission. Further investigation is required to determine whether the benefits justify the associated effort.

This chapter takes an experimental stance and compares user reactions to "dry" and "juicy" versions of interactive infographics, presents a comparative study to understand the impacts of Juiciness regarding user engagement and short-term information retention. To do so, it proposes the following research question:

RQ: How does the incorporation of juicy design elements in interactive infographics influence user engagement and information retention compared to dry/regular designs?

To support this research question, the following research objectives and hypothesis are presented:

³ Changes and adaptations were made from the original piece, mainly in terms of literature review, to support reading flow and efficiency by reducing duplication of quotes and references.

Research Objectives:

1. To assess the impact of juicy design elements on user engagement in interactive infographics.
2. To evaluate whether juicy design elements improve the short-term retention of information presented in interactive infographics.

Hypotheses:

H1: Interactive infographics with juicy design elements will result in higher user engagement scores than dry/regular infographics.

H2: Users interacting with juicy infographics will exhibit better short-term information rates retention compared to those interacting with dry/regular infographics.

It is believed that this research can bring contribution to both academic and practical fields. Academically, it proposes a merging of the emerging field of Juiciness with the already widely explored area of interactive infographics and data visualizations. That directly relates to possible contributions for practitioners which could incorporate Juicy elements within their design process and explore their potentialities along with their users.

Before presenting the experiment, it is provided some context with a Literature Review (section 5.2) of contents related to Interactive Infographics, Juiciness and Information Retention. The Methodology (section 5.3) section explains the process of infographics development, clarifying the differences between dry and juicy versions, and an overview of participants and procedures. Then Results (section 5.4) are presented, followed by a Discussion (section 5.5) that elaborates on findings and mentions limitations and suggestions for future research. The chapter closes with a Conclusion (section 5.6), providing final thoughts.

5.2 Literature Review

5.2.1 User Engagement within Interactive Infographics

According to Lalmas (et al, 2015) and O'Brien (et al, 2018), user engagement (UE) is a multifaceted concept that has garnered increasing interest in human-computer interaction (HCI) and various other fields. The authors characterize user engagement as the depth of an actor's investment when interacting with a digital system. It is considered a quality of user experience (UX), focusing on the positive aspects of interacting with an online application and, in particular, the desire to use that application longer and repeatedly (Lalmas et al, 2015). The same author proposes that, in a broad sense, user engagement encompasses a user's emotional connection, mental focus, and active participation with a technology over time, driven by their needs and the qualities of the system.

As previously noted, interactive infographics are defined by their ability to offer users at least one option to modify the form or content of the graphic in real time, allowing for engagement with the information through functional tools available on the interface. These interactive features can significantly impact user engagement in various ways. Media practitioners believe that interactive infographics are effective in attracting audiences' initial attention, as they offer the ability to interact with an image in a playful way, improving users' attention (Greussing and Boomgaarden, 2021; Coelho and Mueller, 2020). Chart animations, which are a form of interactive visualization, are considered an effective means of attracting people's attention and maintaining their engagement (Ge et al, 2020). By allowing users to control the presentation of information, interactive infographics can enhance readers' concentration and motivation to engage with information (Burnett et al, 2019).

Still, it is important to point out that some research suggests potential downsides of incorporating interaction to infographics in relation to engagement. Greussing and Boomgaarden (2021) mention that interactivity can place considerable demands on news consumers' limited cognitive resources, potentially leading users to focus more on the interaction task itself than on the underlying information. The authors say that if an

interactive visualization is considered complex or confusing, users may not be able or willing to thoroughly process all information available and may be distracted from enjoyable consumption. Nevertheless, interactive infographics have the potential to significantly enhance user engagement through their novelty, aesthetic appeal, provision of user control, and ability to convey information in an engaging manner. (Won, 2017)

5.2.2 Juiciness and User Experience

Juicy design significantly affects user experience in various ways, generally aiming to create a more engaging and satisfying interaction. (Hicks et al, 2019) Previous research detail studies investigating how juicy elements impact player perception, engagement, and even physiological responses like attention and disengagement. Developers utilize juiciness to foster a positive emotional response, a feeling of reward and satisfaction, and an overall enjoyment of being within the game world, contributing to creating a more immersive and enjoyable experience for players. (Durmanova, 2022; Atanasov, 2013) Juiciness is considered an "interaction aesthetic" or a positively beautiful quality of interaction at the "motor level", being about the immediate, moment-to-moment feedback loop between player input and game response. (Kao et al, 2024)

Although research has found out that Juiciness overall implies and generates a positive experience within users, the impact of Juiciness on user experience is not always positive. Too much "juiciness" can be overwhelming and may reduce the player's intrinsic motivation to keep playing. (Luz et al, 2024) It can also be irritating to users due to excessive graphics and sound effects. (Kao, 2020) Too little "juiciness" can result in a less engaging and appealing experience. Participants from a study noted that non-juicy versions felt like something was either missing, or incomplete. (Hicks, 2020) Findings from Kao (*et al*, 2024) show evidence of a "Goldilocks effect" - the human tendency to prefer options that are neither too extreme nor too moderate, but fall within an optimal, balanced range. The same authors found that medium and high juiciness conditions outperformed low and extreme juiciness across measures like interest/enjoyment and presence/immersion.

Current research suggests potential regarding the application of Juiciness and its impacts to user experience, but it is not clear whether juiciness impacts information intelligibility and retention.

5.2.3 Information Retention and Interactive Visualizations

Information retention can be defined as the ability to remember or recall information that has been previously presented, often assessed by measures such as accurate recall or recognition of the material. (Savoy et al, 2009; Fischer et al, 2023; Schechinger, 2023) Levels of information retention can be distinguished between long-term retention, referring to the ability to remember information over a more extended period, ranging from days to weeks, months, or even years (O'Day, 2007); and short-term retention, being closely related to working memory, which has a limited capacity, and a short duration, approximately 30 seconds (Zeglen and Rosendale, 2018)

According to Kizilcec (et al, 2014), a common method to verify short-term retention is to administer recall tests very soon after the presentation of information. These can be multiple-choice questions, select-all-that-apply items, open-ended questions for free recall, amongst others. Some of those techniques are applied and further discussed during the methodology section.

Research from Fischer (et al, 2023) and Schechinger (2023) state that information retention is significantly related to visualizations, as they can influence how information is encoded, stored, and retrieved in memory. The authors mention that by presenting quantitative data in visual formats like images, signs, maps, graphs, and charts, communicators can deliver information quickly, helping individuals to encode information more effectively. Visualizations, such as graphics in lectures or data visualizations in infographics, can facilitate the initial encoding of information into working memory (Shepard and Teghtsoonian, 1961; Fischer et al, 2023). By presenting information visually, it can be captured and held in the visual-spatial sketchpad component of working memory, as described by Baddeley's Theory of Working Memory. (Kizilcec et al, 2014) Schechinger (2023) elaborates that visualizations can also play a

role in reducing cognitive load, which is the amount of mental effort required to process information. She also says that infographics, which often incorporate visualizations, can decrease cognitive load, allowing viewers to retain the information presented more easily.

It is important to mention that visualizations aren't always beneficial to information retention. While visualizations can aid encoding, they can also lead to cognitive overload if they are too complex or poorly designed (Kizilcec et al, 2014). If a visualization presents too much information or is difficult to understand, it can exceed the capacity of working memory, hindering short-term retention (Schechinger, 2023).

Notwithstanding, findings from previous research presented above support strong correlations between interactive visualizations and information retention, posing a fertile field to be explored with the addition of juiciness.

5.3 Methodology

This topic presents the methods used for the experiment, which consisted of user testing sessions of 2 variants of interactive infographics with 3 different subjects. At the same time, participants responded to questions that aimed to measure user engagement and information retention levels. The collected data was then analyzed and results are presented in section 4.

5.3.1 Infographics Development Process

A total of 3 infographics, in two variants: dry and juicy versions. The difference between those is that while the juicy version incorporates many layers of feedback (e.g. animations, transitions, sound fx, screen shakes and particles) that are provided from user inputs, dry versions refrain from using any of these, although being still interactive. The infographics were created with the use of 2 softwares: Adobe Illustrator was used for layout organization and visual assets manipulation, and Construct 3 was the chosen

platform to make their interactive versions. The next subtopics provide details about each infographic.

5.3.1.1 Infographic 1: The Daily Routines of Famous Creative People

This infographic ([link](#)) was originally created by Podio.com (2013). Inspired by the book *Daily Rituals* by Alfred A. Knopf from 2013, this interactive infographic (Figure 5.1) displays visual information with bar charts that are colour coded, corresponding to different practices (sleep, creative work, day job/admin, food/leisure, exercise and other) from daily routines of famous creative people. Amongst the names presented are Sigmund Freud, Benjamin Franklin and Pablo Picasso, just to name a few. To interact with it, the user can filter the category they want to display, making it visible or invisible by clicking on the labels at the header. Apart from that, beside each name there's an information icon (i) that displays their occupation along with a brief profile description. Despite its interactivity, the only animated feature is the fact that the bar charts fade in or out when a category is turned on or off.

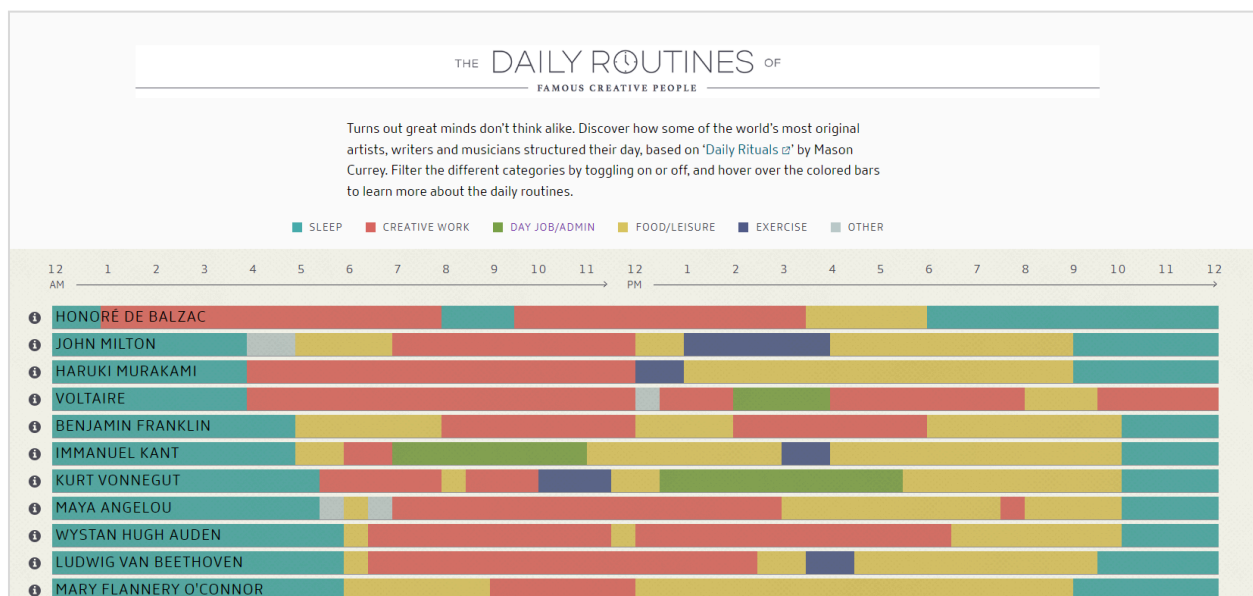


Figure 5.1 The Daily Routines of Famous Creative People - “Dry” version (Podio.com, 2013)

Some changes were applied to develop a juicier version ([link](#)) of the infographic. When loaded, the items subtly fade and move up before landing on their position. The original title had a clock watch merged into the letter “O” from the word Routines, which in the juicy version has spinning pointers. The color squares from the category filters at the top now scale up while hovered with the mouse cursor. If clicked, they spawn some particles. The bar charts now, instead of fading in and out, change their heights with different random timing, the screen shakes, and a sound is played along with it. The information icons (i) also increase while hovered over and the description is displayed with a “scale-up” animation along with a “pop” sound.

5.3.1.2 Infographic 2: Burcalories

Burcalories (Figure 5.2) is an interactive infographic created by the author, inspired by the SkyBurger game (Nimblebit, 2009). It invites the user to pick items, piling them up to build a burger while checking nutritional values, represented by numbers and bar charts.

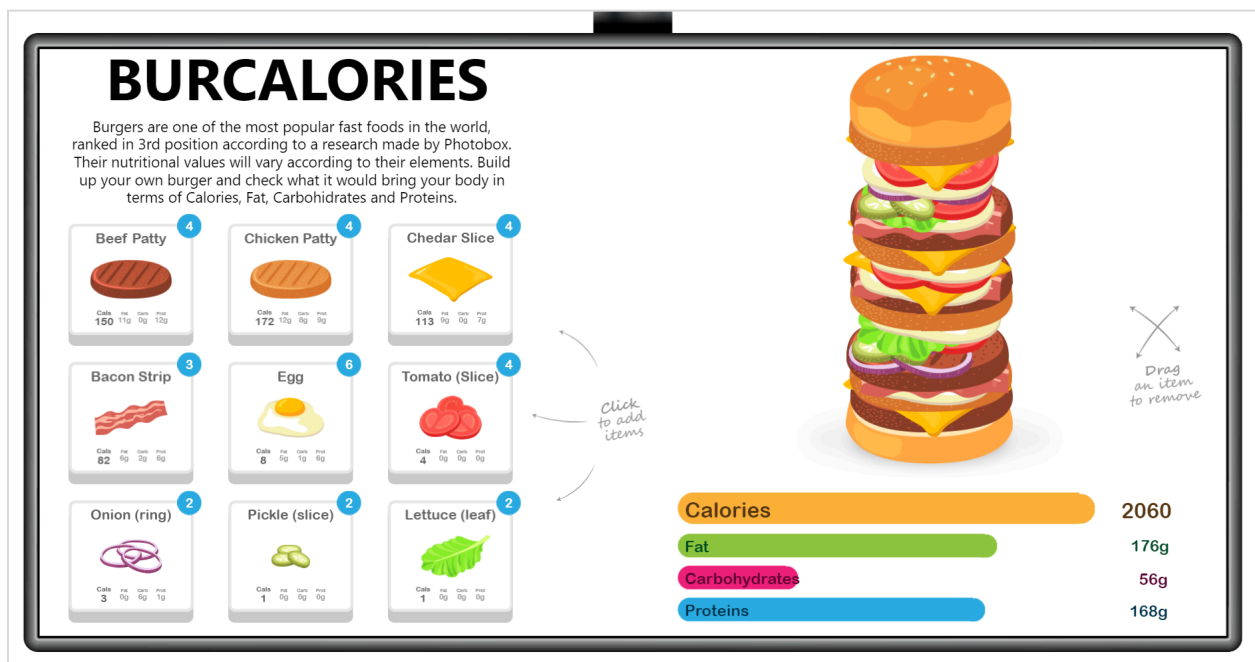


Figure 5.2 Burcalories - “Juicy” version

The dry version ([link](#)) instantly loads, revealing all of its components at once. The user can add burger items by clicking on them, making them spawn on the burger. To remove an item, the user needs to click on the desired one inside the burger. No sounds, animations or other visual effects were applied to this version.

The juicy version ([link](#)) starts with slowly revealing different elements from the infographics that fade in on the screen. The user then needs to pick an item to start building up the burger. When an item button is clicked, a couple of events take place simultaneously: (1) the button simulates the pressing motion by moving down and returning to its default position; (2) the item counter on the top right portion of the item button adds 1 to its value and spawns some particles behind it; (3) the top bun bounces up as it spawns the selected item below; (4) the bar charts will increase their width with visual motion based on the values from the selected items; (5) a “pop” sound is played; (6) a “squish” sound plays when the new items collides with a previously created item. If the user wants to remove items, they drag and drop them from the burger. Items that fall beyond the layout height will be destroyed, changing their amounts and nutrition values on the bar charts. Given the items have a physics behaviour applied to them, as well as collisions are active, there’s a chance that multiple items will fall from the sandwich. That also makes the burger unstable, risking to collapse on its own if too many items are placed.

5.3.1.3 Infographic 3: The Main Chakras

The Main Chakras (Figure 5.3) is an interactive infographic also created by the author. It provides information about the main 7 chakras which refer to energy points in the human body. According to Kundalini yoga tradition, they are thought to be spinning disks of energy that should stay “open” and aligned, as they correspond to bundles of nerves, major organs, and areas of our energetic body that affect our emotional and physical well-being (Google Arts & Culture, 2022).

Different from the previous infographics, where interactions take place into one scene, this piece makes use of 2 different layouts, the first one being an introduction about the

infographic main subject, and the second one breaking down information more specifically related to each chakra. The dry version ([link](#)) has no animation, sound, transitions or any other form of juicy elements applied to it. Clickable elements from the first layout are “begin” and “next” buttons, which allow the user to move to next steps. When the second layout is reached, with an instant frame change, it reveals a silhouette of a meditating individual and different elements that represent the unidentified chakras flashing on the screen, randomly changing their X and Y coordinates, also with randomized timing. When clicked, the chakra is instantly placed into its body location, changing its color. Once the chakras are all set, the user can again on each one of them to get more information that is displayed on the left and right areas of the layout. Users also have access to an information button and a restart button.

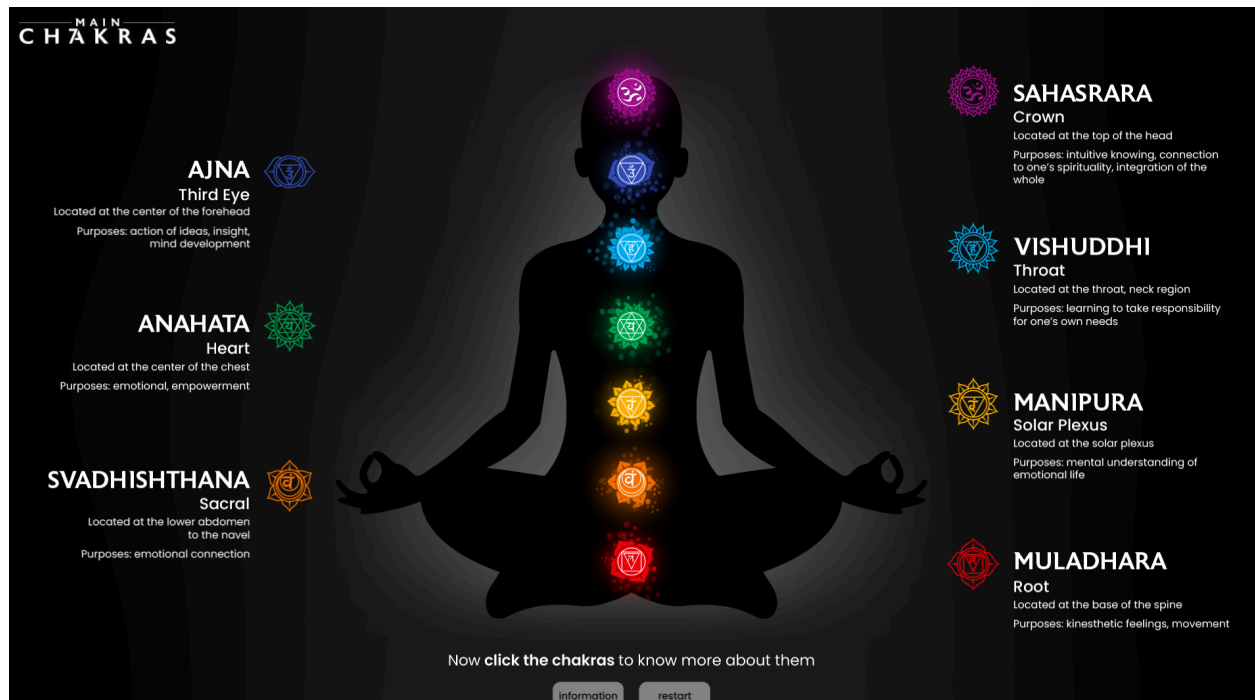


Figure 5.3 The Main Chakras - “Juicy” version

The juicy version ([link](#)) heavily explores juiciness. Almost every element on the screen is in movement (animated), where some elements are both moving and spinning at the same time. Every clickable element when actioned will return multiple feedback. Buttons

from the initial layout are floating up and down, and transitions are always smooth with fade in and outs. The second layout this time slowly reveals its components, one at a time. The unidentified chakras now fly around the screen with smooth random movements, while their decorations spin at the same time. Plus, they spawn a trace of particles at all times. This time, instead of just clicking them, the user has to drag them into their body location, which is indicated by a colored blur. Once in their body location, the user can again click each chakra, which will spawn an outlined copy of it that will move into another location, slowly revealing textual information about them. These texts smoothly move up and down, as well as the meditator silhouette, intending to represent the idea of breathing in meditation practices. Most of the interactions are followed by sound effects.

5.3.2 Participants

Participants for this study come from various backgrounds. They were contacted through multiple channels of contact, mainly via email and WhatsApp, and eventually from word to mouth. Initially, they were informally invited to take part in the research, with a brief explanation. Those who demonstrated interest would share their email address to receive the formal invitation with instructions on how to conduct the test - these will be further explained in the following topic. Data collection took place between March 3rd to 21st, 2025.

5.3.3 Procedures

Once interested individuals provided their email addresses, they received detailed instructions (Appendix B) about how to conduct the test, which was divided in 3 steps, happening twice: (1) interact with a dry version of one infographic via the link provided; (2) evaluate the infographic from the User Engagement Scale (O'Brien *et al*, 2018); and (3) responding to a short quiz about the infographic content. The second part would

consist of the same steps, but this time interacting with a different infographic at its juicy version. Figure 5.4 displays how the distribution was made.

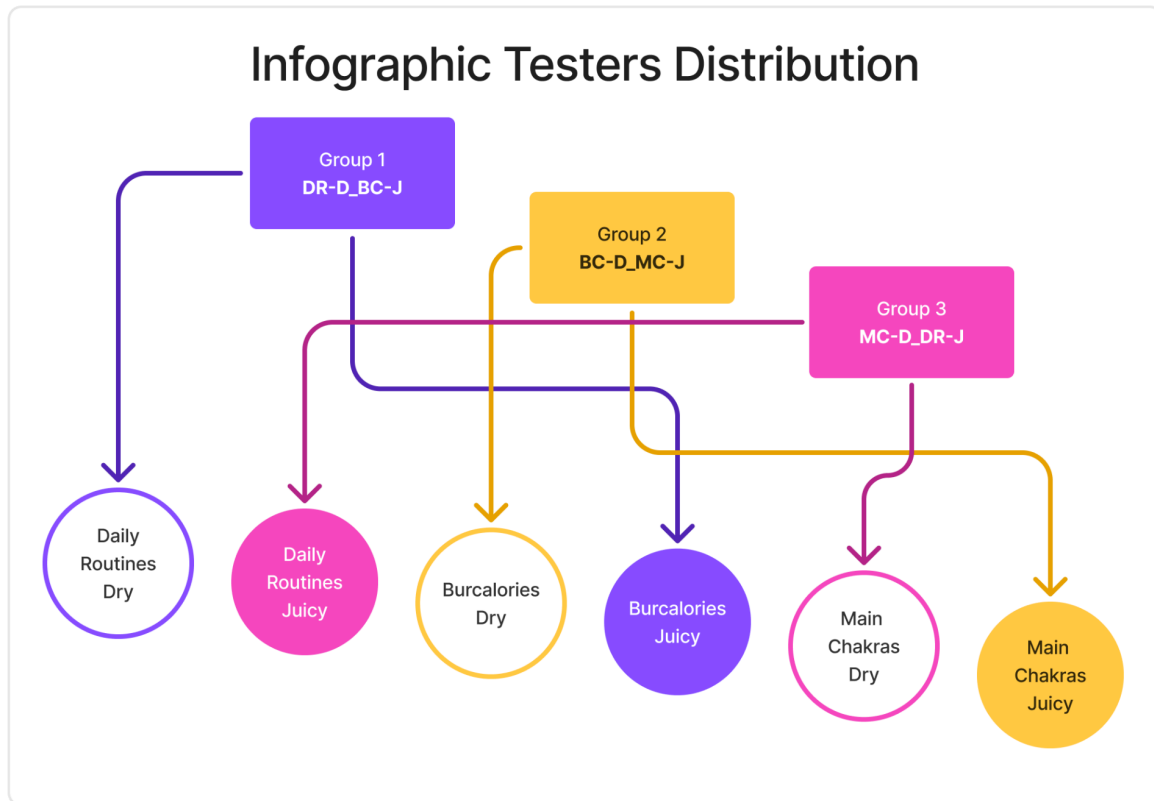


Figure 5.4 Participants distribution (Author, 2025)

Participants were distributed like that for 2 main reasons: (1) they would have a chance to test one dry and one juicy version of infographics; and (2) they were not testing the same infographic twice so they could be tested for information retention with 2 different pieces, allowing for further comparisons once all the tests were completed. Respondents were assigned with unique identifiers based on the infographics they've interacted with.

The User Engagement Scale (UES) and the information retention questionnaires for each infographic were organized into Google forms.

5.3.3.1 User Engagement Scale (UES)

The original UES, proposed by O'Brien (*et al*, 2018) consisted of 31 items aiming to measure six dimensions of engagement:

- **Focused attention (FA)**, which refers to feeling absorbed in the interaction and losing track of time.
- **Perceived usability (PU)**, related to negative affect experienced as a result of the interaction and the degree of control and effort expended.
- **Aesthetic appeal (AE)**, meaning the attractiveness and visual appeal of the interface.
- **Endurability (EN)** or the overall success of the interaction and users' willingness to recommend an application to others or engage with it in future.
- **Novelty (NO)**, curiosity and interest in the interactive task.
- **Felt involvement (FI)**, the sense of being "drawn in "and having fun.

A refined version and a shorter form (UES-SF) have also been developed, grouping items from EN, NO and FI into a Reward Factor (RW). According to the author and their findings, the UES has been used in a range of digital domains (e.g. information search, online news, education, social networking systems, and video games) being its short version an effective tool to be used across various studies.

Being one of the goals of the present study to test if user engagement is affected by Juiciness within interactive infographics, the short-form version of the User Engagement Scale was the chosen tool for doing so. Minor wording adjustments were applied to the form to make it related to infographics. Table 5.1 displays how questions were organized.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
	1	2	3	4	5
FA-S.1	I lost myself in this experience				
FA-S.2	The time I spent using this infographic just slipped away.				
FA-S.3	I was absorbed in this experience.				
PU-S.1	I felt frustrated while using this infographic.				
PU-S.2	I found this infographic confusing to use				
PU-S.3	Using this infographic was difficult				
AE-S.1	This infographic was attractive				
AE-S.2	This infographic was aesthetically appealing				
AE-S.3	This infographic appealed to my senses				
RW-S.1	Using this infographic was worthwhile				
RW-S.2	My experience was rewarding				
RW-S.3	I felt interested in this experience				

Table 5.1 Adaptation of the User Engagement Scale Short Form (O'Brien *et al*, 2018)

There was also an optional open ended question asking respondents if they would like to provide any extra feedback regarding interacting with the infographic.

5.3.3.2 Short-Term Information Retention Questions

To evaluate short-term information retention, participants responded to questions where they were invited to remember their experience with the infographics. According to Kilzicec (*et al*, 2014), a common method to measure short-term retention is to administer recall tests very soon after the presentation of information. For doing so, specific questions were applied for each infographic subject:

- The Daily Routines of Famous Creative People

Q: From memory, name as many daily routines categories as you can (open-ended question)

- Burcalories:

Q1: Which of the following items has the most Carbohydrates? (multiple-choice question)

Q2: Which of the following elements is the most Caloric? (multiple-choice question)

- The Main Chakras:

Q: From memory, name as many chakra body locations as you can. (open-ended question)

Along with those, for all the infographics users were prompted with the following question:

Q: What is your take away from this infographic? Please elaborate your answer with as much detail as you can.

The open-ended responses were organized into documents that were later analyzed to recognize patterns within the answers, as well as to identify repeated terms for providing an overview of the responses from each of the 2 variants of the 3 infographics. The answers of each form were stored in new Google Drive spreadsheets, each one identified according to the respective presentation(MC-J, MC-D, DR-J, DR-D, BC-J and BC-D).

To the open questions "*Would you like to provide any extra feedback*" , "*From memory, name as many daily routines categories as you can*", "*From memory, name as many chakra body locations as you can*" and "*What is your take away from this*

infographic?", Google Notebook LM application was employed and supported counting of occurrences (e.g. chakras body locations, daily routines categories).

The same tool assisted with assessing positive and negative impressions from the respondents, helping to identify patterns and sentiments, both convergent and divergent, in regards to the two versions (dry x juicy) of the infographics. Generated results with the support from the application were compared to the documents that compiled the answers from the user testing sessions and proved to be consistent. Figures 5.5 and 5.6 show screenshots as a sample of the results obtained, which are further discussed in the following section.

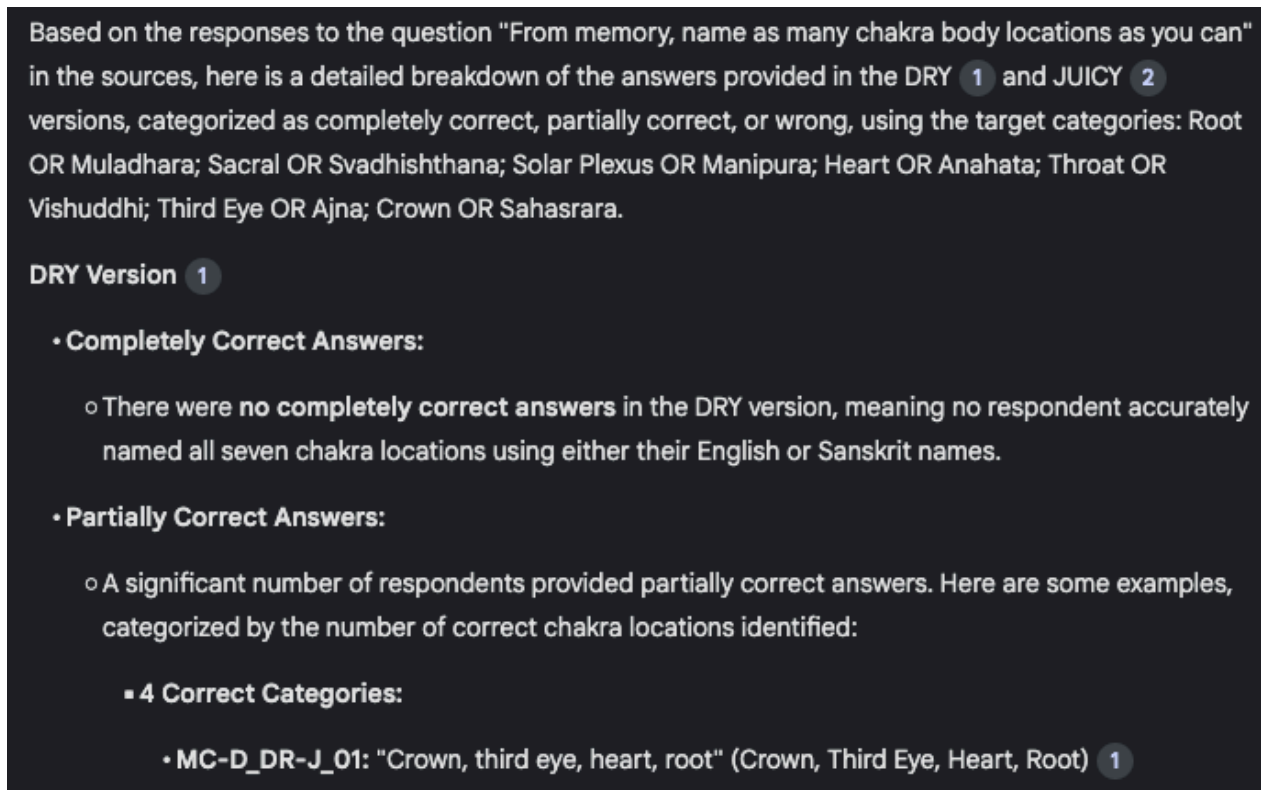


Figure 5.5 Recalling Chakra Locations - Screenshot from Notebook LM

Regarding both versions of **THE MAIN CHAKRAS** infographic, the feedback from the open-ended question reveals several points of comparison in user takeaways.

Overall Positive Takeaways:

Both versions of the infographic successfully introduced the concept of chakras to many respondents and provided them with some basic knowledge about their existence and potential role in the body. Many users, especially those with little to no prior knowledge, found the experience **interesting and informative**.

- From the Dry version, one respondent stated, "I liked to know about the chakras." 1 . Another noted, "I've learned that our bodu has different chackas and point of energy to be explored." 2 . Similarly, a user of the Juicy version said, "It was interesting and informative. I had no information about chakras and was entrained in playing with the symbols while reading the descriptions about each chakra." 3 . Another echoed this, saying, "Interesting information as I did not have previous knowledge about chakras" 3 .

Figure 5.6 Chakra Infographic User Feedback - Screenshot from Notebook LM

5.4 Results

A total of 54 participants voluntarily and anonymously took part in the test. They were equally distributed, where groups of 18 individuals interacted with two infographics each. 108 responses were obtained from the interactions.

The following topics present the overall results.

5.4.1 User Engagement Scale results

When comparing the 2 variants of each infographic, juicy versions display a small advantage in terms of overall engagement, as shown in Figure 5.7.

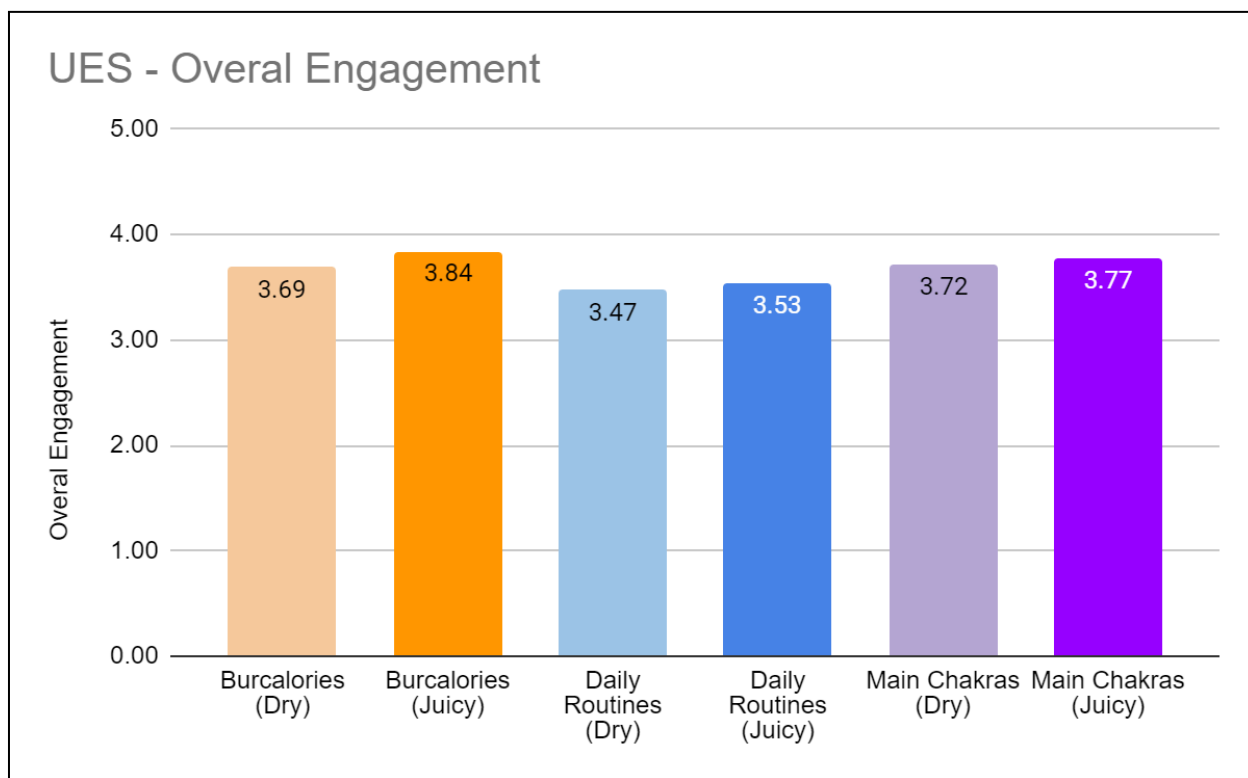


Figure 5.7 UES Overall Engagement results

The juicy version of the Burcalories infographic presented the highest score (3.84 / 5.00), whereas the dry version of The Daily Routines of Famous Creative People has the lowest score (3.47 / 5.00). Still, the score difference between the 2 infographics is only 0.37 points. Burcalories also shows the highest difference comparing its two versions, where the juicy version (3.84) is 0.15 higher than the dry version. The infographic with the smallest difference between the 2 versions was The Main Chakras, with the juicy version being only 0.05 points higher than its dry version.

As previously explained, participants did not access 2 versions of the same infographic. Figure 5.8 shows the comparison results from the infographics that were accessed within the same test process by participants groups. In this case, one juicy infographic - *The Daily Routines of Famous Creative People* - presented a lower engagement level when compared to the dry infographic - *The Main Chakras* - with a difference of 0.19 points.

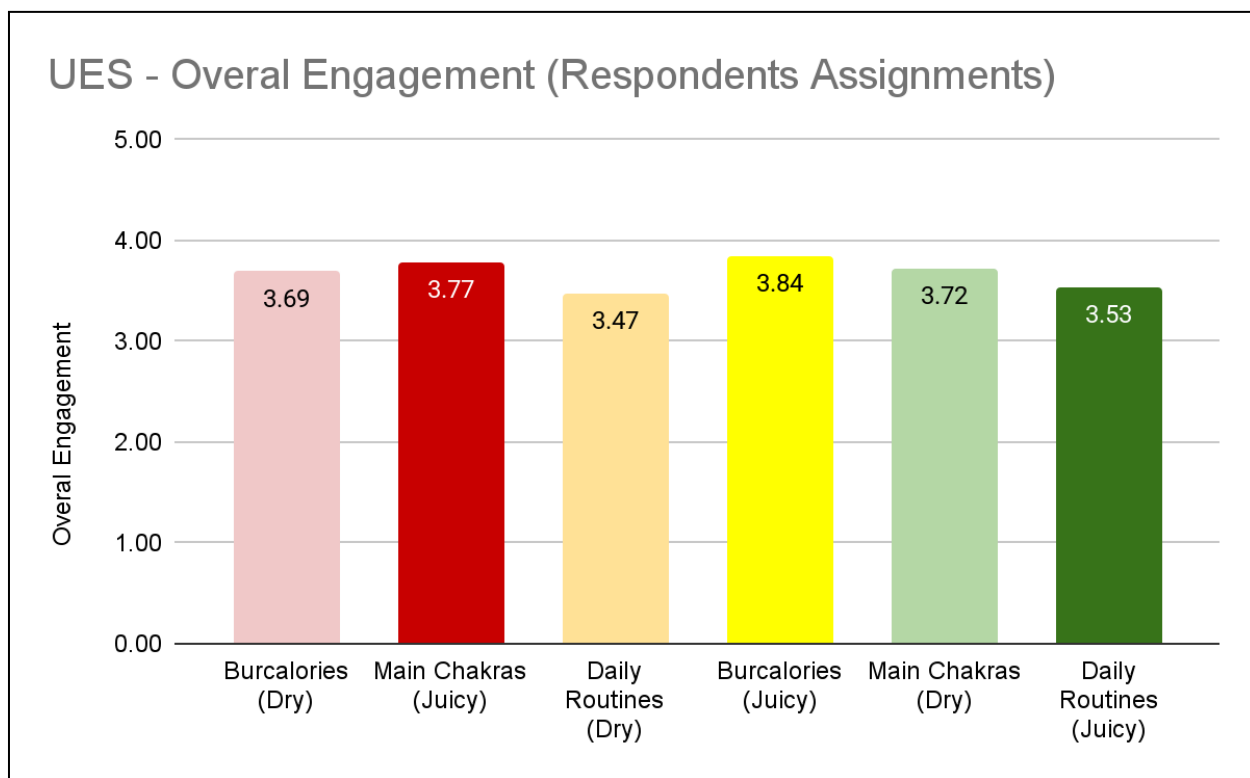


Figure 5.8 UES Overall Engagement results comparing infographics assigned to the same respondents group.

Average scores for each subscale were also calculated. Results (Figure 5.9) are somewhat similar to Overall Engagement.

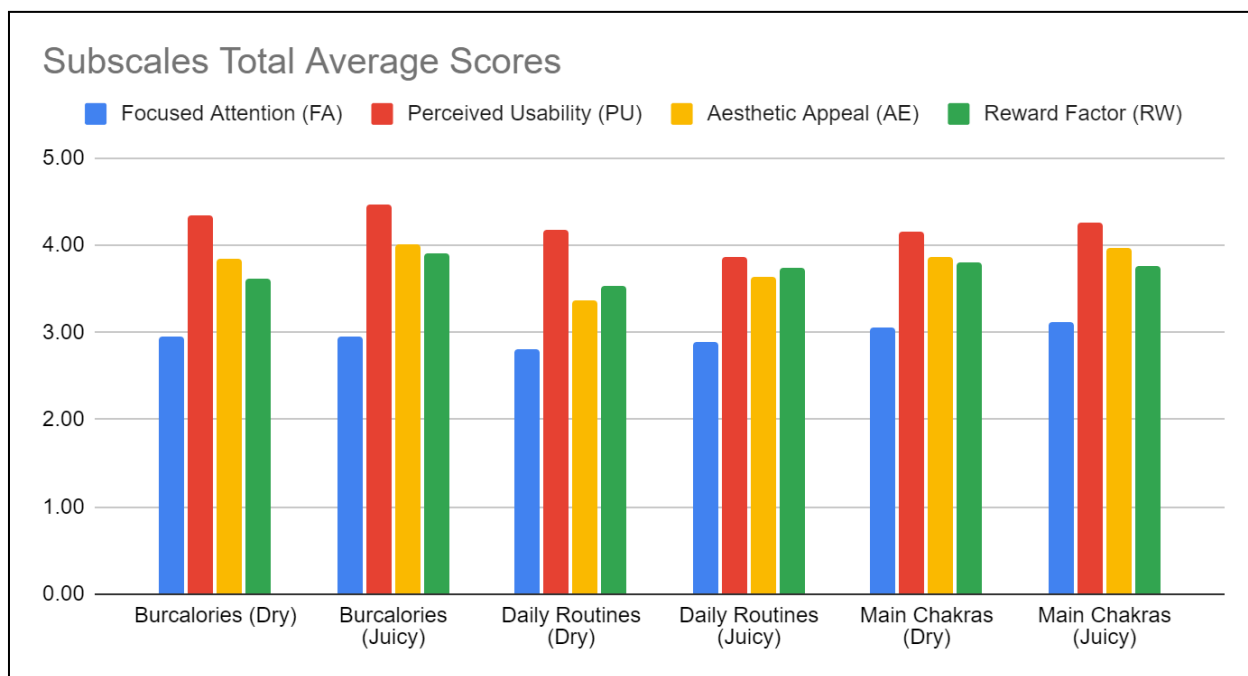


Figure 5.9 UES Subscales Total Average Scores

Subscales results show that Perceived Usability (PU) presents the higher scores amongst the 4 categories, whereas Focused Attention (FA) showed the lowest averages for each infographic.

In two categories, each one from two different infographics, there were examples where dry versions presented higher scores than their juicy counterparts. For Perceived Usability (PU), The Daily Routines of Famous Creative People dry version scored 4.17 versus 3.87 from its juicy version. Reward Factor (RW) was slightly higher for the dry version of The Main Chakras (RW = 3.80) compared to its juicy version (RW = 3.76).

In summary, the total averages do not significantly differ much between dry and juicy versions, nor as well between different infographics.

5.4.2 Feedback and Takeaways

This section condenses the results obtained from 2 questions from forms, (1) the optional open ended question that invited respondents to provide extra feedback and (2) the mandatory question inquired what was the user takeaway from the infographic. Responses demonstrate that, while some users skipped the optional question, they provided some feedback on the mandatory one, which was the last question from the questionnaire. The following topics cover the results for the 2 versions of each infographic.

5.4.2.1 The Daily Routines of Famous Creative People

Both versions of the infographic were generally found to be interesting and informative, sparking curiosity about the daily habits of famous creative individuals. Respondents appreciated the opportunity to learn about these routines and observe potential patterns or the lack thereof. From the Dry version, one respondent stated, "The theme was unexpected and interesting. I enjoyed it..." Similarly, a respondent from the Juicy version mentioned, "These were really interesting curiosities, I loved learning about them."

The interactive nature of both infographics was also seen as a positive aspect by some users, allowing them to engage with the data in a more meaningful way. The ability to filter categories in the Juicy version was particularly well-received by some. A Dry version user commented, "I really enjoyed the interactivity with the infographic, simple and direct, achieving its goal of making data visualization easier for the user.". Regarding the Juicy version, a user said, "The fact I could filter the categories was really attractive to me."

The infographic served as a reminder that there isn't a single "right" way to be creative or successful, as routines varied significantly among the individuals presented. This was a key insight for many respondents. A Dry version user noted, "That creators have different routines, some having a completely opposite routine from regular day-to-day

job routine regular people have." A Juicy version respondent echoed this, stating, "The routine is variable by person, there are no static rules to be creative. It's a matter of finding which routine works better for you."

A significant negative aspect for some users, particularly with the Juicy version, was difficulty in navigating and understanding the infographic. Some found the amount of information overwhelming or the interaction methods unclear. One Dry version user admitted, "I felt completely lost at first but it made sense after a while. However, it has a lot of information, so it was too much for me to absorb it.". A Juicy version respondent stated, "The infographic was difficult to read and to be able to identify each of the data in a simple way, there was a lot of data organized but difficult to differentiate which made it confusing, I could not learn the information, and it was not interactive and that made it a little boring.". Another user also mentioned, "It took me a while to realize that only the Information icon on the left actually contained some interaction and provided extra information. I thought that the bars that defined their daily life were clickable, which made me feel lost on what I was supposed to do.".

Some users in both versions expressed a desire for more context or supporting information, such as the sources of the routine data or potentially pictures of the famous individuals. A Dry version user wondered, "...how do they know these people's routines? Where did this come from? I guess that would have been interesting to add." Another suggested, "It could have a picture of each famous person.".

One specific criticism of the Juicy version was that comparing categories visually was difficult despite the use of different colours. A user commented, "The different colors of the graph was easy to identify the categories but was difficult to compare them. I think with numbers I can visualize more clearly." Furthermore, one user of the Juicy version found the interaction frustrating and difficult to figure out, hindering their ability to learn from the infographic. A respondent said, "It's hard to remember any information on this infographic as I was spending more time trying to figure out how to interact with it. Very frustrating".

5.4.2.2 Burcalories

Both versions of the infographic were generally perceived as interesting and fun ways to learn about the nutritional values of burger ingredients and how they contribute to the overall calorie count and macronutrient breakdown. Respondents from both versions noted that the interactive nature of the tool made it engaging. One comment from a respondent that interacted with the juicy version reads “This infographic was fun! The way the ingredients fall down when you remove them was funny and appealing, like a real life game or toy.” One dry version tester wrote “I found it interesting to visualize the total calories depending on what you included in the burger, and interacting with the ingredients/burger was fun.”

Many users found the infographic helpful for understanding the impact of different ingredients on the nutritional profile of a burger. This led to insights about making more informed food choices and being more aware of calorie intake. A Dry version user noted, "This infographic shows how different ingredients in a burger contribute to my nutritional intake in terms of calories, fat, carbohydrates, and proteins. It allows me to customize a burger and see the impact on my daily food intake." Similarly, a Juicy version user stated "I was able to gather information on how to make healthier food choices."

The visual appeal and ease of use were also highlighted as positive aspects in both versions. For the Dry version, a respondent commented, "The graphic is well-designed, and I appreciate the colors and drawing style. It's very clean and easy to work with...". Regarding the Juicy version, a user said, "It was fun and easy to see how many calories I was adding with each ingredient."

A significant point of concern across both versions was the lack of nutritional information for the bread buns. Respondents felt this was a crucial omission for accurate calorie and nutrient tracking. A Dry version user stated, "I feel like the bread buns should've also had its calories/nutrients tracked." A Juicy version respondent also pointed out, "...it felt really weird that the bread was not counting as any nutritional value, that made it feel wrong."

Another common issue, particularly in the Dry version feedback, was related to the user interface for removing ingredients. Some users found it unintuitive that they had to click directly on the burger to remove items, expecting +/- signs or buttons instead. One Dry version user explained, "I had a bit of difficulty understanding that I should click on the burger directly to remove items - maybe because I am conditioned to the +/- sign near the quantity from other interfaces". Another elaborated, "I also felt these instructions were a little confusing, since I expected that there would be a button to click for removing an item (similar to the button used to add items), instead of directly clicking the item in the burger itself. Clicking the items in the burger to remove them sometimes removed more than one time."

In the Juicy version, some users reported technical issues and interface bugs, such as the carbohydrate count not appearing or issues with items falling and not stopping. One Juicy version user mentioned, "I don't know if it was my mistake, but the carbs never appeared." Another described, "...when I tried to remove the ingredients, the top bread started to fall and come back and it was quite annoying to wait for it to stop falling so I could continue the game (it kept falling maybe 5 times non stop until it stopped)".

Regarding sound feedback, one respondent mentioned they “expected more ‘wow’ when adding/removing ingredients, such as sound effects or smart animations between state changes.” In the same direction, two respondents from the juicy version mentioned “I liked the ‘pop’ sounds” and “the sound effects made me laugh”.

In summary, both the Dry and Juicy versions of the Burcalories infographic were appreciated for their interactive and educational aspects. However, the Juicy version leaned towards a more entertaining experience with its animations and sounds, while also facing technical issues. The Dry version was considered functional but less exciting, with interface intuitiveness being a key area for improvement, alongside the crucial need to include the nutritional value of the bread in both versions.

5.4.2.3 The Main Chakras

Both versions of the infographic successfully introduced the concept of chakras to many respondents and provided them with some basic knowledge about their existence and potential role in the body. Many users, especially those with little to no prior knowledge, found the experience interesting and informative. From the Dry version, one respondent stated, "I liked to know about the chakras." Similarly, a user of the Juicy version said, "It was interesting and informative. I had no information about chakras and was entrained in playing with the symbols while reading the descriptions about each chakra.". Another went in the same direction, saying, "Interesting information as I did not have previous knowledge about chakras".

Both infographics also sparked curiosity and motivated some users to want to learn more about the subject. A respondent from the Dry version mentioned, "the interactive experience brought a lot of curiosity to find out more about each element.". Another stated, "this infographic caught my attention. It was interesting to know the Chakras' positions, and know that it is related to different human feelings, actions and health. I will do research on that and bring it to my personal life.". For the Juicy version, a user commented, "It felt very exploratory and built my curiosity - making me wonder what would happen after I drag each symbol to the corresponding body part.", and another said "the visual made me want to know more about the chakras."

Despite the positive aspects, both versions also received criticism. A recurring issue in the Juicy version was the interaction involving moving chakras, which some users found frustrating or distracting. One Juicy version respondent mentioned, "Having to 'chase' the white images to place them was not very fun, in my opinion.", and another stated, "Sometimes I had to chase the little spinning chakras around to catch and move them". Furthermore, the amount of movement in the Juicy version, such as the circular movements while reading, was considered "a bit too much" by some.

The Dry version's initial moving elements also caused some confusion. One user reported, "but at the beginning with all of them moving I did not know what to do.". Additionally, one respondent found the Dry version failed to promote user engagement

due to a lack of interest in the subject, a black background, and a lack of visual feedback on clicks, leading to frustration.

Some users in both versions felt that the infographics could have provided more in-depth explanations. A Dry version respondent suggested, "There could have been more explanations about this and more movement, which would have been more illustrative and eye-catching to remain in the memory.". A Juicy version user felt the experience was "really superficial" and another wished to know "more about how to increase the ways I engage with each of these chakras to better find balance."

Finally, some users in the Juicy version found the number of interactions and animations excessive, making the experience feel slow and drawn out. One Juicy version user stated, "I believe that the infographic, while visually appealing, requires too many interactions to access all the information, which seems pointless and makes the experience drag on too long, with considerable time spent just waiting for animations to finish.".

5.4.3 Information retention results

5.4.3.1 The Daily Routines of Famous Creative People

For this infographic, participants were asked to recall as many content categories as they could from memory. The 6 correct categories were: Sleep, Creative Work, Day Job/Admin, Food/Leisure, Exercise, and Other. The results (Table 5.2) provide a comparative overview of how each version may have supported participants' ability to absorb and remember structured information.

Metric	Dry Version	Juicy Version
Average Recall	4.06	4.17
Perfect Recalls (6/6)	2	4
Recalls (5/6)	3	6
Recalls (4/6)	7	3
Recalls (3/6)	1	1
Recalls (2/6)	1	1
Recalls (1/6)	1	2
Most Recalled Category	Sleep (16)	Sleep (17)
Least Recalled Category	Other (6)	Other (7)

Table 5.2 The Daily Routines of Famous Creative People Infographic: Information Retention Comparison Dry x Juicy

The Juicy version demonstrated a marginally higher average recall (4.17 categories) compared to the Dry version (4.06). Furthermore, the Juicy version yielded more participants achieving full recall of all six categories. Table 2 demonstrates the differences in recall distribution, with the Juicy version showing more respondents recalling five or six categories, suggesting a potential impact of Juicy Design on overall cognitive engagement and memory encoding.

These findings indicate a modest but observable advantage in information retention for the Juicy version of the infographic. While the differences in average recall were not dramatic, the Juicy version supported more complete recall and reduced confusion or misinterpretation.

5.4.3.2 Burcalories

Answer choices from the 2 multiple choice questions differ between versions. For the first question, which asked users to select the item richer in carbohydrates, the dry version collected 12 correct answers, whereas the juicy version got 7 correct responses (Figure 5.10).

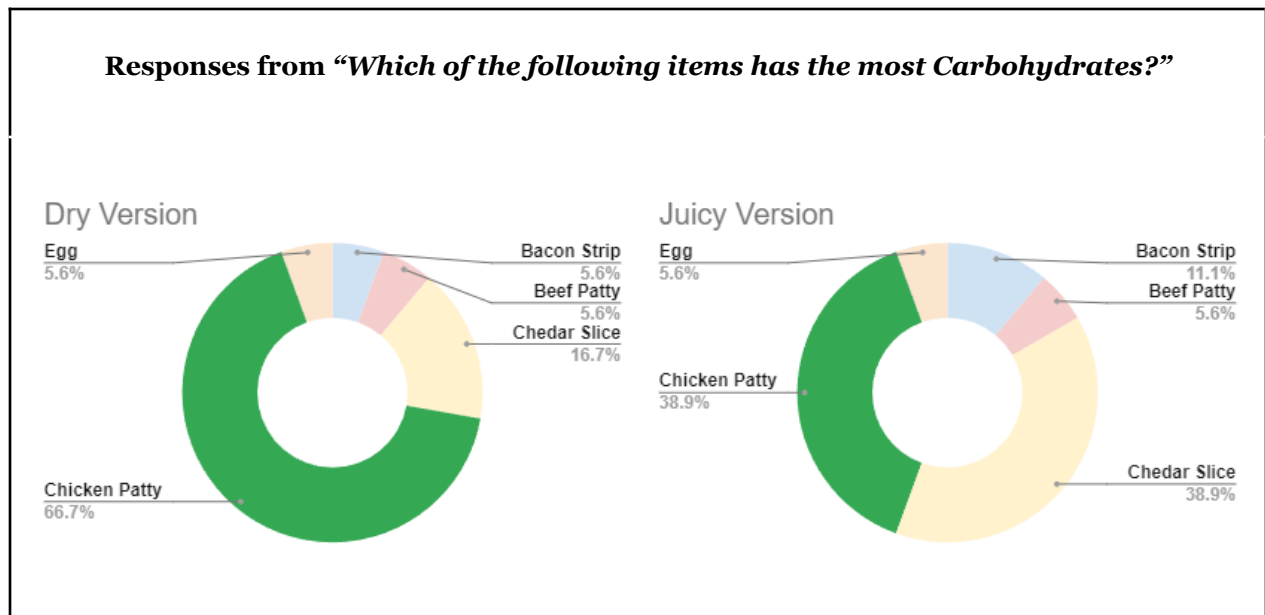


Figure 5.10 Responses comparison from Burcalories infographics multiple choice question 1
(Author, 2025)

Question 2 inquired about the most caloric item, and the results from each version are even more distinguished: 8 correct answers for the dry version and just 1 correct answer on the juicy version (Figure 5.11).

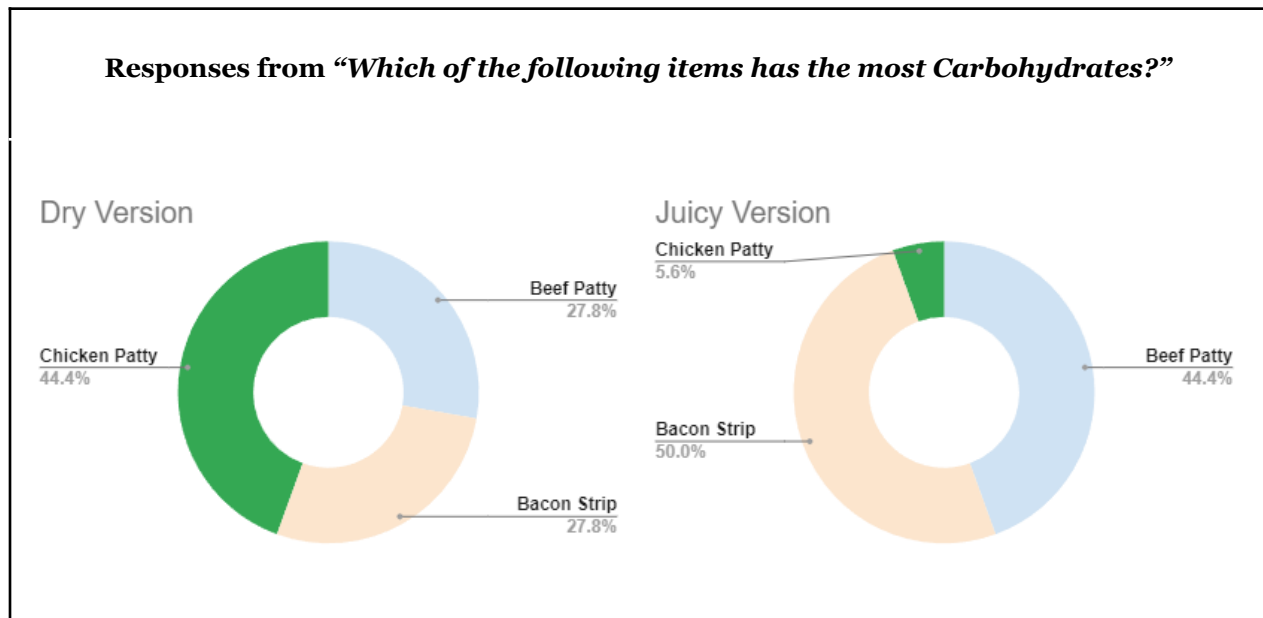


Figure 5.11 Responses comparison from Burcalories infographics multiple choice question 2
(Author, 2025)

The correct choice for both questions was the “Chicken Patty” item, and its nutritional values were available within the button used to place that item into the burger. At the same time, by adding the Chicken Patty item to the burger, the bar graphs would stretch longer than when other items were placed.

Despite the fact the Dry version collected a higher number of correct answers, in both versions it is unclear if that information was obtained based on the data displayed within the infographic or if the respondent trusted their own senses to select an option.

5.4.3.3 The Main Chakras

Similarly to the analysis conducted for The Daily Routines of Famous Creative People infographics, participants were asked to recall and name as many chakra body locations as they could from memory. The responses were then coded and quantified based on the correct recognition of the seven standard chakra positions: Crown (Sahasrara), Third Eye (Ajna), Throat (Vishuddhi), Heart (Anahata), Solar Plexus (Manipura), Sacral (Svadhishthana), and Root (Muladhara). The goal was to evaluate how design differences influence the quantity and distribution of recalled information. Table 5.3 presents the results.

Metric	Dry Version	Juicy Version
Avg. correct chakra locations recalled	3.78	4.61
Mode (most frequent score)	6 (4 participants)	6 (6 participants)
Participants with 0 correct	3	1
Participants with 7 correct	3	2
Participants recalling 5+ chakras	8	10
Most Recalled Chakra	Heart (Anahata) – 14 mentions	Heart (Anahata) – 17 mentions
Least Recalled Category	Sacral (Svadhishthana) – 7 mentions	Root (Muladhara) – 9 mentions

Table 5.3 The Main Chakras: Information Retention Comparison Dry x Juicy

The results show a subtle yet meaningful difference in retention outcomes between the two versions of the Chakras infographic. While the Dry version had slightly more top scorers (7 out of 7), the Juicy version produced a broader concentration of high scorers, especially among those recalling 5 or 6 chakras. These findings suggest that a Juicy design may facilitate better average recall and reduce the number of participants who

forget most of the content. The richer visual cues and interactions of the Juicy version appear to offer more anchors for memory, reinforcing the hypothesis that juiciness positively influences information retention in interactive infographics.

5.5 Discussion

The feedback gathered from the two versions of the interactive infographics revealed a clear tension between engagement and cognitive load. While the Juicy versions of the infographics were often praised for their entertaining and emotionally engaging elements (such as animations and sound effects), several users reported experiencing frustration due to excessive or unclear interactions. For instance, in the Burcalories infographic, the interactive animations, such as the falling burger ingredients, were considered fun by some users, but they also led to unnecessary delays in information processing. Similarly, in the Chakras infographic, users were distracted by the spinning chakras, which they found difficult to move and follow, thus impairing their ability to absorb the educational content. On the other hand, Dry versions were typically more straightforward, enabling easier navigation and clearer data visualization, but they were also seen as less engaging and, at times, superficial.

Results from the User Engagement Scale (UES) shows that the differences in Overall Engagement and subscale scores between the Dry and Juicy versions were relatively small across the various infographics. While Juicy versions demonstrated a slight edge in overall engagement, the Dry versions often scored higher in specific categories such as Perceived Usability and Reward Factor. These results suggest that while juicy elements like interactivity and animation may increase emotional appeal and engagement, they are not always critical to user satisfaction or information retention. This may imply that the design of an interactive infographic should prioritize clarity and usability over novelty or visual complexity, particularly when the subject matter is new to the user.

Interactivity, particularly the ability to filter, move elements, or visualize data dynamically, was a positive feature in both the Juicy and Dry versions. In the Daily

Routines and Burcalories infographics, users appreciated the ability to customize their interaction, either by filtering categories or by seeing how ingredients affected nutritional values. This level of control over the experience fostered a sense of agency and personalization, which helped users feel more invested in the information being presented. However, for some users in the Juicy versions, the interactivity was not always intuitive, which led to confusion and frustration. A key example of this was in the Chakras infographic, where some users struggled with the interaction of moving chakras to their corresponding body parts, which detracted from their overall experience. These results underscore the importance of ensuring that interactive features are not only engaging but also intuitive and aligned with user expectations.

The emotional appeal of interactive infographics was notably enhanced by the Juicy elements, which incorporated animations and sound effects. For example, users enjoyed the sound effects in the Burcalories infographic, with some mentioning how the "pop" sounds made the interaction more fun and engaging. Such features contributed to an overall positive emotional response, making the learning process more enjoyable. However, while these elements increased engagement, they did not always contribute to information retention, as seen in the feedback about the Juicy version of the Daily Routines infographic. A number of users reported feeling overwhelmed by the amount of data and the difficulty of navigating through the interactive layers. This raises an important point: emotional design elements must support the learning objective and not merely serve as decorative features.

Regarding information retention, the Juicy versions of the infographics generally showed a modest improvement, particularly in average recall and the number of participants achieving complete recall. The Juicy design's interactive elements and richer visual cues appear to support better memory encoding and retrieval, leading to slightly improved recall rates across different types of content. However, the differences between Dry and Juicy versions were not always dramatic, suggesting that while interactivity and visual richness enhance retention, the content type and cognitive engagement also play significant roles in determining the success of information retention in interactive infographics.

5.6 Conclusion

The present study proposed a comparison between juicy and dry versions of 3 infographics to verify how they would perform in terms of user engagement and information retention levels amongst users. Even though with minor differences, results demonstrate that both proposed hypotheses are partially confirmed. H1: Interactive infographics with juicy design elements will result in higher user engagement scores than dry/regular infographics was identified for all the infographics, while H2: Users interacting with juicy infographics will exhibit better short-term information rates retention compared to those interacting with dry/regular infographics applies to The Daily Routines of Famous Creative People and The Main Chakras.

As previously demonstrated by other research (Durmanova, 2022; Singhal and Schneider, 2021; Kao, 2020; Hicks, 2020), this study findings suggest that juiciness can significantly enhance user experience by making interactions more enjoyable, immersive, and aesthetically pleasing. However, the key lies in thoughtful design and moderation. Designers need to carefully consider the context and the amount of "juiciness" to apply, as both insufficient and excessive feedback can negatively impact the user's overall experience. When implemented well, "juiciness" can be a powerful tool for creating positive and engaging user experiences across a wide range of applications.

Future studies could incorporate more robust software for visual content creation, such as Unity and Unreal Engine, offering the possibility to create 3D assets and more complex coding, verifying if different visual styles offer similar or distinguished results. It is also suggested that future studies compare different versions of the same infographic, with various levels of juiciness, with the same testers trying all of those variants, in order to gather impressions from different versions with the same subject and content. That could lead to opportunities to identify optimal levels of juicy design for interactive infographics.

Chapter 6

Conclusions

This chapter presents an overview of the main findings obtained from this thesis, organized into subtopics, providing summaries from findings of chapters 3 to 5.

Finally, it closes with a conclusion and suggestions for future works.

6.1 Findings Overview

This topic offers a summary of the main findings from works presented on Chapters 3 to 5.

6.1.1 Assessing Juicy Elements In Interactive Infographics

[Chapter 3](#) looked for the presence of juiciness - more specific into the juicy elements of animation, particles, audio feedback, screen shake and persistence - on interactive infographics that are freely accessible online. A total of 195 infographics were analyzed, resulting in the following main findings:

1. Animation was the most frequent juicy element encountered from the study sample, present in 73,85% of the analyzed infographics.
2. In terms of the number of juicy elements used, the majority of infographics (n=95) incorporated just one element. Not a single infographic incorporated all the 5 elements within their composition.
3. Two visualizations - Optikammer by Team Optikammer (2016) and Seeing CO₂ by Extraordinary Facility (2021) - incorporate 4 juicy elements. Both of them offer real-time control, which is one of the core characteristics of game feel (Swink,

2008). This game-like/playable proposal offered a more fruitful environment for the presence of a larger amount of juicy elements.

Table 6.1 presents the primary components, often derived from game design, that contribute to the "juicy" effect.

Juicy Element	Design Suggestion and Description
Animation	Use dynamic or moving elements employing frame transitions to create the illusion of motion. This is the most frequently used element in interactive visualizations
Particles	Incorporate small visual units that respond to events, such as tiny dots reacting to user input, often representing data quantities. Particles should typically be paired with animation to enhance the visual experience.
Audio Feedback	Integrate sounds (music or sound effects) that directly respond to user actions (e.g., a "pop" sound or "crash" sound). Sound effects can enhance immersion and enjoyment.
Persistence	Include visual traces left by events that occur during interaction, which can be permanent or temporary. Examples include lasting changes (like a wall crack) or temporary effects (like lines fading out).
Screen Shake	Implement the movement of the entire screen and its visual elements as an additional layer of feedback. This can be used to reinforce the effect of physical actions, such as something dropping.

Table 6.1 Core Juicy Elements (What to Incorporate)

These findings suggest that juiciness does not require a uniform or exhaustive application of all juicy elements. Instead, juiciness should be strategically integrated and thoughtfully applied in order to create a highly engaging experience for users.

6.1.2 Juiciness and Interactive Infographics: An Ethnographic Perspective

[Chapter 4](#) proposed an ethnographic perspective by interviewing interactive

visualization practitioners, inquiring them about their knowledge, perceptions and impressions of juiciness applied to interactive infographics.

Interestingly, as listed in the findings from Chapter 3, the most commonly perceived and used juicy element, both in the participants' own work and the examples they provided, was animation.

The participants acknowledged that the application of juiciness presents a range of challenges. Responses indicate that the process of incorporating "juiciness" into their interactive infographic designs can be time-consuming and is not always suitable for all types of audiences or clients. They also warn about the risk of overuse, which can diminish the effectiveness of the visualization. Aspects such as context, target audience, and goals of the visualization must be carefully considered to ensure the proper application of Juiciness. The effectiveness of juiciness depends less on the quantity of elements and more on their thoughtful integration, as shown below (Table 6.2).

Guideline Focus	Design Suggestions / Rationale
Prioritize Purpose	Ensure every juicy element serves a functional purpose that enhances the reader's understanding of the information. Aesthetics should support functional clarity, not exist merely as decoration.
Enhance Continuity	Use animation to enhance the sense of continuity within the data visualization. It can also help reduce friction and make data visualization easier to understand.
Promote Engagement	Integrate elements to delight the user and make the interaction rewarding. Juicy elements can incite feelings like excitement, curiosity, and competence.
Ensure Intuitive Interaction	Interactive features must be intuitive and align with user expectations to avoid confusion and frustration. Ensure the interactions are smooth and seamless.
Embrace Game-Like Controls	For richer experiences, explore incorporating features that offer real-time control and keyboard inputs, akin to gameplay, which facilitates a higher amount of juicy elements.

Table 6.2 Strategic Application and Best Practices (How to Implement Juiciness)

Still, in alignment with previous research about juiciness, study respondents agreed that juicy design elements can enhance user experience in interactive infographics; nonetheless, they focus attention on the importance of balancing these elements to avoid overwhelming the core message of the infographic.

6.1.3 Juicy or Dry? A Comparative Study of User Engagement and Information Retention in Interactive Infographics

[Chapter 5](#) presented a comparative study of interactive infographics designed into juicy and dry versions, aiming to verify if juiciness positively affects user engagement and information retention when incorporated into interactive visualizations. Results provide the following main findings:

1. While the Juicy versions of the infographics were often praised for their entertaining and emotionally engaging elements (such as animations and sound effects), several users reported experiencing frustration due to excessive or unclear interactions.
2. For the User Engagement Scale (UES), juicy versions of each infographic presented higher scores, although with very minimal difference between higher and lower values. Therefore, the hypothesis that juicy infographics would provide higher user engagement is numerically confirmed, but can still be considered inconclusive taking into account the minimal difference between scores and the participants sample size (n=54 divided into 3 test groups).
3. In terms of information retention, 2 infographics out of the 3 used showed better results with juicy versions. That makes the hypothesis that juiciness would increase levels of information retention partially confirmed.

Similarly to Chapters 3 and 4, findings from Chapter 5 suggest that juiciness can enhance user experience. Still, designers need to carefully consider the context and the amount of "juiciness" to apply (Table 6.3), to create positive and engaging user

experiences across a wide range of applications.

Area of Concern	Warning and Contextual Constraint
Avoid Overwhelming the User	Too much "juiciness" can be overwhelming, reducing engagement and intrinsic motivation. It risks staggering the user with excessive interaction and feedback.
Minimize Distraction	Avoid implementation that causes users to click around just for fun, disregarding the main content or message. Overdoing elements could hide the information being conveyed.
Mind Cognitive Load	Excessive interactivity can place considerable demands on limited cognitive resources, potentially leading users to focus on the interaction task rather than the underlying information.
Consider Subject Seriousness	Juiciness is generally less suited for heavy or sensitive topics (e.g., war, death) that require a more serious tone. The tone of the juiciness must align with the tone of the subject matter.
Be Prepared for Costs	Incorporating rich juicy elements demands more time and coding skills. Custom solutions are often required, as standard software may not support juicy design out-of-the-box.

Table 6.3 Contextual Warnings and Limitations (What to Avoid)

6.2 Conclusions

This thesis proposed the merging of two concepts - Interactive Infographics and Juiciness - that share similarities and were believed to offer opportunities to become complementary with expected positive outcomes.

The studies presented in Chapter 3, 4 and 5 were performed in reality in the same order they are presented. The intention was to (1) initially identify the presence of juiciness within infographics; then (2) analyze if this concept was understood and would/could be incorporated by designers, along with their perceptions about it; and finally (3) verify how users would respond to juiciness actually incorporated into interactive infographics. This sequence allowed a progression between works, where the next would use findings from the previous ones.

The findings uncovered here indicate that juicy elements have been used within interactive infographics for a while, likely with the intention to support higher levels of engagement and improvements in terms of information transmission. In spite of that, “juicy elements” or “juiciness” don’t seem to be terms yet used within the conception of interactive visualizations.

Interactive infographics’ designers identified benefits of incorporating those features, stressing out that they should serve a purpose, especially considering that their application might be more complex and time-consuming if compared to static or non-jucy visual pieces.

This corroborates and can be perceived with the approaches taken when infographics for the study presented in Chapter 5 were developed. The juicy versions of Burcalories and The Main Chakras infographics used 70% more lines of code when compared to their dry counterpart. That demonstrates that including juicy elements such as animations, particles, physics and sound effects, demand more from creators and the system.

There are clear differences between games—the medium in which juiciness as a concept was developed—and interactive infographics when it comes to business models, audiences, duration of engagement, and team sizes. For example, while games often take longer periods and larger development teams to be conceived, interactive infographics sometimes need to be created within hours of a breaking event, such as a natural disaster, by a much smaller group. These differences significantly influence the application of juiciness. Findings from this research indicate that while juiciness has the potential to enhance user engagement and information retention, its integration in interactive infographics is often constrained by time, resources, and audience-specific considerations.

For instance, the results in Chapter 3 show that most interactive infographics incorporate only one juicy element, with animation being the most prevalent. This aligns with the practical challenges indicated by designers in Chapter 4, who described the incorporation of juiciness as time-consuming and context-sensitive. Moreover, the comparative study in Chapter 5 demonstrated that while juicy versions of infographics

were engaging and supported information retention in certain cases, excessive or unclear interactions sometimes led to user frustration. These findings emphasize the need for a strategic and context-related application of juiciness in interactive infographics, particularly given the rapid production cycles and smaller teams often involved.

On the other hand, the parallels between games and interactive infographics suggest opportunities for knowledge transfer. For example, the inclusion of game-like features such as real-time control, observed in highly juicy infographics, demonstrates how principles from game design can enrich infographic design when resources and timelines permit. This highlights the importance of balancing creative goals with practical constraints to maximize the benefits of juiciness across diverse contexts.

Finally, it is believed that the main finding from the results and discussions in all of the chapters was the idea of a thoughtful, meaningful, well planned and structured incorporation of juiciness into interactive infographics. Juicy elements should serve a purpose within the infographic subject matter, adding extra layers of relevant feedback that can reinforce concepts and information. The same way visual elements such as colors, typography, textures, imagery and icons, to name a few, are not randomly placed within visual compositions, instead responding to aspects related to branding, target audience and user needs, those should also be considered for the incorporation of juicy elements.

6.2.1 Future Work

It remains unclear to what extent interactive infographic readers would benefit from the incorporation of Juiciness. Considering the many factors involved during ideation and development process (i.e. medium, target audience, format, budget, timeframes), interactive visualization designers could establish which juicy elements could be incorporated and how “juicy” the interactions should be. At the same time, the main subject of the infographic plays a determinant role regarding how juicy it would be: the tone used to list and display the greatest achievements by humans in sports is not likely

to be similar when describing and narrating a catastrophe that resulted in the loss of human lives. That poses questions that might be considered for future work: can Juiciness be adjusted to the seriousness of a subject? If Juiciness is employed to more sensitive content, would it be perceived as being disrespectful to the subject or could it work in favour of promoting the distribution and eventual virality of an important matter, enlightening the topic?

Results show potential for further experiments. It is suggested that future work could explore optimal levels of Juiciness for interactive infographics, comparing quantities of juicy elements and juicy intensity (low, medium, high). Those could be tested with different audiences and subjects.

Although evidence and findings from previous studies indicate that the concept of Microinteractions and Juiciness share common intentions, especially when it comes to promoting user engagement, there's a lack of studies that actually make a comparison between the 2 concepts. An article posted on Medium titled “Juicy UI: Why the Smallest Interactions Make the Biggest Difference” by Mezo Istvan (2025) suggests the concept of a “juicy user interface” (or “juicy UI”). The author states that a juicy UI provides abundant, often delightful feedback to user interactions - more than strictly necessary - making digital experiences feel rewarding, playful and alive. It is suggested that future studies could provide a formal framework to compare differences, similarities and points of convergence between Juiciness and Microinteractions.

During this research, a gap has been identified regarding studying and analyzing the presence of Juiciness within Serious Games, with current work focusing on the presence of Visual Embellishments, showing some positive results regarding their incorporation (Vanden Abeele *et al*, 2015).

One limitation was identified in the study presented in Chapter 5, as many participants pointed out that they would prefer being able to participate using their mobile phones, given the lack of time availability. This can be also seen as an opportunity, where it encourages future studies to explore interactive infographics incorporating juiciness specifically designed for mobile devices.

These suggestions, along with previous reflections from this thesis, might serve as a guide for more assertive considerations on the application of juiciness, always with the aim to promote positive and engaging experiences for users.

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Appendix

Appendix A

Interview Questions Base Document

INTERVIEWEE: <Interviewee Name>

Date: <DD/MM/YYYY>

1. Personal Introduction

- a. How did you get into interactive infographics / data visualization? How long have you been doing this?

2. Introduction to/Familiarity with Juicy Design:

- a. Are you familiar with the concept of Juicy Design?
 - i. If **NO**: show a visual example (<https://www.pogo.com/games/peggle-blast/play>) of a juicy visualization and then...
 1. A definitions of Juiciness/Juicy Design:
"Juiciness/Juicy Design refers to the use of visually and interactively rich feedback to enhance user engagement, satisfaction, and responsiveness, employing elements like animations, sounds, and transitions to create rewarding and immersive interactions."
 - ii. If **YES**: how would you define it in the context of interactive infographics?
- b. Have you encountered or applied Juicy Design principles in your work? If so, could you provide examples? (ask for links)

3. Perceptions of Juicy Design in Interactive Infographics:

- a. Do you think Juicy Design elements (such as animations, feedback, sound effects) can/could enhance the user experience of interactive infographics? Why or why not?
- b. In your experience, do you find Juicy Design elements to be distracting or beneficial in conveying information effectively within infographics?

4. Challenges and Limitations:

- a. What challenges do you see in applying Juicy Design to interactive infographics?
- b. How might overuse of Juicy Design elements impact usability or the effectiveness of the infographic?
 - i. Are you able to measure an infographic success in terms of engagement and effectiveness?
- c. In your view, are there specific types of information or audiences where Juicy Design might be particularly effective or ineffective?

5. Impact and Value:

- a. Do you believe Juicy Design contributes to user engagement or improved information retention in interactive infographics? Could you elaborate on your perspective?
- b. How do you balance aesthetic appeal and functional clarity when designing interactive infographics?

6. Future of Juicy Design in Infographics:

- a. Do you see Juicy Design becoming a more prominent aspect of interactive infographic design in the future? Why or why not?

- b. Would you consider exploring or incorporating more Juicy Design elements in your future projects?
What would drive that decision?

7. Would you know about any professionals willing to participate in this research?

Appendix B

Instructions for Infographics User Test

Dear <Participant Name>,

You are being invited to participate in a research study to investigate how Juiciness affects users' perception and content engagement when applied to Interactive Infographics.

It consists of evaluating your experience when interacting with 2 interactive infographics.

After interacting with each infographic, you will be asked to:

- evaluate 12 aspects of each infographic, subdivided into 5 categories, on a scale basis (from 1 – Strongly Disagree to 5 – Strongly Agree).
- answer 2-3 questions about each infographic, one at a time.

This research does not pose risks to participants. All data will be confidential.

The test must be completed from a COMPUTER (desktop or laptop) with access to the internet
(MOBILE DEVICES such as Smartphones or Tablets won't work!)

Please follow and complete the steps listed below:

1. Click this link <dry infographic link> and interact with the first infographic
 - a. For a better view, select **Go fullscreen** [] at the bottom right corner of the view area
2. After interacting with the infographic, close it (make sure to close the tab/window)
3. Click on this link <User Feedback form Dry Infographic> and answer the questions
4. Now click this link <juicy infographic link> to interact with the second infographic
 - a. For a better view, select **Go fullscreen** [] at the bottom right corner of the view area
5. After interacting with the infographic, close it (make sure to close the tab/window)
6. After interacting with it, click on this link <User Feedback form Juicy Infographic> and answer to the form questions

Once the above steps are finished, your participation is complete.

IMPORTANT: Please read, sign and return the INFORMATION AND CONSENT FORM document attached.

Thank you for your time and participation!

Bruno Campos