ORAL PRESENTATION

# ENGAGING THE SENSES: A STUDY OF SYNESTHETIC DESIGN IN MOTION GRAPHICS

**Jesenka Pibernik[1], Jurica Dolić[1], Marta Jagačić[1] and Filip Cvitić[1]**

[1] University of Zagreb, Faculty of Graphic Arts, Croatia

***Abstract:***

*This empirical investigation examines synesthetic design principles in motion graphics, exploring how sensory and emotional dimensions interact to create cohesive visual communication. Through an experimental design involving 37 participants, the study analyzed five animated sequences depicting fluid movements in red and blue color variations, utilizing an online survey methodology to assess multimodal perceptual responses. The research employed quantitative analysis to investigate how color, motion, and sound collectively influence viewers' perceptions of temperature, emotional tone, speed, and strength associations. Statistical findings revealed significant correlations between chromatic variations and perceptual interpretations, demonstrating that specific animation elements can strategically modulate sensory experiences. Color demonstrated substantial impact on thermal and emotional perception, while movement dynamics substantially influenced interpretations of velocity and energetic potential. By providing empirical evidence of cross-modal sensory interactions, this study contributes insights to perceptual psychology and motion graphic design, offering an understanding how designers can more effectively engage multiple sensory channels to enhance visual communication and emotional resonance.*

***Keywords:*** *synesthetic design, motion graphics, senses, animations.*

## 1. INTRODUCTION

Synesthesia, an uncommon neurological condition, is characterized by the involuntary elicitation of an additional perception—such as color—triggered by a primary stimulus characteristic, such as shape. This phenomenon serves as a foundational concept for understanding synesthetic design.

Synesthetic design represents an approach that explores and integrates the interconnectedness of multiple senses throughout the design process. This methodology aims to unify matter, shape, and content in a manner that appeals to diverse sensory modalities, thereby providing users with a multi-sensory experience (Hubbard, 2007). The focus extends beyond merely creating multisensory experiences; it encompasses a comprehensive understanding and harmonization of the relationships among different sensory attributes of a product or artifact (Van Campen, 2010.). This involves examining how various sensory qualities—such as sight, sound, touch, taste, and smell—can interact and complement one another to create a cohesive experience. Designers function as manipulators of the senses, working with various stimuli to achieve mutual harmony among them and evoke the human experience of reality. As articulated by Haverkamp, these intuitive strategies are grounded in cross-modal analogy, association, and symbolism that facilitate connections between the senses and enhance interpretability for users (Haverkamp, 2013).

A critical indicator of successful synesthetic design in motion graphics is its imperceptibility to the observer. The essence of this design lies in the harmonious synergy of sound, color, and movement, wherein none of these elements should dominate or distract from the primary message (Anceschi, 2000). Design, by its nature, appeals to our senses, which makes any kind of interaction and experience with a product unique and subject to further interpretation (Merter, 2017). Therefore, in developing high-quality synesthetic design, adherence to fundamental principles established through various scholarly studies is imperative. These principles include the judicious use of colors to elicit desired emotional responses, the harmonious integration of visual and auditory stimuli, and well-researched connections between colors and tastes (Spence, 2010). The importance of the product experience resulting from the interplay of senses demands for the development of new qualitative and quantitative research methods. The objective of this paper is to ascertain whether it is feasible to define a set of principles that accurately encapsulates formal elements, synesthetic possibilities, and animation techniques.

## 2. EXPERIMENTAL

To understand the interplay between sound, color, motion, and sensory attributes we made a breakdown of the key parameters and considerations for analysis:

- Colors: Red and blue were chosen as the two liquids. These colors are often associated with specific psychological and cultural meanings.
- Animation: The movement of the liquids illustrated five distinct fluid movements—stillness, rain, pouring, dripping, and splattering
- Sound: how well the sound matches the graphics in animations, as well as their descriptions of the pitch of the sound. Among the eighteen animations shown to participants, ten featured identical soundscapes while eight were differentiated by four higher tones and four lower tones.

### 2.1 Materials

To investigate this relationship, five animations depicting different fluid movements were created to assess their impact on subjects' multimodal perception (Table 1.). Each of five types of animations was designed in two colors: blue (B) and red (R). Then, different type of sound was added, suggesting the natural sound of flow. The pitch of sound was varied for still water and spraying.

**Table 1:** Stimuli (Animated Liquids): H- higher pitch of sound, L- lower pitch of sound

| Animation type/sound | | Link to animation |
|---|---|---|
| 1. Still liquid/ Sound beneath the sea surface | B1 | https://youtu.be/nb_UdkfmFCM |
| | R1 | https://youtu.be/jDeJ-e3kpu4 |
| | B1-H | https://youtu.be/K43dqfkEkAs |
| | B1-L | https://youtu.be/Ks-X6Cb2COg |
| | R1-H | https://youtu.be/GZwoE7oUA4M |
| | R1-L | https://youtu.be/-Lmxe1c5tQI |
| 2. Rain/ The sound of rain | B2 | https://youtu.be/JNS3e1fquSQ |
| | R2 | https://youtu.be/v7wQOqaFTsM |
| 3. Poring liquid/ Pouring sound | B3 | https://youtu.be/-UDKqniKEec |
| | R3 | https://youtu.be/aTNVCMaJS3I |
| 4. Dripping/ Dripping sound | B4 | https://youtu.be/jCwDDfNBH60 |
| | R4 | https://youtu.be/VmkXa5mFCE4 |
| 5. Spraying/ Liquid splash | B5 | https://youtu.be/WOk7JbhGU28 |
| | R5 | https://youtu.be/y6S8M10TzvE |
| | B5-H | https://youtu.be/Ke5Ab4AglA0 |
| | B5-L | https://youtu.be/ABxaqb5VLgo |
| | R5-H | https://youtu.be/2In0Q4uryiA |
| | R5-L | https://youtu.be/Bzz_kcgsJ1k |

### 2.2 Methods

The study examined the interconnections among hearing and sight, within the context of motion graphics experiences. The subjects comprised a randomly selected group representing diverse ages, educational backgrounds, and cultural contexts. The experiment included a total of 37 participants: 22 from Croatia and 15 from other countries. Of the participants, 64.8 % (24) were bachelor and graduate students, 10.8 % (4) were postgraduate students, and 23.3 % (9) were employees. The total sample was comprised of 21,6 % male and 78.4 % female participants. Conducted via an online survey divided into two sections, the study aimed to determine how specific aspects of animation influenced viewer's experience. The first section's aim was to determine experience of sound related to the color and animation type, the second section's aim was related to the emotional perception and liquid's characteristic perception.  The order of animation presentation was randomized for each respondent. The study combined forced-choice tasks (for perceived speed, strength, relaxation, and attractiveness) with scaled-response tasks (for sound, hardness, and warmth).

## 3. RESULTS WITH DISCUSSION

### 3.1 The sound matches the graphics of the animation

The first part of the research focused on participants' perceptions of how well the sound matches the graphics in animations (Table 2.), as well as their descriptions of the pitch of the sound (Table 3.). The data is divided into two sections:

1. Participants rated how well the sound matched the graphics using a Likert scale (1 = completely agree, 5 = completely disagree).

**Table 2:** Sound-Graphics Match.

| Animation | Higher pitch of sound | AS | SD | Lower pitch of sound | AS | SD |
|---|---|---|---|---|---|---|
| still liquid | B1-H | 2,03 | 0,87 | B1-L | 2,16 | 1,12 |
| | R1-H | 2,89 | 1,17 | R1-L | 2,46 | 1,04 |
| spraying | B5-H | 2,08 | 1,23 | B5-L | 2,00 | 1,31 |
| | R5-H | 2,14 | 2,14 | R5-L | 1,97 | 1,26 |

Participants perceived the match between sound and graphics differently depending on the color of the liquid and the pitch of the sound. Blue liquids were generally perceived as a better match for higher-pitched sounds in still liquid animations, while red liquids were perceived as a better match for lower-pitched sounds across all animations.

2. Participants described the pitch of the sound in the animations (1 = low, 5 = high).

**Table 3:** Pitch Description.

| | Blue liquids | AS | SD | Red liquids | AS | SD |
|---|---|---|---|---|---|---|
| still liquid | B1 | 1,49 | 0,73 | R1 | 1,54 | 0,73 |
| rain | B2 | 3,38 | 0,89 | R2 | 3,57 | 0,80 |
| poring liquid | B3 | 3,57 | 0,77 | R3 | 3,49 | 0,96 |
| dripping | B4 | 3,46 | 1,22 | R4 | 3,46 | 1,12 |
| spraying | B5 | 3,65 | 0,79 | R5 | 3,51 | 0,90 |
| sum | | 15,55 | | | 15,57 | |

Still liquid animations were associated with low-pitched sounds, while dynamic animations (rain, pouring, dripping, spraying) were associated with moderately high-pitched sounds. Slight variations in pitch ratings were observed based on the color of the liquid.

### 3.2 Type of animation and color associations

The second part of research compared participants' perceptions of two animated liquids: red and blue. The attributes were: perceived speed (Table 4.), strength (Table 5.), relaxation (Table 6.), and attractiveness (Table 7.). The participants had to choose which one was perceived as quicker, stronger, more relaxed, and more attractive.

**Table 4.** Perceived speed

| Animation | Blue liquids | points | Red liquids | points | I don't see the difference. |
|---|---|---|---|---|---|
| rain | B2 | 12 | R2 | 7 | 18 |
| poring liquid | B3 | 11 | R3 | 6 | 20 |
| dripping | B4 | 3 | R4 | 8 | 26 |
| spraying | B5 | 14 | R5 | 13 | 20 |
| sum | | 30 | | 34 | 84 |

**Table 5.** Perceived strength

| Animation | Blue liquids | points | Red liquids | points | I don't see the difference. |
|---|---|---|---|---|---|
| still liquid | B1 | 9 | R1 | 13 | 15 |
| rain | B2 | 10 | R2 | 10 | 17 |
| poring liquid | B3 | 15 | R3 | 7 | 15 |
| dripping | B4 | 6 | R4 | 9 | 22 |
| spraying | B5 | 13 | R5 | 6 | 18 |
| sum | | 29 | | 47 | 72 |

**Table 6.** Perceived relaxation

| Animation | Blue liquids | points | Red liquids | points | I don't see the difference. |
|---|---|---|---|---|---|
| still liquid | B1 | 25 | R1 | 6 | 6 |
| rain | B2 | 20 | R2 | 8 | 9 |
| poring liquid | B3 | 20 | R3 | 7 | 10 |
| dripping | B4 | 13 | R4 | 8 | 16 |
| spraying | B5 | 24 | R5 | 6 | 7 |
| sum | | 89 | | 27 | 32 |

**Table 7.** Perceived attractiveness

| Animation | Blue liquids | points | Red liquids | points | I don‘t see the difference. |
|---|---|---|---|---|---|
| still liquid | B1 | 19 | R1 | 11 | 7 |
| rain | B2 | 23 | R2 | 8 | 6 |
| poring liquid | B3 | 24 | R3 | 6 | 7 |
| dripping | B4 | 25 | R4 | 6 | 6 |
| spraying | B5 | 20 | R5 | 11 | 6 |
| sum | | 86 | | 36 | 26 |

To determine if the preferences for red vs. blue are statistically significant for each attribute, we used chi-square test**.** The chi-square test revealed statistically significant differences in participants' preferences for red vs. blue liquids across all attributes. Blue is strongly associated with calmness and attractiveness, while red is slightly preferred for perceived speed and strength. The "I don't see the difference" option was frequently chosen, indicating that some participants did not perceive a clear distinction between the two colors for certain attributes (Table 8.).

**Table 8.** Preferences for red vs. blue liquids across all attributes

| **Attribute** | **Blue Liquids** | **Red Liquids** | **I Don't see the Difference** | **Total** | **Chi-Square** |
|---|---|---|---|---|---|
| Perceived Speed | 30 | 34 | 84 | 148 | $\chi 2=36.71$, $p<0.05$ |
| Perceived Strength | 29 | 47 | 72 | 148 | $\chi 2=18.84$, $p<0.05$ |
| Calmness | 89 | 27 | 32 | 148 | $\chi 2=48.60$, $p<0.05$ |
| Attractiveness | 86 | 36 | 26 | 148 | $\chi 2=42.07$, $p<0.05$ |

Additionally, the participants performed scaled-response tasks. They rated the hardness (1=soft, 5=hard) (Table 9.) and warmth (1=warm, 5=cold) (Table 10.) of the same animated liquids.

**Table 9.** Hardness ratings

| Animation | blue | AS | SD | red | AS | SD |
|---|---|---|---|---|---|---|
| still liquid | B1 | 2,11 | 1,05 | R1 | 2,22 | 1,00 |
| rain | B2 | 2,43 | 1,14 | R2 | 3,24 | 1,30 |
| poring liquid | B3 | 2,11 | 1,13 | R3 | 2,08 | 0,98 |
| dripping | B4 | 2,05 | 1,18 | R4 | 2,59 | 1,19 |
| spraying | B5 | 3,14 | 1,27 | R5 | 2,05 | 1,20 |
| sum | | 11,84 | | | 12,18 | |

**Table 10.** Temperature ratings

| Animation | blue | AS | SD | red | AS | SD |
|---|---|---|---|---|---|---|
| still liquid | B1 | 4,16 | 1,17 | R1 | 2,19 | 1,35 |
| rain | B2 | 4,22 | 1,11 | R2 | 2,59 | 0,93 |
| poring liquid | B3 | 3,81 | 1,20 | R3 | 2,57 | 1,07 |
| dripping | B4 | 3,59 | 0,98 | R4 | 2,41 | 1,01 |
| spraying | B5 | 3,89 | 0,77 | R5 | 2,49 | 1,19 |
| sum | | 19,67 | | | 12,25 | |

To analyze the data provided in the Likert-scale responses for hardness and warmth, we performed paired t-tests (if the data meets the assumptions of normality). We also calculated effect sizes using Cohen's d to assess the magnitude of the differences between red and blue liquids.

- Hardness: Red liquids are perceived as harder in some conditions (rain, dripping), while blue liquids are perceived as harder in others (spraying).
- Warmth: Blue liquids are consistently perceived as colder than red liquids across all conditions, with large effect sizes.

By performing these analyses, we can conclude that there are significant differences in how participants perceive the hardness and warmth of red and blue liquids, with warmth showing a stronger and more consistent effect.

To find out more whether participants' preferences for red or blue liquids are correlated with their ratings of hardness and temperature we performed a correlational analysis and a subgroup analysis of the data obtained by forced choice and Likert scale methods. The results suggested that color preferences influence participants' perceptions of hardness and temperature, but the relationships are relatively weak. Hardness perceptions are significantly influenced by color preferences. Participants who prefer a particular color tend to perceive liquids of that color as harder. The regression analysis reveals that temperature perceptions may be less strongly influenced by color preferences compared to hardness perceptions. These findings suggest that color preferences play a stronger role in shaping perceptions of hardness compared to temperature. Further research with a larger sample size and additional variables could provide more robust insights.

## 4. CONCLUSIONS

Our research unveils the intricate relationships between sound, color, and liquid animation dynamics, challenging simplistic perceptual mapping theories. The study demonstrates that color-sound associations are profoundly context-dependent, with blue liquids consistently linked to calmness and higher-pitched sounds in still animations, while red liquids correlate with warmth, strength, and lower-pitched sounds. Movement type significantly modulates these perceptual interpretations, revealing that slower animations emphasize hardness and controlled characteristics, whereas faster, more chaotic movements blur traditional color-attribute associations. Notably, spraying animations represent a perceptual "neutral zone" that challenges established categorizations. The results suggested that color preferences influence participants' perceptions of hardness and temperature, but the relationships are relatively weak.

These findings contribute to our understanding of cross-modal perception of animated liquids, suggesting that sensory experiences are more fluid and interconnected than previously understood. By illuminating how sound pitch, color, and animation dynamics interact, the research provides valuable insights for design, user experience, and cognitive psychology, highlighting the sophisticated, non-linear ways in which humans interpret sensory information. While providing significant insights, the study acknowledges the need for further investigation into: cultural variations in color-sound perception, neurological mechanisms underlying these cross-modal associations and potential.

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## ADDITIONAL DATA ABOUT AUTHORS

### Corresponding author

Jesenka Pibernik
Department for graphic
design and imagining
Faculty of Graphic Arts
University of Zagreb
Getaldićeva 2
10 000 Zagreb

+385996067669
jesenka.piberni@grf.unizg.hr

### Co-author(s):

Jurica Dolić
New Media Design
RIT Croatia
Don Frana Bulića 6
20000 Dubrovnik, Croatia
jurica.dolic@croatia.rit.edu

Marta Jagačić
Faculty of Graphic Arts
University of Zagreb
Getaldićeva 2
10 000 Zagreb
mar.jagacic@gmail.com

Filip Cvitić
Department for graphic design
and imagining
Faculty of Graphic Arts
University of Zagreb
Getaldićeva 2
10 000 Zagreb
+385915593064
filip.cvitic@grf.unizg.hr