26TH INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
5-6 SEPTEMBER 2024, ASTON UNIVERSITY, BIRMINGHAM, UNITED KINGDOM

ASSESSING THE EMOTIONAL, PHYSICAL, AND COGNITIVE IMPACT OF MULTISENSORY DESIGN EXHIBITS AT DUTCH DESIGN WEEK

Bryan F. HOWELL, Sophie J. HOUGHTON, Holly M. GRAFF, Clara G. SWENSON and Davis H. SEEGMILLER
Brigham Young University, United States of America

ABSTRACT
Design students face the challenge of presenting their work at university events with little training in designing exhibits. To help design students successfully communicate their projects, they would benefit from studying design exhibits that enhance viewer engagement. Human-centred design is often multisensory and appeals to human emotions, thought patterns, and relatable behaviours. However, "the "lower" senses of smell, taste, and touch are rarely taught in school curricula. This research combines multisensory engagement of six human senses, sight, smell, taste, sound, touch, and spatial awareness, with facets of emotional, cognitive, and physical (ECP) behaviour to explore how sensory stimuli impact a visitor's experience with exhibits. Fourteen undergraduate design students and one design instructor collected sensory and ECP data on 41 exhibits while attending the 2023 Dutch Design Week. Emotionally, the senses of taste and smell had the highest impact on the visitor. Cognitively, the senses of taste and touch scored highest. Physically, the sound, spatial, and smell senses had the most impact. Sight had the lowest variance in ECP scores, while taste had the greatest. Results verify that as the number of senses increases, so does the exhibit impact. Studying exhibit design engagement caused two student researchers to redesign their end-of-year presentations to include more senses. Design exhibitions engage visitors visually, limiting audience proximity and engagement with display content. Exhibits designed to incorporate smell, taste, touch, sound, spatial awareness, and sight, in that order, can transform casually observing visitors into engaged participants consuming an exhibit's content rather than merely viewing it.

Keywords: Design student exhibits, exhibit education, design presentation methods, Dutch Design Week exhibits

1 INTRODUCTION
Design students often face the challenge of presenting their work at university or public events with little training in designing project exhibits. Exhibits are an effective, experiential way to communicate ideas, connect with visitors, and teach concepts. However, some exhibits accomplish this goal more significantly than others. To help design students successfully communicate their work to visitors, they would benefit from studying human-centred design methods to enhance visitor impact in contemporary exhibitions.

Human-centred design is often multisensory and appeals to human emotions, thought patterns, and relatable behaviours [1]. However, Classen teaches us that "the "lower" senses of smell, taste, and touch are rarely engaged by the school curriculum, for these senses are not generally considered to provide "ways to wisdom" but rather, only channels for pleasure or displeasure". Cultures that try to educate all the senses are stereotyped as sensualist and decadent" [2]. Obrist et al. explain that exhibits engaging multiple senses encourage visitors to experience and interpret content with increasing impact [3]. Contemporary museum education has also embraced the principles of multisensory exhibits [4]. Engaging exhibits convey essential information to the visitor and strive to garner visitor investment toward this content. Liang & Nan report that "good" exhibits involve, at their core, interactivity to express their purpose [5]. Thus, this study embraces multisensory design principles and incorporates six human senses, sight, smell, taste, sound, touch, and spatial awareness, or the relationship between oneself and other entities within a space, as one of two components to assess exhibit impact. The second

component assesses emotional, cognitive, and physical (ECP) behaviour as outlined in Kahn's study measuring employee engagement or disengagement through ECP behaviours [6] along with Packer and Ballantyne's exhibition study using ECP behaviours "to characterise the content and intensity of visitor experiences at different sites or for different groups" [7].
Exhibition "engagement" defines a visitor who is emotionally (E) or empathically connected with the work exhibited; they are cognitively (C) vigilant regarding the content and become physically (P) involved with the exhibit. Engaged visitors freely express their thoughts and feelings, their creativity is triggered, and their beliefs and values connect with the work. Conversely, disengaged visitors withdraw, are emotionally absent, cognitively passive, and lack physical connection with the work.
To explore how sensory stimuli impacts a visitor's ECP experience with an exhibit, design students attending the 2023 Dutch Design Week (DDW) in Eindhoven, Netherlands, enlisted their fellow travellers to collect data by photographing and recording their sensory and ECP experiences with selected exhibits. Researchers hypothesised that study participants who reported multiple sensory engagement with an exhibit would also report higher emotional, cognitive, and physical connections with the exhibit. They also believed that students who studied the different components of design exhibits would gain new insights and thus impact their end-of-year exhibit design plans. Additionally, they surmised that the methods used and their experiences in gathering and sorting the data, combined with the study findings, would be a helpful model for future students and educators striving to enhance a design program's end-of-year exhibit impact and engagement.

2 METHOD

2.1 Participants

Fourteen undergraduate design students, seven females and seven males, from illustration, graphic, industrial, and user experience design, and one design instructor from Brigham Young University collected data on 41 exhibits.

2.2 Data Collection

The students collected qualitative written and visual data on their mobile phones using Google Forms. Responses were recorded instantaneously in a spreadsheet, and photos were uploaded into shared folders. Three surveys were created. The first survey contained six questions describing an exhibit and how many of the six senses, touch, sound, smell, sight, taste, and spatial perception, were experienced. Participants also recorded the exhibit's perceived emotional, cognitive, and physical impact. The second survey contained three questions exploring the exhibit designer's sensory experience intentions. The third survey combined the two surveys and was collected from students who were slow to write and post results. Students collected data in pairs, one collecting visitor impressions and the other gathering exhibitor insights. Exhibits were selected based on personal appeal.

2.3 Data Analysis

Exhibit photos were printed, assigned a number, and sorted on three large mobile whiteboards. Each exhibit was tagged with notes identifying which of the six senses were engaged by that exhibit along with its ECP score based on a five-point Likert scale, anchored with "very poor" at the low end and "very well" at the high end. The scores were recorded on colour-coded notes and adhered to the respective exhibit photo, allowing researchers to quickly view, sort, and evaluate the data.

3 RESULTS

The scores compare the number of senses engaged by an exhibit and how emotionally, cognitively, and physically impactful a student participant considered it to be. Figures 3-5 below report all 41 exhibit responses using 20% transparent circles. The darker the circle, the higher the number of exhibits reported at that score. The lighter the circle the fewer number of exhibits at that score. None of the exhibits reported engaging five or six senses.

3.1 Average ECP scores for individual senses.

All ECP scores were averaged and categorised by sense. For example, in Figure 1, the leftmost medium green bar represents the average of all emotional scores reported for all exhibits engaging the sense of sight.

Emotionally, taste and smell senses had the highest impact on participants, with a score of 5.0. Cognitively, the taste and touch senses scored highest at 4.50 and 4.45.
Physically, the sound, spatial, and smell senses scored the highest at 4.52, 4.52, and 4.50.
Sight had the least variance in scores, with a high of 4.36 and a low of 4.28. Taste had the greatest score variance, with a high of 5.00 and a low of 4.00; it also had the lowest score recorded.

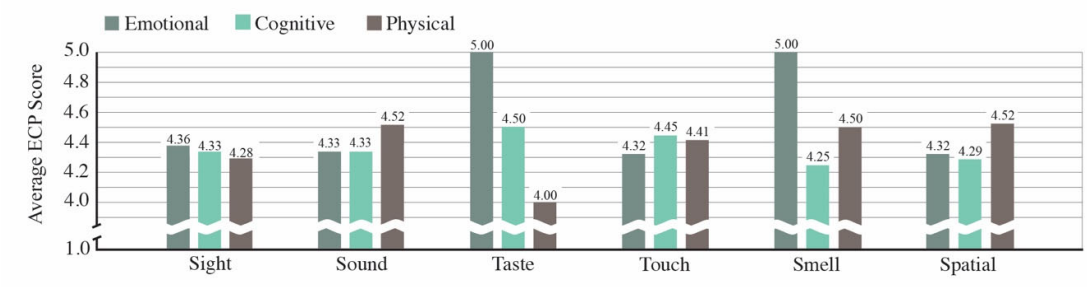

Figure 1. The average ECP scores for all six senses

3.2 Number of senses and total ECP score

An exhibit's "combined ECP score" sums all emotional, cognitive, and physical scores received in relation to the number of senses the exhibit engaged. The lowest possible score is 3.0, and the highest is 15.0, see Figure 2. As the number of senses engaged increases, the variance between scores decreases.
One sense has a total of three scores, the least number of scores, a seven-point spread between scores, the broadest score difference, the two lowest scores, and one score at 15, or 33% of one sense scores.
Four senses report a total of 13 scores, a three-point spread between scores, the narrowest score difference, and seven scores at 15, or 54% of four sense scores, significantly outnumbering the high scores of the other three senses.

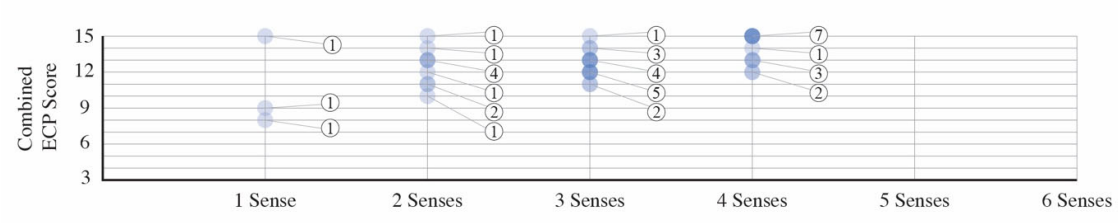

Figure 2. Combined ECP scores for all exhibits by the number of senses

3.3 Number of senses

Figures 3-5 show individual emotional, cognitive, and physical scores, ranging from 1.0, very poor, to 5.0, very strong, and grouped by the number of senses.

3.3.1 Emotional scores by number of senses

Figure 3 compares the emotional impact score with the number of senses an exhibit engaged. This graph demonstrates the clearest trend between an increasing impact score and the number of senses engaged. Ten exhibits, the most of any intersection on the graph, scored a 5.0 with four senses engaged. None of the exhibits scored below 3.0.

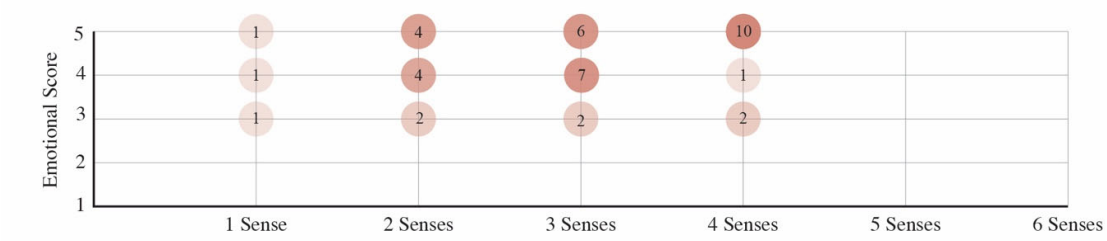

Figure 3. Emotional scores by the number of senses engaged

3.3.2 Cognitive scores by number of senses

Figure 4 compares the cognitive impact score with the number of senses an exhibit engaged. The highest concentration of responses falls on exhibits that engage three and four senses. This result still leans towards positive visitor engagement with increasingly multisensory exhibits.

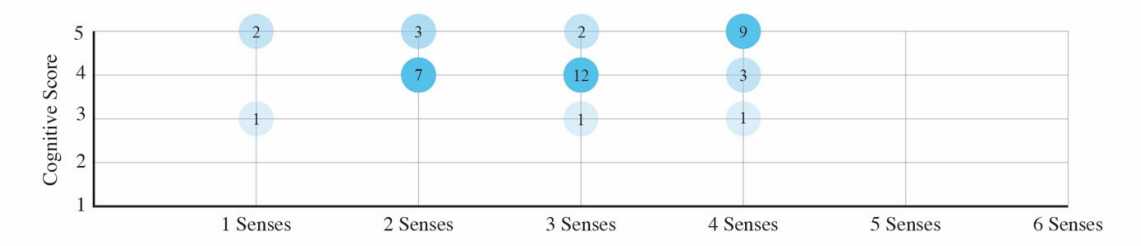

Figure 4. Cognitive engagement scores by the number of senses engaged

3.3.3 Physical scores by number of senses

Figure 5 compares the physical impact score with the number of senses an exhibit engaged.

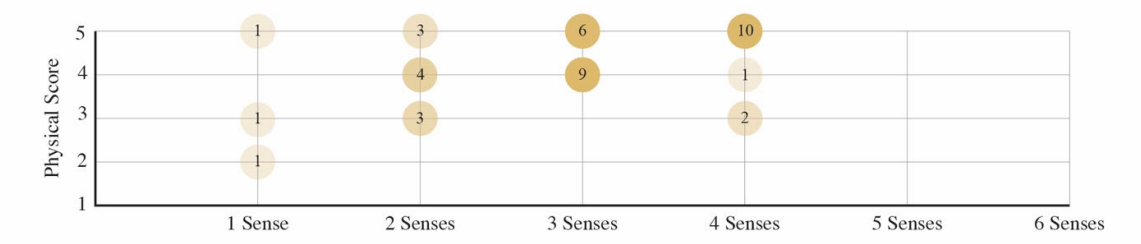

Figure 5. Physical engagement scores by the number of senses engaged

This graph shows the lowest score for an exhibit, 2.0, in the one sense column. The highest concentration of responses falls on exhibits that engage three and four senses, with scores of 4.0 and 5.0, respectively, reinforcing that exhibits with three and four senses have a higher potential for visitor engagement.

4 DISCUSSIONS

4.1 Average ECP Score for all Six Senses

Figure One indicates that exhibits that engaged either the sense of taste or smell had a perfect emotional impact score of 5, suggesting a correlation between taste, smell, and emotional engagement. This high emotional response reflects research reporting that strong chemical and emotional responses triggered by taste and smell have evolved to safeguard humans against potentially harmful substances [8]. Other research suggests that increasing the number of senses within an exhibit allows visitors to experience exhibit content in a natural, understandable way–a way in which they are accustomed to experiencing their surrounding world [9]. Alternatively, exhibits engaging taste and smell were less common at DDW, and their novelty may have amplified their ratings.

High average ECP scores for all senses indicate the impact exhibits had upon the students collecting the data. As students experienced and evaluated different exhibits, they also critically examined various exhibit design components and informed their own design sensibilities.

4.2 Combined ECP Scores of Exhibits Correlated with Number of Senses Engaged

Figure Two indicates a positive correlation between the number of senses engaged in an exhibit and its impact on the visitor. Thirteen exhibits engaged one and two senses and had lower ECP scores than the 28 exhibits engaging three and four senses with higher ECP scores.

Table One records averaged combined ECP scores according to the sense involved and ordered from high to low.

Table 1. Sense vs. Average ECP Score

Sense	Smell	Taste	Touch	Sound	Spatial	Sight
Ave. ECP score	4.58	4.50	4.39	4.39	4.37	4.32

These results indicate that exhibits engaging the sense of smell received the highest ECP impact score. Conversely, exhibits engaging the sense of sight scored the lowest. Notably, sight is the most frequently engaged sense (present in all 41 evaluated exhibits) yet received the lowest average impact score.

4.3 Average ECP and Combined Score per Sense

Figure Six combines data from Figures 4, 5, and 6 and averages ECP scores by the number of senses engaged. The darkest green or rightmost bar in each sense grouping combines all ECP scores per number of senses. These combined ECP scores, starting at 3.88 for one sense, 4.17 for two senses, 4.24 for three senses, and 4.60 for four senses, verify that as the number of senses increases, so does the exhibit impact.

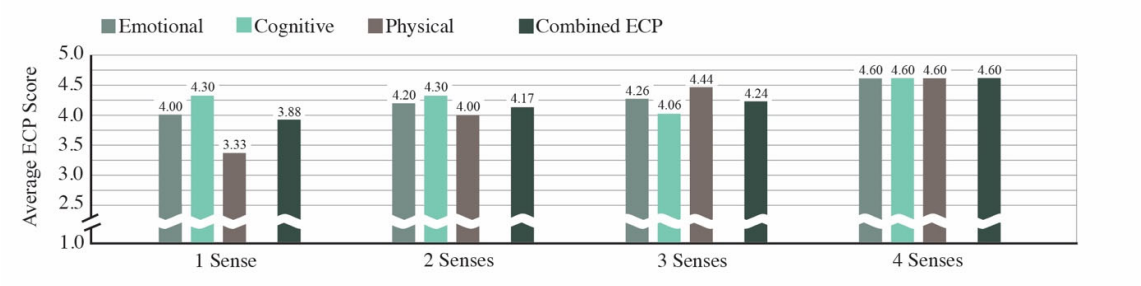

Figure 6. Average and combined ECP scores per sense

When observing individual E, C, and P scores, the three senses/cognitive score is the lone result diverging from the increasing pattern. This could be explained by visitors' resonating with exhibit content regardless of sensory engagement, or it could be errors in data collection. Further exploration into this anomaly uncovered research indicating the brain's ability to link knowledge and memories to sensory experiences, which increases cognitive activity [10]. Results on this graph affirm the researcher's initial hypothesis that a positive correlation exists between the number of senses engaged in an exhibit and the exhibit's impact on the visitor.

5 CONCLUSIONS

This study aimed to expand perspectives on how sensory engagement impacts visitor's emotional, cognitive, and physical engagement with an exhibit. This study caused another immediate outcome: two of the student researchers to redesign their end-of-year exhibit. One student stated:

> *I once considered the senses of taste and smell irrelevant to my senior thesis project; this paper's findings have pushed me to find ways to engage those senses with my audience to increase exhibit engagement.*

The data collection experience and findings outlined in this study could also be a helpful model for students and educators striving to enhance the impact and engagement of end-of-year exhibitions.

Traditionally, design exhibits limit audience proximity and interaction by taking a vision-only approach to their content. Exhibits designed to incorporate smell, taste, touch, sound, spatial awareness, and sight, in that order, can transform casually observing visitors into engaged participants consuming an exhibit's content rather than merely viewing it.

ACKNOWLEDGEMENTS

The authors are indebted to Alisa Mann and J Tanner Howell for their assistance in interpreting and clarifying the data.

REFERENCES

[1] Landry L. "What Is Human-Centered Design?" Harvard Business School Online, Harvard Business School, 15 Dec. 2020, online.hbs.edu/blog/post/what-is-human-centred-design.

[2] Classen C. Other Ways to Wisdom: Learning Through the Senses Across Cultures. International Review of Education, 1999, 45, 269–280.
[3] Obrist M., Boyle G., van Brakel M. and Duerinck F. Multisensory experiences & spaces. In *2017 ACM International Conference on Interactive Surfaces and Spaces*, Brighton, UK, October 17, 2017, pp. 469-472.
[4] Kalantzis M. and Cope B. Designs for Learning*. E-Learning and digital media*, 2004, 1(1), 38-93.
[5] Liang X. and Nan W. Human-Exhibition Interaction (HEI) in Designing Exhibitions: A Systematic Literature Review. In *International Journal of Hospitality Management*, 2019, vol. 77, pp. 292-302.
[6] Kahn W. Psychological Conditions of Personal Engagement and Disengagement at Work. *Academy of Management Journal,*1990, 33(4), 692-724.
[7] Packer J. and Ballantyne R. Conceptualising the Visitor Experience: A Review of Literature and Development of a Multifaceted Model. Visitor Studies, 2016, 19(2), 128–143.
[8] Reden N. "Sensory History and Multisensory Museum Exhibits" (2015). History Theses. 34.
[9] Mastinu M., Melis M., Yousaf N. Y., Barbarossa I. T. and Tepper B. J. Emotional responses to taste and smell stimuli: Self-reports, physiological measures, and a potential role for individual and genetic factors. *Journal of Food Science*, 2023, 88, A65–A90.
[10] Shams L. and Seitz A. Benefits of Multisensory Learning. *Trends in Cognitive Sciences*, 2008, vol. 12, pp. 411-417.