Design and Evaluation of a Minimalist Interactive Wall Art Piece Responsive to Movement and Light

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Abstract

This paper describes the design, prototyping, and evaluation of a minimalist interactive wall art piece that responds to user movement and ambient light. It examines how subtle, embodied interaction and environmental responsiveness can encourage emotional engagement and a sense of personal presence within a domestic space. A functional prototype incorporating various electronic components was developed and evaluated with eight participants using a mixed methods approach. The findings suggest that the interaction was intuitive and emotionally engaging, and participants often described the experience as personal. Passive interaction modes were particularly valued for creating calm, ambient experiences. Overall, the results highlight the role of aesthetic decisions and personalisation in interactive art, and suggest that minimalist forms of interaction can support meaningful user engagement. Future work will focus on long term deployment in domestic environments and the development of expanded customisation options.

Keywords

Interactive Art, Interaction Design, Embodied Interaction, Ambient Interaction, User Experience, Prototyping, Emotional Engagement, Minimalist Design

1 Introduction

Art exists in multitudes and takes many forms, serving as a means to express personal thoughts, lifestyle, values, and identity. However, most existing works in this space remain static, often limiting their sense of presence and vitality. In response, this research presents the design and evaluation of a minimalist interactive wall art piece that responds to both user movement and environmental lighting conditions, creating a more engaging and dynamic experience. To better understand how responsive artworks have been conceptualised and evaluated, the following section reviews relevant research on interactive art and interaction design, with the exploration on responsiveness, user participation, and experiential engagement.

As with interactive design in digital media, Mi Jing and Yu Ma[4] argue that art is shifting the audience from being passive observers to active participants, where real time feedback and responsiveness are essential for a meaningful engagement. This perspective links to the design of the interactive wall art, as it responds immediately to the users presence and environmental conditions through light based interaction.

Similarly the research by Guo et al.[1], demonstrates that interactive installations can foster emotional engagements by responding to users through embodied interaction and environmental sensing rather than users direct input. While Nam and Nitsche[5] further frame interactive installations as performative systems that engage participants through presence, movement, and contextual interaction, having the artwork itself as an active performer. These perspectives strongly inform and are linked to the design of the wall art prototype, which operates in a domestic setting and reacts to the users walking past it as well as to ambient lighting conditions, creating a calm and responsive experience without needing explicit user control.

As for the evaluation of interactive art, Höök et al.[2] argues that such works should be evaluated through both experiential and emotional responses, as just using usability metrics alone fail and fall short to capture the open ended and informative nature of artistic interactions. This perspective supports the mixed method evaluation approach used in this project, combining observational feedback with survey data to assess user satisfaction and engagement.

Prototypes have been recognised as a central method in the interaction design research. As argued by Houde and Hill[3] in their research, prototypes should be understood not by their fidelity, but rather by the design questions they intended to explore. They proposed a model in which prototypes investigate a design role in the user's lives by investigating how it looks, feels, and functions technically. This perspective is relevant to this research as the interactive wall art prototype explores the qualities of light based interaction, the role of responsive art in a domestic context, and the technical feasibility of the sensor driven behaviors.

Based on these perspective, this study explores the following research question

How does a minimalist, movement and environmental responsive interactive wall art piece influence the users emotional engagement, perceived personal responsiveness, and suitability for use in a domestic setting?

These perspectives support the project's focus on creating a minimalist, ambient interactive wall art piece, while also justifying the use of a functional prototype and a mixed method evaluation approach. Combining the prototype with experiential user testing, the project treats the prototype not only as a technical artifact, but as a performative and experiential design piece.

2 Method

This research focuses on a prototype driven approach, in which a functional prototype will be designed and implemented to test and evaluate the interactive wall art. This research also includes a mixed method approach, combining quantitative and qualitative data collected from the user tests. Prototyping was chosen as it can

provide valuable insights as it allows for the testing of interactions and functionalities in a real world context, thereby supporting the evaluation of usability and user satisfaction.

The next step was to define the functions the wall piece would include. As the design aimed for a minimalist look, it was decided with the client that the piece should react by displaying animation when a user walks past it, as well as respond to the room's environment conditions to create interactivity. These behaviours were considered the minimum requirement for the prototype, with any additional functionality intended to further enhance the design. As a result, an additional feature was introduced that allowed the users to manually adjust the light intensity, creating a button to switch between the interaction modes.

In **mode 1**: The light was controlled automatically using an ultrasonic sensor and a photoresistor, creating a passive system in which the user does not need to physically interact with the piece, as the interaction is triggered by environmental input.

In **mode 2**: The user presses a button to switch modes, the difference is that the photoresistor becomes disabled enabling the user to manually control the light intensity through the side mounted slide potentiometer, while the ultrasonic sensor retains its action of detecting movement.

To create the prototype with the defined requirements, a range of software tools, machines, and electronics components were used. Before building the housing of the art piece, the electronic components were selected, including, an addressable LED strip, an ultrasonic sensor, a photoresistor, an Arduino Uno, a slide potentiometer, and several tactile buttons. All components were connected and programmed using the Arduino IDE. The Arduino was used to power and control the electronic components in the prototype; the LED strip provided the illumination of the artwork; the ultrasonic sensor was used to detect user movement; the photoresistor responded to ambient light levels by adjusting brightness accordingly (dim when bright or go bright when dim); the slide potentiometer enabled manual brightness control of the leds; and the buttons were used to switch modes and turn the LEDs on or off. Once these components were connected and benched tested, the housing could be constructed.

The housing consisted of a faceplate, a backside, and side panels, all of these were designed using Autodesk Fusion and later exported to SVG files for laser cutting the 3mm wood. The faceplate design was inspired by a small section of the Early Digital Artwork titled Gaussian-Quadratic by A. Michael Noll[6] seen in Figure 1, which was used throughout the duration of the project.

A 3D printer was then used using white PLA material was then used to produce a light diffuser to fill in the void through which the light will shine, creating a clean and uniform visual appearance, as shown in Figure 2, The 3D printer was also used to fabricate the lids potentiometer cover and button covers.

This initial prototype was then presented to the client, and revived feedback was gathered for iteration and refinement, resulting in the second prototype as seen in Figure 3 and 4. The changes included creating a new face plate featuring a larger section of the early digital artwork and painting the faceplate black to achieve a more finished product. While similar techniques were used for the updated faceplate, the 3D printed method for the diffuser could not be reused due to tight tolerances and caused light leakage. Due

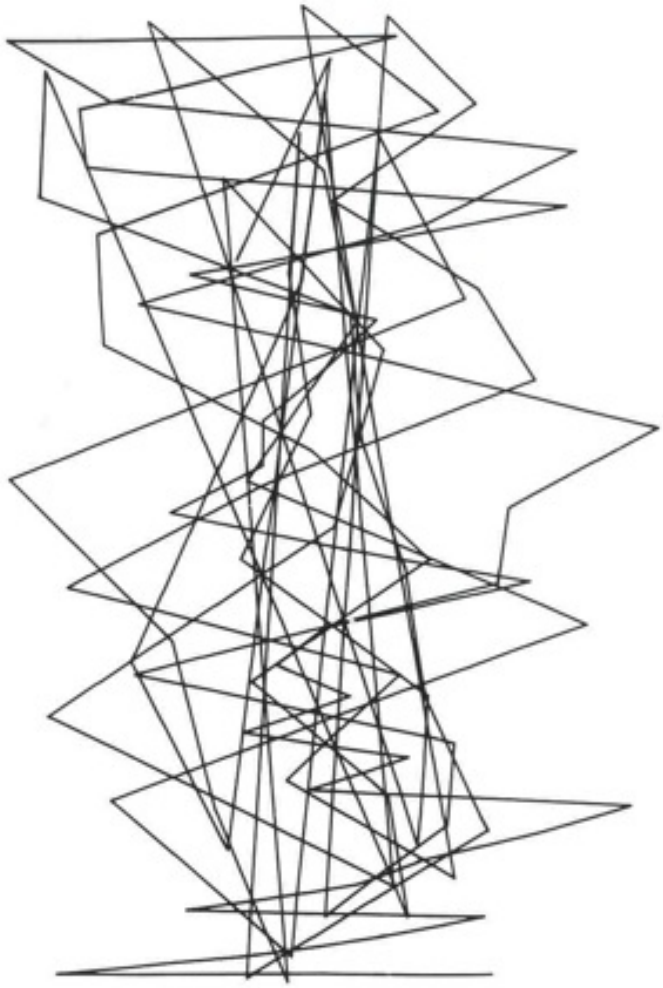

Figure 1: Gaussian-Quadratic by A. Michael Noll

to that the diffuser elements had to be instead adhered to a white piece of parchment paper to archive the desired light diffusion.

Once the second prototype was completed, it was introduced to the participants and the user testing began. A total of eight participants took part in the testing process. At the beginning of each session, participants were provided a consent form outlining a brief description of the project and informing them of their right to withdraw from the testing at any time. After consenting, participants were given an overview of the prototype and its functionality.

User testing was conducted in a relaxed and exploratory manner, allowing participants to freely interact with the prototype and ask questions while the prototype functions were explained to them. Observations, questions, and comments were noted down throughout the session to be later used for analysis. Following the interaction phase, participants completed a survey consisting of five Likert scale questions, two checkbox questions, and one open ended question. These survey questions and responses can be found in the appendix of this paper. The collected data was then used to

Figure 2: First iteration of prototype

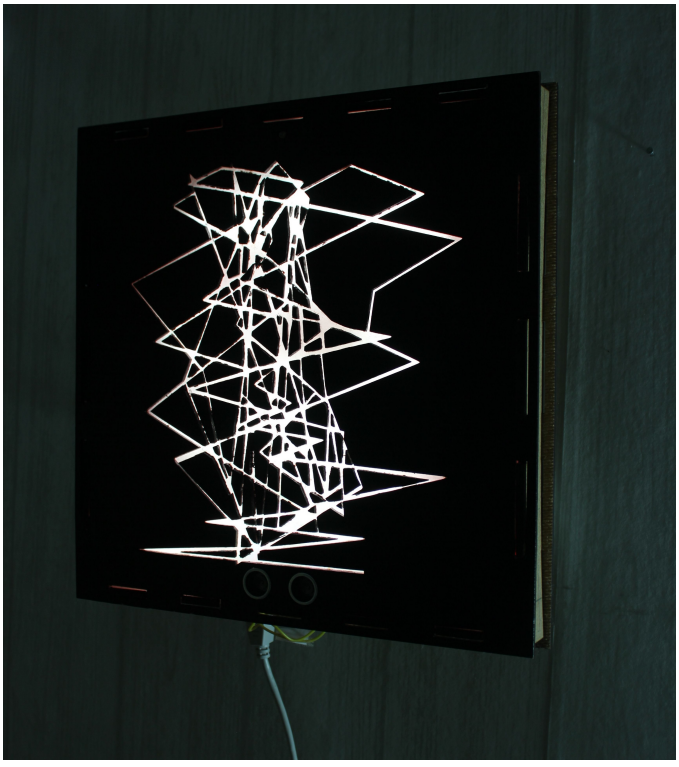

Figure 3: Second iteration of prototype in passive mode

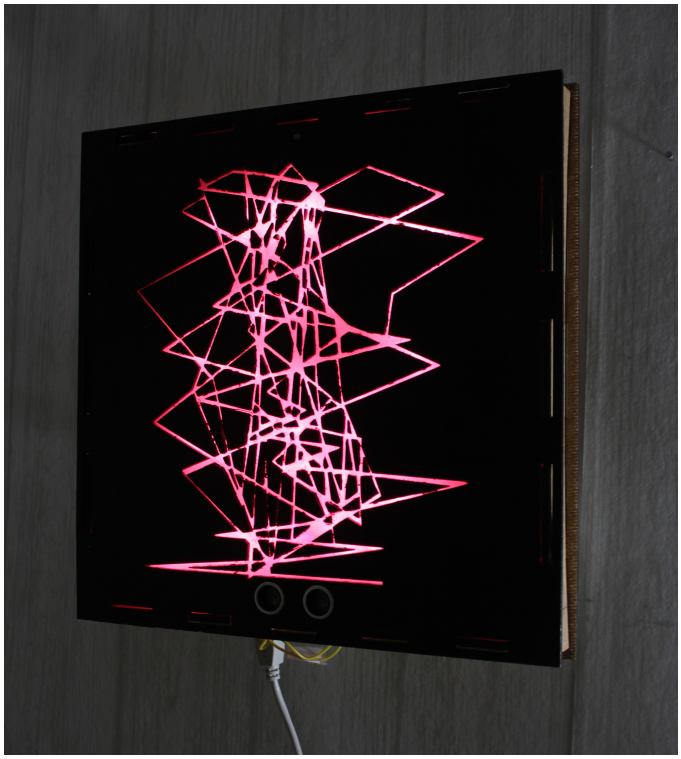

Figure 4: Second iteration of prototype when sensor triggered

conduct a thematic analysis to further understand the prototypes usability, emotional impact and overall product success.

3 Results

A thematic analysis was conducted on the qualitative and quantitative responses gathered from the survey and conversation with the eight participants. The analysis combined the Likert scale data with the open ended responses to identify the recurring patterns related to the emotional response, interaction understanding, personalisation, and contextual use within the home.

Theme 1: Intuitive and Legible interaction

The majority of the participants demonstrated a clear understanding of the lights' intended behaviour. This was reflected in the Likert scale responses, with seven of the eight participants agreeing or strongly agreeing that they had immediately understood what the light was meant to do (seven of the eight participants ratings of 3 or above).

While a small number of participants reported initial uncertainty, qualitative feedback indicated that the uncertainty was short lived and resolved through interaction rather than instruction. Participants also described the relationship between the movement and colour change as readable and natural. These findings suggest that the minimalist interaction logic effectively communicated system behaviour without the need for an explicit explanation, aligning with the design goal of intuitive ambient interaction.

Theme 2: Emotional Engagement through Movement and Colour

Participants' responses to the colour change were mainly positive, they frequently reported the feelings of comfort, playfulness, and curiosity, while only one participant selected distraction and none selected annoyance or indifferent. The colour change triggered by walking past the light was widely liked and appreciated, with all the participants rating this interaction positively (ratings of 4 and 5) Participants as well noted that the lights automatic brightness adaptions supports its use in varying lighting conditions, reinforcing its role as an ambient and environmentally responsive piece. The movement triggered interaction and brightness adaptation were described by several participants as refreshing and visually pleasing, particularly in low light environments. These findings suggest that emotional engagement emerged primarily through embodied interaction and visual feedback rather than direct manipulation, reinforcing the role of movement as a meaningful input modality.

Theme 3: Personal and Responsive Presence

Responses indicated that the light was often seen as reacting to the user rather than activating in response to the motion. Majority of the participants rated the interaction as more personal than impersonal (with higher rating around 4 and 5) Qualitative comments described the light as personal and comforting, further supporting this perception. These findings reflect the success of the light in creating a sense of personal responsiveness positioning it as an active performative object rather than a passive decorative piece.

Theme 4: Calmness Versus Colour Intensity

While the participants generally described the experience as calm and comforting, a recurring comment emerged regarding the colour intensity and palette. Several participants expressed a desire for more muted or cooler tones such as blue, green, or teal, noting that the warmer colours hue of red orange felt aggressive/ distracting or associated with danger.

This contrast highlights a tension between the intended calm interaction and the emotional associations evoked by specific colours. The findings therefore suggest that while the interaction design supports calm and personal engagement, the colour selection plays a critical role in sustaining that experience and would benefit from further refinement.

Theme 5: Desire for Personalisation and Customisation

A strong theme that came across was the desire for a greater personalisation. Participants suggested the ability to choose or exclude specific colours, customising the faceplate design (shape, colours, and size), use personal imagery for faceplate (such as children's drawings). and creating multiple units arranged as a collage.

These suggestions indicate that users viewed the piece not as a finished artifact, rather as a medium for personal expression. This theme highlights the potential for extending the design beyond a single object into a modular or customisable system, which can flourish emotional attachment and long term user engagement.

Theme 6: Contextual use in Transitional home space

Participants most frequently imagined placing the interactive light in hallways and living rooms, with fewer selecting spaces such as bedrooms or workspaces. This suggests that the light was best seen and suitable for transitional or shared environments.

Comments describing the light being ideal for slow, ambient moments further reinforces its role as an atmospheric element rather than a functional light source. This aligns with the project's intent to create a background presence art piece that enhances everyday movement through space.

Theme 7: Refinement of physical controls

A small theme concerned the usability of the physical controls. One participant suggested replacing the mode button with a toggle switch to improve affordance and reduce confusion, indicating awareness of interaction clarity even in a minimalist design. This feedback supports iterative refinement of tangible interactions while maintaining the overall simplicity and minimalism of the interaction.

To address the research question, the results indicate that the minimalist, movement responsive interactive wall art successfully fostered users emotional engagement and a sense of personal responsiveness within a domestic setting. The participants generally found the interaction intuitive and easy to understand, with the emotional responses being primarily through the embodied movement and visual feedback rather than direct user manipulation.

The piece was commonly perceived as calm and suitable for use in transitional home spaces, supporting the role as ambient interactive art rather than a functional lighting solution. In addition, mode 2 was appreciated by the participants as an optional feature, although their primary engagement remained focused on the passive interaction. While the colour intensity and palette influenced perceptions of calmness, the overall findings demonstrate that a subtle, passive interaction can create a meaningful and personal experience in minimalist interactive wall art.

4 Discussion and Conclusion

The findings indicate that a minimalist, movement based interaction can effectively support emotional engagement and a sense of personal responsiveness in interactive wall art within a domestic setting, transforming static wall art into performative and engaging experience.This positive emotional engagement through embodied interaction seen in this research supports the arguments of Guo et al.[1], who demonstrates that interactive installations can foster emotional engagement through environmental conditions and bodily presence in place of direct user input. Similarly, Nam and Nitsche[5] frame interactive installations as performative systems.

The results from the responses and data analysis further suggest that the interactive wall art can successfully integrate into everyday homes without becoming intrusive. This is further seen from the participants' appreciation of the passive mode as they value interaction that adapts to them rather than requiring continued attention or control.

The interactive wall light successfully captured the participants interest and engagement. Participants were able to understand the lights' behavior intuitively, without the need for any additional documentation or explanation, suggesting that the minimalist interaction design was clear and effective. Participants expressed interest in the product if it were to enter production, particularly if opportunities for personalisation were included. Several participants highlighted the value of customisation in fostering emotional attachment, such as the ability to modify the shape, colour, and faceplate design to their liking. One participant noted that "it would be great to have art related to you, such as your kids' drawings", underscoring the importance of personal meaning in interactive

art. From that feedback the light fulfilled its intended purpose of being minimalist while remaining effective and engaging to the participants, suggesting that minimal interaction can still allow for personal expression.

Despite these strengths, limitations emerged in relation to colour selection. While the movement triggered colour change was appreciated, some participants reported discomfort with the red-orange hue. When asked, the responses ranged from that the colour was distracting or caused discomfort as one participant associates that colour with danger. This highlights the importance of aesthetic choices in influencing the emotional attachment and engagement for the potential users even when the interaction design functions as intended. From a design perspective, these findings suggest that offering users control over colour palettes is important in sustaining emotional attachments and calm engagement. This indicates that the design of minimalist interactive art should balance expressive feedback with adaptability, which allows the users to shape the experience to their liking without undermining its ambient and unobtrusive nature.

This research had some limitations: Firstly, the number of participants was small (8 total), while the user group was sufficient to identify trends, patterns, and design insights during this research. It would be beneficial having a larger and more diverse sample as it could reveal more additional usability issues, preferences, or personalisation requests that did not emerge within this research.

Secondly, the user testing was conducted in a setting that was not in the ideal environment that being the participants own home. This was largely due to the short testing period as well as only having one prototype. As a result the findings may not fully reflect how the interactive wall art would be experienced in a real domestic environment. Therefore factors such as daily routines, long term exposure, and personal spatial context may have an influence on emotional attachment, usefulness, and perceived calmness.

Thirdly, the prototype was not developed with production feasibility as a primary focus. The prototype used off the shelf components which required adapting and combining elements that would likely be replaced or optimised in the final product unit. As these components occasionally affected the systems reliability and responsiveness, meaning that the prototype may not fully represent the performance of a purpose built commercial version.

Finally, the evaluation was short term, this limits the ability to assess long term engagement, adaptation, or changes in the end user emotional response over time. To address this issue, it would be vital to extend the use cases and product deployment to understand how the novelty of the interaction evolves over time and whether the light continues to provide meaningful ambient engagement.

To conclude, this research explored how minimalist movement responsive interactive wall art influences the users emotional engagement, sense of personal responsiveness, and suitability for use in a domestic setting. The findings indicate that the interactive artwork was generally perceived as intuitive, emotionally engaging, and able in creating a personal connection through subtle, embodied interaction and environmental responsiveness rather than direct user control.

Although the results were largely positive, they should be considered within the scope of the research limitations, particularly the small participant group and the inability to evaluate the prototype in a domestic setting. These factors may affect how the artwork is experienced over longer periods of time and different living contexts. However, the research highlights the importance of aesthetic decisions in interaction design, demonstrating how elements such as colour choice can significantly affect the emotional perception and user comfort. This was evident by the feedback regarding discomfort with the red-orange hue and the strong desire for personalisation as it can foster emotional attachment to interactive art.

Future research could build upon these findings by conducting long term, in home evaluations and exploring expanded personalisation options such as including different colour palettes, design forms, and scales of the piece. Such investigations would provide deeper understanding and insights into sustained engagement and support the further development of the prototype towards a final market ready interactive art piece.

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A appendix

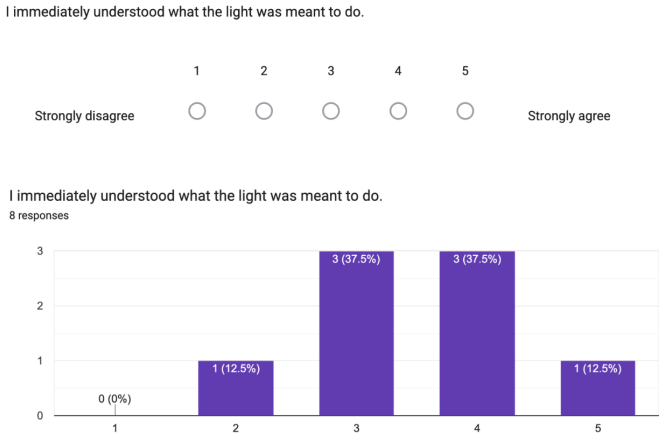

Figure 5: Survey question and responses

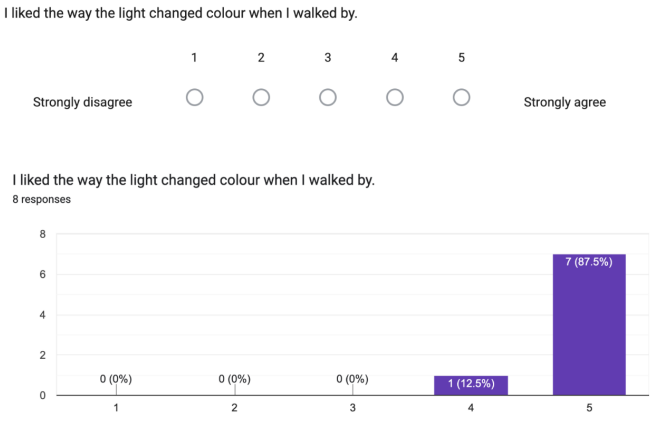

Figure 6: Survey question and responses

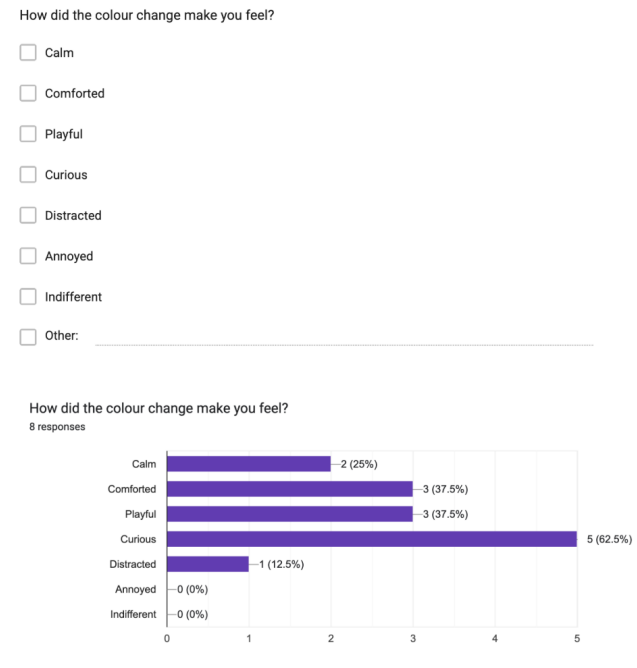

Figure 7: Survey question and responses

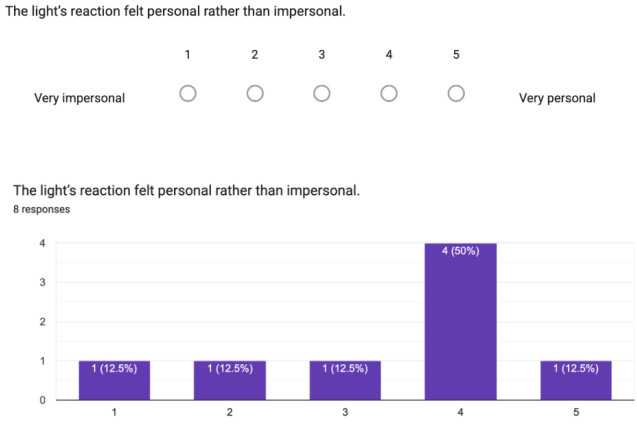

Figure 8: Survey question and responses

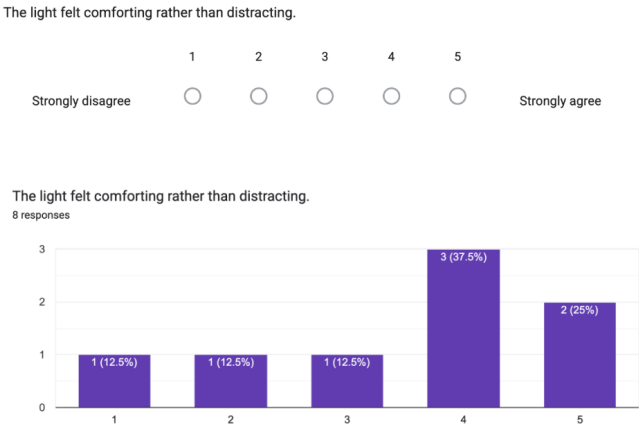

Figure 9: Survey question and responses

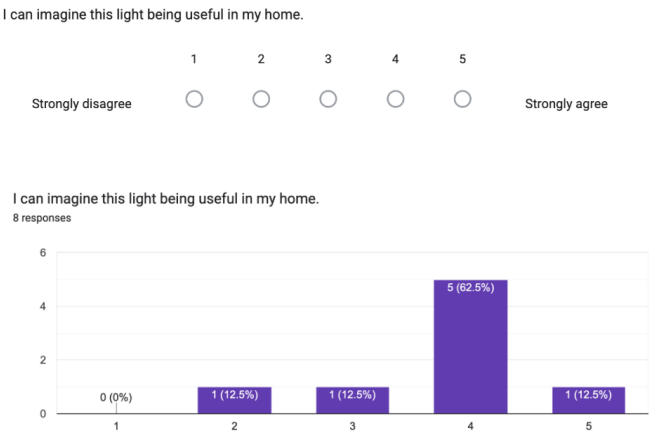

Figure 10: Survey question and responses

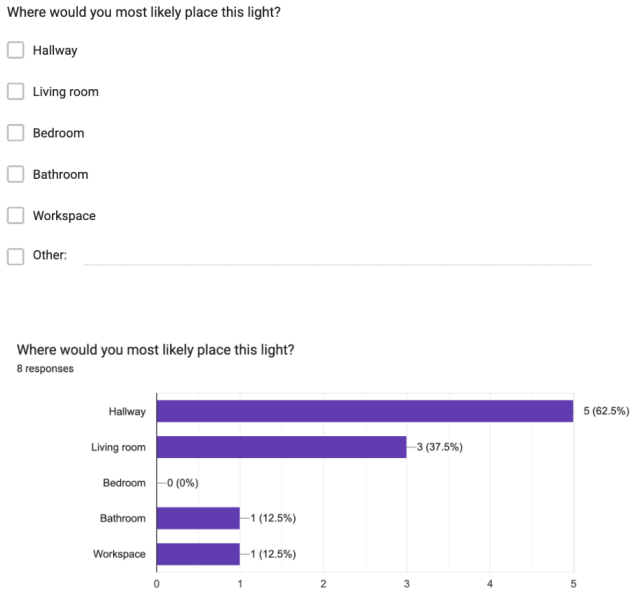

Figure 11: Survey question and responses

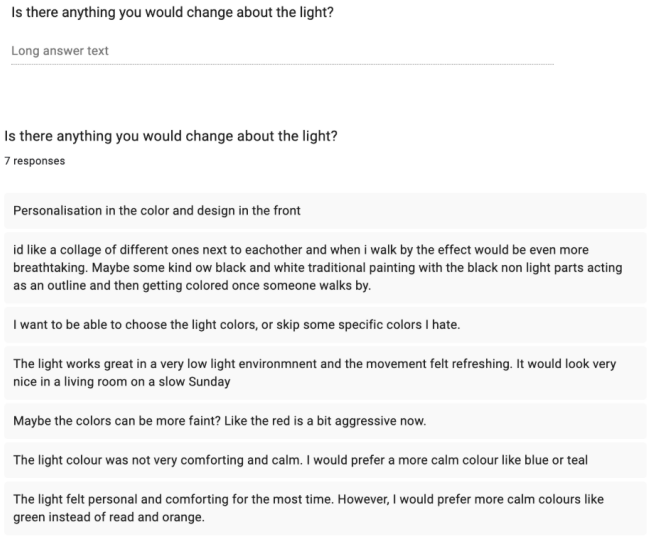

Figure 12: Survey question and responses