

Embodied Multimodal Dialogue in Interactive Art Installations: Toward Sustainable Creative Practices

Arminda Guerra^{1,2}

¹ Polytechnic University of Castelo Branco, Portugal

² LARSyS, Lisbon, Portugal
{aglopes}@ipcb.pt

Abstract. Multimodal interaction has become a central concern in contemporary Human–Computer Interaction (HCI), particularly in contexts where bodily engagement and sensory integration are fundamental to user experience. Interactive art installations constitute a specific domain within HCI in which interaction is exploratory, situated, and often resistant to conventional usability evaluation. Although principles from User-Centered Design (UCD), Interaction Design, and User Experience (UX) are frequently invoked to describe such systems, their empirical application to interactive art remains methodologically underspecified. This paper examines multimodal dialogue as an analytical lens for understanding interaction in artistic installations. Three interactive installations, SandBox, TIDE (IDEArt), and Threshold, are analyzed as qualitative case studies using a unified research design. Data were collected through systematic observation, semi-structured interviews, and audiovisual documentation, and analyzed using thematic analysis. The results identify recurrent patterns of embodied interaction, sensory exploration, and interpretative meaning-making across the three installations. In preference to proposing a new theoretical framework or quantitative evaluation model, this study contributes a methodologically transparent approach to investigating multimodal dialogue in interactive art, demonstrating, through evidence gathered across three case studies, how embodied and interpretative forms of interaction support sustained engagement, methodological reuse, and the long-term relevance of interactive installations beyond technological novelty.

Keywords: Multimodal interaction; Interactive art installations; Embodied interaction; Dialogue; Qualitative HCI; Sustainable creative practices.

1 Introduction

The increasing pervasiveness of multimodal interaction has significantly expanded the scope of Human-Computer Interaction (HCI), moving beyond screen-based interfaces toward systems that engage the human body, multiple sensory channels, and spatial environments. In parallel, interactive art installations have emerged as a fertile ground for experimentation with embodied interaction, sensory dialogue, and experiential meaning-making. These installations frequently operate outside conventional paradigms of task efficiency and usability, prioritizing exploration, interpretation, and affective engagement.

Beyond expanding interaction modalities, the growing adoption of digital technologies in embodied and experiential systems has also raised questions about sustainability in design practice. Within this study, sustainability is understood not only in environmental terms but also as the capacity of interactive systems to remain meaningful over time, to support repeated interpretation, and to minimise dependence on continual technological renewal. These dimensions resonate with current discussions on sustainable creative practices within HCI, where long-term experiential value, methodological reuse, and design longevity are increasingly recognised as relevant forms of sustainability.

Interactive art installations provide an appropriate context for examining these issues because they are frequently revisited, reconfigured, and experienced by different audiences across multiple exhibition settings. Their value often derives less from technological novelty than from the embodied and interpretative experiences they enable. Consequently, investigating how participants engage with such installations also provides an opportunity to examine how embodied interaction may contribute to sustainable creative practice through continued relevance, reuse of design approaches, and sustained experiential engagement.

By examining interactive art installations as methodological case studies, this paper situates artistic practice within the discourse of sustainable innovation in creative industries. Instead of treating sustainability as an external constraint, the study approaches design methodology itself as a driver of sustainable transformation, capable of influencing cultural change, pedagogical frameworks, and interdisciplinary collaboration.

Despite growing academic interest, interactive art remains an ambiguous domain within HCI research. While many installations are discussed using the vocabulary of User Experience (UX), Interaction Design, or User-Centered Design (UCD), these concepts are often applied descriptively rather than analytically. As a result, claims regarding immersion, emotional engagement, or meaningful interaction are frequently asserted without sufficient methodological grounding. This tension has been noted in prior research, which highlights the difficulty of reconciling artistic exploration with scientific rigor [1], [2].

The present study addresses this challenge by focusing on the notion of dialogue as a central mechanism in interactive art. Dialogue is understood here

not as verbal exchange alone, but as an embodied, multimodal process through which users interact with artifacts, environments, and meanings. Drawing on perspectives from interaction design, social semiotics, and experiential HCI, this paper investigates how multimodal dialogue can be empirically examined in interactive art installations without reducing their artistic complexity.

The present study builds upon a long-term practice-based research trajectory situated at the intersection of interactive art, design, and Human-Computer Interaction. Previous work by the author has consistently explored dialogue as a relational and embodied process emerging between people, artifacts, and contexts rather than as a purely verbal exchange [3]. This perspective informs the conceptual grounding of the installations analyzed in this paper and provides continuity across more than a decade of artistic and research practice.

Earlier installations such as TIDE (IDEArt) [4] and Threshold [5] were developed at a time when multimodal and embodied interaction had not yet become established topics within mainstream HCI discourse. These works anticipated later developments in experiential and embodied HCI by foregrounding sound, bodily movement, and spatial interaction as primary modes of dialogue. More recently, the SandBox installation further articulated this trajectory by explicitly examining memory, touch, and auditory experience through empirical observation and user engagement [6].

Instead of introducing a fundamentally new theoretical framework, the present paper consolidates and systematizes insights derived from this body of work by applying a unified qualitative methodology across multiple installations. In doing so, it addresses the need, highlighted in recent HCI literature, for greater methodological transparency and analytical rigor in studies of interactive art and experiential systems. By examining these installations through a common qualitative framework, the study also explores how methodological consistency can support the accumulation of transferable knowledge across artistic HCI projects, contributing to more sustainable research and design practices.

The research is guided by the following question: How can multimodal dialogue in interactive art installations be systematically studied using a coherent qualitative methodology? Rather than proposing a new interaction model or evaluative framework, the study contributes a transparent qualitative approach for analysing embodied interaction across multiple artistic installations. In addition, by examining recurrent patterns of engagement across three case studies developed over more than a decade, the paper discusses how embodied interaction may support sustainable creative practices through experiential longevity, methodological reuse, and reduced dependence on technological novelty.

2 Related Work

2.1 Computer Interaction Historical Context: Interactive Art and Embodied Interaction

Interactive art installations examined within HCI research can be situated within a longer international trajectory of artistic and technological experimentation with embodied interaction. Early developments in interactive environments, particularly the work of Myron Krueger in the late 1960s and 1970s, established the body as a primary interface and interaction as a spatial, performative, and experiential process. Krueger's concept of "responsive environments" anticipated later concerns in HCI regarding unencumbered bodily interaction and the integration of movement, perception, and feedback. From the 1980s onward, institutions and exhibition platforms such as Ars Electronica played a central role in consolidating interactive and media art as an international field. Through exhibitions, festivals, and critical discourse, interactive installations were framed not only as technological experiments but as cultural practices engaging participation, perception, and meaning-making. Similarly, large-scale exhibition contexts such as the Venice Biennale progressively incorporated interactive and digitally mediated artworks, situating embodied interaction within contemporary art discourse. The installations analysed in this paper, SandBox, TIDE (IDEArt), and Threshold, emerge from this broader international landscape. While developed in specific institutional and temporal contexts, they align with artistic traditions that foreground bodily engagement, multisensory interaction, and interpretative openness rather than task efficiency or functional optimisation.

2.2 Multimodal Interaction in HCI

Research on multimodal interaction has long emphasized the integration of multiple sensory modalities as a means to support richer, more natural, and more expressive forms of human-computer interaction. Multimodality enables users to distribute cognitive and physical effort across channels such as speech, gesture, touch, and vision, reducing interactional load while increasing expressiveness [7].

Within HCI, multimodal systems have been shown to support accessibility, engagement, and experiential richness, particularly in non-task-oriented and exploratory contexts [8]. Interactive art occupies a distinct position within this research landscape. Instead of optimizing efficiency or task completion, artistic interactive systems often foreground ambiguity, play, and interpretation as central interactional values. Interactive art is a processual dialogue between system and participant, in which meaning emerges through interaction rather than being predefined [9]. Similarly, design approaches deliberately embrace

uncertainty and experiential richness, even when such approaches resist formal evaluation according to conventional usability metrics [10].

More recent HCI scholarship has sought to address these concerns by explicitly framing interactive art installations as sites of multimodal dialogue, where interaction unfolds through the dynamic interplay of bodily movement, sensory modalities, spatial configuration, and user interpretation. In this context, dialogue is understood not as verbal exchange but as a situated, embodied process that evolves [13], [14]. Studies presented at venues such as CHI, TEL, and ISEA increasingly emphasize that artistic installations resist conventional usability metrics while fostering engagement through ambiguity, exploration, and affective resonance [15]. Meaning in interaction arises through users' interpretative and emotional engagement, reflecting the experiential and non-deterministic nature of artistic interactive practices [16].

2.3 Embodiment and Somaesthetic Interaction

Parallel to developments in multimodal interaction research, theoretical work on embodiment has significantly shaped contemporary understandings of interaction in HCI. Embodied interaction frameworks position cognition and meaning-making as inseparable from bodily movement, perception, and situated engagement. In preference to treating the body as a mere input mechanism, embodiment-oriented approaches understand interaction as a lived, sensory, and relational process unfolding in context.

Within this trajectory, somaesthetic interaction design has contributed a more finegrained account of how bodily awareness, subtle movement, and felt experience can be intentionally cultivated through design. Höök and colleagues argue that interaction design can deliberately support sensory attention and bodily reflection, emphasising the role of touch, posture, tension, rhythm, and movement in shaping experience. In this perspective, the body is not simply the site of action but also the locus of interpretation and meaning construction. Related work by Schiphorst and others further underscores the importance of affective awareness, bodily presence, and felt engagement in interactive systems. These approaches challenge purely cognitive or task-based models of interaction and instead foreground experiential depth, sensory immersion, and relational negotiation.

Research on embodied and somaesthetic interaction highlights how movement, touch, and bodily perception function as dialogical mechanisms through which users negotiate meaning in situ [12], [17]. Interaction in artistic systems can therefore be understood as an ongoing exchange between body, artefact, and environment.

This embodied perspective aligns closely with the notion of multimodal dialogue adopted in this study. Dialogue is not limited to verbal exchange but emerges through coordinated sensory modalities, spatial configuration, bodily negotiation, and environmental responsiveness. The installations examined here

invite participants to engage through touch, listening, movement, and attentional focus, placing embodiment at the centre of the interaction process. This perspective is consistent with Dourish's conception of embodied interaction as situated action, in which meaning emerges through engagement with the physical and social environment and through lived bodily experience [21]. This perspective provides additional theoretical support for examining multimodal dialogue as an experiential process grounded in bodily participation and environmental responsiveness.

2.4 Methodological Challenges in Artistic HCI

At the same time, this emphasis on experience has drawn sustained criticism within HCI. Several authors note that research on interactive art frequently relies on anecdotal evidence, subjective interpretation, and post-hoc theorization, often without sufficiently articulated methodological frameworks [11], [12]. Although qualitative approaches such as ethnography, observation, and reflective practice are widely accepted within HCI, the lack of explicit methodological transparency can weaken the scientific contribution of experiential and artistic studies.

2.5 Positioning the Present Study

Within this broader trajectory, early practice-based contributions demonstrated the potential of dialogue, embodiment, and multisensory engagement as central mechanisms of interaction even before these concepts were formally articulated within HCI theory. Design is a dialogical process in which meaning emerges through interaction among designers, users, artifacts, and contexts [3]. This conceptualization informed early interactive art projects such as TIDE (IDEArt) [4], which explored mediated voice and auditory dialogue, and Threshold [5], which investigated bodily interaction within architectural space.

Subsequent work on SandBox extended this line of inquiry by empirically examining how tactile interaction and sound contribute to memory, interpretation, and experiential meaning, using systematic observation and user feedback as primary methods [6]. While these studies provided valuable insights into individual installations, they were developed and documented independently and did not aim to establish a shared analytical framework.

The present study situates itself within this evolving body of work by bringing together these installations under a unified qualitative methodological approach. The principal contribution of this study lies in articulating multimodal dialogue as an empirically observable and analytically defensible phenomenon across multiple installations and interaction modalities. By doing so, the study responds to ongoing calls within HCI for greater methodological transparency while also providing a qualitative framework that can be transferred to the study of other artistic interactive systems. This methodological continuity further enables discussion of how embodied interaction may contribute to sustainable

creative practices through the long-term relevance and reuse of both design approaches and research methods.

2.6 Design Methodologies, Education, and Sustainable Innovation

Interactive art installations are increasingly recognised not only as artistic artefacts but also as environments in which design methodologies can be explored, evaluated, and refined. Within this context, sustainability extends beyond environmental considerations to include the capacity of interactive systems to remain meaningful across different exhibition settings, audiences, and technological contexts.

Installations based on embodied interaction invite participants to construct meaning through bodily engagement, sensory exploration, and interpretation, allowing experiential value to emerge independently of continual technological novelty. Such characteristics may contribute to longer experiential lifecycles by allowing the same installation to generate new experiences without continual technological replacement or redesign.

Sustainability also applies to research practice. Qualitative methodologies that can be consistently applied across multiple artistic projects facilitate comparison, methodological reuse, and the accumulation of transferable knowledge. The present study adopts this perspective by analysing three interactive installations through a common qualitative framework, enabling not only cross-case comparison but also discussion of how methodological consistency can support sustainable creative practice in artistic Human-Computer Interaction.

3 Materials and Methods

This study employs a qualitative multiple-case study design, which is well-suited to exploratory research in complex, context-dependent environments [18]. Three interactive art installations were selected as case studies due to their explicit reliance on multimodal interaction and bodily engagement: SandBox, TIDE (IDEArt), and Threshold. Although developed in different contexts and periods, all three installations were designed to invite open-ended interaction rather than task-based use.

To address methodological inconsistency across installations, the present analysis applies a unified methodological framework to all three cases, ensuring coherence in data collection and analysis.

Participants were recruited opportunistically during public exhibitions and academic events in which the installations were presented. A total of 60 participants were observed across the three case studies, of whom 33 also took part in informal or semi-structured interviews (Table 1). Participation was voluntary and non-intrusive, and no personally identifying information was collected. Interviews were conducted immediately after the interaction with participants who either volunteered to discuss their experience or were invited

to participate when their interactions were considered particularly informative for the study, for example, because they encountered difficulties during the interaction or expressed a strong interest in reflecting on their experience. As appropriate for qualitative multiple-case research, the aim was not statistical representativeness but the identification of recurrent patterns of embodied interaction across different installation contexts.

Table 1. Distribution of Participants

Installation	Participants Observed	Participants Interviewed
SandBox	22	12
TIDE	18	10
Threshold	20	11
Total	60	33

Data collection combined three complementary methods. First, non-participant observation was conducted, focusing on users' bodily movements, interaction sequences, and engagement duration. Second, informal and semi-structured interviews were carried out immediately after interaction, allowing participants to reflect on their experience while it remained fresh. Third, audiovisual documentation, including photographs and video recordings, captured interaction dynamics for subsequent analysis.

The collected data were analyzed using thematic analysis following the approach outlined by [19]. Observational notes and interview transcripts were iteratively coded to identify recurring behaviors and experiential themes. While no inter-coder reliability measures were applied, analytic memos and repeated review cycles were used to mitigate interpretative bias. This approach aligns with qualitative traditions in HCI while acknowledging inherent subjectivity.

The qualitative methods adopted in this study are consistent with those employed in earlier investigations of the author's interactive installations. Previous empirical analysis of SandBox demonstrated that observational studies and user interviews are effective in capturing experiential dimensions such as memory association and sensory engagement [6]. The present research extends this methodological approach across multiple installations, ensuring consistency in data collection and analysis while enabling comparative interpretation.

The methodological coherence applied across the three case studies also supports one of the central contributions of this paper. By applying the same qualitative procedures across installations developed in different contexts and periods, the study enables systematic comparison while preserving the experiential specificity of each work. This methodological consistency contributes to the transferability of the proposed approach and supports the accumulation of knowledge across artistic HCI research.

As this study is grounded in practice-based research, the author assumed the dual role of designer and qualitative researcher. While this position provided detailed knowledge of the installations and their exhibition contexts, it also required careful attention to reflexivity during data collection and analysis. To minimise potential bias, the same procedures were applied consistently across all three case studies, and interpretations were grounded in observational records, participant accounts, and audiovisual documentation.

To make the methodological contribution of this study more explicit and transferable, Table 2 summarises the sequence of qualitative procedures applied consistently across the three case studies. Although developed within the context of interactive art installations, this framework may be adapted by researchers investigating embodied interaction in other artistic HCI contexts.

In preference to prescribing a fixed evaluation protocol, the framework provides a methodological guide that can be adapted to different artistic contexts while maintaining consistency in qualitative data collection and analysis.

Table 2. A transferable qualitative framework for analysing multimodal dialogue in interactive art installations

Phase	Purpose	Data Source	Output
Observation	Document embodied interaction and behavioural patterns and engagement	Field observations	Interaction records
Semi-structured interviews	Capture participants' interpretations and reflections	Interview transcripts/notes	Experiential accounts
Audiovisual documentation	Preserve interaction dynamics and support subsequent analysis	Photographs and video recordings	Visual evidence
Thematic analysis	Identify recurrent themes across multiple data sources	Observations, interviews and audiovisual material	Cross-case themes
Cross-case comparison	Compare themes across installations and derive methodological implications	Themes from all three case studies	Transferable analytical framework

4 Case Descriptions

SandBox is an interactive installation that combines tactile and auditory interaction through direct engagement with sand. Users place their hands into a box filled with sand while listening to sound fragments triggered by movement. These fragments include recorded voices, environmental sounds, and personal narratives related to the sea. The interaction invites users to explore the materiality of sand while constructing meaning through sound and memory. The

physical configuration of the installation and typical interaction postures are illustrated in Figure 1. The use of sand as an interaction material was a deliberate design decision, introducing resistance, instability, and tactility as central components of interaction.



Fig. 1. SandBox

TIDE (IDEArt) consists of a series of visual artworks augmented with whispered synthetic speech emitted through embedded transducers. The installation juxtaposes handmade and digitally produced elements, creating a dialogue between visual and auditory modalities. Interaction is subtle and contemplative, relying on proximity and attentive listening rather than overt physical manipulation. Figure 2 documents the spatial arrangement of the artworks and the proximity-based interaction required to perceive the whispered audio, highlighting the subtle bodily orientation and attentive listening involved.



Fig. 2. TIDE

Threshold is a site-specific installation composed of suspended copper tubes positioned within an architectural passageway. As users move through the space, their bodily contact with the tubes triggers audiovisual responses. Interaction is unavoidable and embodied, making the user's body an integral component of the system. As shown in Figure 3, the installation occupies an architectural passageway, making bodily contact with the suspended copper tubes unavoidable and integrating interaction into everyday movement through the space.



Fig. 3. Threshold

5 Results

This section presents the empirical findings derived from systematic observation, informal and semi-structured interviews, and audiovisual documentation conducted across the three interactive installations: SandBox, TIDE (IDEArt), and Threshold. The findings are organised around recurrent patterns of embodied interaction identified across the three case studies and are grounded in both observed behaviours and participants' reflections. Interpretative claims remain closely connected to the empirical material.

Across all three installations, users exhibited prolonged periods of contemplation before active interaction. Observation notes consistently document moments in which participants stood still, visually scanning the installation, listening attentively, or slowly approaching the artifact. In TIDE (IDEArt), several users remained positioned in front of individual artworks for

extended durations, often leaning closer to the surface as if to better perceive the whispered audio. One participant commented, "I didn't realize at first that the sound was coming from the drawing itself. I had to stop and really listen." This suggests that engagement frequently began with perception and contemplation, with active interaction emerging progressively as participants explored the installations.

In SandBox, users often hesitated before touching the sand, visually inspecting the box, and listening to the ambient soundscape. Once interaction began, hand movements were slow and exploratory, indicating a careful negotiation between touch and auditory feedback. A participant reflected, "It feels like the sound is buried in the sand. You have to search for it." Such statements indicate that interaction was perceived not as direct control, but as a dialogical process of discovery.

In Threshold, contemplation was spatial and bodily. Visitors entering the space frequently slowed their pace, raised their heads to observe the suspended copper tubes, and adjusted their walking trajectory. In several cases, users paused beneath the structure before continuing, appearing to anticipate contact. One user remarked, "You can't rush through it. Your body has to adapt." These observations suggest that the installation elicited a heightened bodily awareness even before explicit interaction occurred.

Following this initial contemplative phase, interaction unfolded through embodied exploration. In SandBox, users modulated hand pressure, speed, and depth within the sand, seemingly experimenting with how sound fragments responded. In Threshold, bodily movement, particularly the head, shoulders, and upper torso, became the primary interaction modality. Some users adopted exaggerated movements, while others minimized contact, indicating individual strategies of engagement. Importantly, these behaviors were not uniformly playful or expressive; they ranged from cautious and restrained to performative and exploratory.

The emergence of narrative interpretation observed in SandBox is consistent with findings reported in earlier studies, where users associated tactile and auditory interaction with autobiographical memory and imagined scenarios [6]. In the present analysis, similar narrative behaviors were observed not only in SandBox but also in TIDE (IDEArt), suggesting that narrative construction constitutes a recurrent mechanism of multimodal dialogue across installations with distinct material configurations.

Narrative construction emerged as a recurrent phenomenon, particularly in SandBox and TIDE. Users frequently verbalized associations between the sounds they heard and personal memories or imagined scenarios. One SandBox participant stated, "It reminds me of being at the beach as a child, but it's not a specific memory; it's more a feeling." Similarly, in TIDE, users described assembling fragmented whispered phrases into interpretative wholes. A participant noted, "I don't understand every word, but together they create a mood." These accounts indicate that meaning-making emerged through participants' interpretation of the interaction, consistent with experiential models of Human-Computer Interaction.

Affective responses were expressed cautiously and often indirectly. Instead of explicitly labeling experiences as “emotional” or “immersive,” users tended to describe states of attention, calmness, or curiosity. For example, a visitor to Threshold observed, “It makes you aware of yourself in the space. You start noticing how you move.” Such reflections suggest a process of embodied self-awareness, in which participants became increasingly aware of their bodily experience, sensory perception, and interaction with the installation.

Across installations, engagement duration exceeded what is typically observed in gallery settings for non-interactive works. While not quantitatively measured, observational records consistently indicate that users spent several minutes interacting with or contemplating each installation, often returning for repeated interaction cycles. This repeated engagement suggests that interaction was not driven by novelty alone, but by experiential qualities that encouraged sustained attention and reinterpretation over time. The recurrence of this pattern across installations developed in different years and technological contexts suggests that participants' engagement was primarily supported by embodied exploration and interpretative openness rather than by technological novelty alone.

6 Discussion

The findings provide empirical support for the central research question by demonstrating how multimodal dialogue emerges through the interplay of bodily movement, sensory feedback, and interpretative meaning-making. Dialogue unfolded as a processual interaction between the user and the artefact, mediated by the body, the senses, and the evolving relationship established during the interaction.

One key insight concerns the role of contemplation as an integral component of interaction. Across all three installations, observations indicate that dialogue frequently began with stillness, attentive observation, and perceptual tuning before any overt physical action occurred. This finding aligns with McCarthy and Wright's assertion that experience is shaped by anticipation and interpretation as well as by action [20]. From this perspective, contemplation forms part of the interaction sequence itself, contributing to the emergence of multimodal dialogue rather than preceding it.

Comparing the three installations reveals how different material and spatial configurations shape the form of multimodal dialogue. In SandBox, dialogue was localized and tactile, unfolding through the hands and mediated by granular materiality. In TIDE, dialogue was intimate and perceptual, relying on proximity, listening, and visual attention. In Threshold, dialogue was distributed across the whole body and the architectural space, rendering interaction unavoidable and situational. Despite these differences, all three installations elicited similar patterns of exploratory behavior and interpretative engagement, suggesting transferable mechanisms of multimodal dialogue.

The narrative constructions observed in *SandBox* and *TIDE* support existing research on meaning-making in HCI, which emphasizes that users actively construct interpretations instead of passively receiving content [16]. Importantly, these narratives were not explicitly prompted by the system but emerged through interaction, reinforcing the dialogical nature of the installations.

The recurring interaction patterns observed across the three installations provide evidence that participants' engagement was sustained through embodied exploration, sensory attention, and interpretative meaning-making, with the experiential qualities of the interaction proving more influential than technological novelty alone. Although developed in different years and using different technological configurations, the installations elicited comparable behaviours, including prolonged contemplation, repeated interaction, and personal narrative construction. These findings suggest that the experiential value of the installations derives primarily from the quality of embodied interaction, supported by participants' active engagement and interpretation across all three case studies.

The case studies also illustrate how open-ended interaction contributes to the continued relevance of interactive artworks. Each installation encouraged participants to explore, reinterpret, and revisit the interaction according to their own experiences instead of following predetermined sequences of use. Such characteristics support the long-term relevance of the installations by allowing meaningful engagement to emerge through repeated interaction without requiring continual technological renewal. In this sense, the findings suggest that sustainability in artistic Human-Computer Interaction is reflected in the persistence of experiential value, interpretative openness, and continued engagement alongside environmental and technological considerations.

This study deliberately refrains from equating observed behaviors with predefined emotional states. While users occasionally expressed pleasure or fascination, affective engagement was primarily inferred through sustained attention, repeated interaction, and reflective commentary. This cautious interpretative stance strengthens the credibility of the findings and avoids speculative claims.

Methodologically, the results demonstrate that interactive art installations can be studied using qualitative rigor without reducing experiential complexity. By applying consistent data collection and analysis methods across installations, the study responds directly to critiques of methodological inconsistency. Moreover, by explicitly separating empirical observation from interpretative discussion, the paper clarifies the evidentiary basis for its claims. This methodological consistency also facilitates the reuse of the proposed qualitative approach in future studies of artistic HCI, extending its contribution beyond the three installations examined here.

The findings of this study should be understood as part of an ongoing investigation into dialogue, embodiment, and multimodal interaction within artistic contexts. Building on the author's previous empirical and conceptual work, which has consistently emphasised dialogue as an experiential and

relational process [3], [6], this study extends that perspective through a comparative qualitative analysis of three interactive art installations. By revisiting earlier installations such as TIDE (IDEArt) and Threshold through a unified analytical lens, the present study demonstrates how insights developed over time can be systematically examined within contemporary HCI research standards. This longitudinal perspective contributes to the field by showing how practice-based research can evolve toward greater methodological articulation without abandoning its experiential foundations.

Finally, the findings suggest that multimodal dialogue functions as a productive analytical concept for HCI research in artistic contexts. Dialogue, understood as an embodied and sensory exchange, provides a framework for linking user behavior to experiential outcomes without relying on task-based metrics. This contributes to ongoing discussions in HCI on how to evaluate systems designed to support exploration, ambiguity, and meaning-making, where efficiency is not the primary design objective. Taken together, the three case studies demonstrate that embodied interaction can support sustainable creative practice by maintaining participants' engagement independently of continual technological innovation. The findings indicate that, within artistic Human-Computer Interaction, sustainability extends beyond environmental performance and technological efficiency to include experiential longevity, interpretative openness, and methodological continuity. These characteristics emerge directly from the observed interaction patterns and provide a practical basis for future research and design in creative digital practice.

7 Limitations and Future Work

This study is limited by its qualitative scope and reliance on short-term interactions. Although the multiple-case design enabled the identification of recurrent patterns across three installations, the absence of standardized UX or affective measures restricts the generalisability of the findings. Interpretative bias cannot be fully eliminated despite the methodological procedures adopted to support analytical consistency. Future research should integrate validated UX scales, longitudinal methods, and mixed-methods approaches to further strengthen the empirical evidence and examine the long-term sustainability of embodied interaction in artistic HCI.

8 Conclusion

This paper set out to address the following research question: How does multimodal dialogue emerge in interactive art installations through embodied interaction, sensory engagement, and user interpretation, and how can this dialogue be empirically examined using qualitative methods? The study responded to this question by analyzing three interactive art installations, SandBox, TIDE (IDEArt), and Threshold, using a unified qualitative research

design grounded in systematic observation, user interviews, and thematic analysis.

The findings demonstrate that multimodal dialogue in interactive art does not arise primarily through verbal exchange or explicit system feedback, but through a processual interaction between the user's body, the sensory affordances of the installation, and the interpretative work performed by the participant. Across all three installations, dialogue emerged as an embodied negotiation in which users adjusted their movements, attention, and perceptual focus in response to sensory cues. This dialogical process was observable in moments of prolonged contemplation, exploratory bodily action, and iterative engagement, suggesting that dialogue unfolds over time rather than as an immediate reaction.

By comparing installations with distinct material and spatial configurations, the study showed that while the form of interaction varies - tactile and localized in SandBox, perceptual and intimate in TIDE, and spatially distributed in Threshold - the underlying mechanisms of multimodal dialogue remain consistent. In each case, users engaged in exploratory interaction followed by interpretative meaning-making, often constructing personal narratives or experiential associations. These observations provide empirical support for understanding dialogue as a multimodal and embodied phenomenon grounded in sensory experience, bodily interaction, and meaning-making. Methodologically, the research demonstrated that multimodal dialogue can be examined empirically within interactive art contexts without reducing experiential complexity to task-based or quantitative metrics. By applying the same data collection and analysis procedures across all three installations, the study addressed common criticisms regarding methodological inconsistency in artistic HCI research. The explicit separation between observation, user-reported reflection, and analytical interpretation further strengthens the credibility of the findings and clarifies the evidentiary basis for claims regarding engagement and meaning-making. The transferable qualitative framework presented in this study offers practical guidance for future investigations of embodied interaction in artistic HCI while maintaining the flexibility required by diverse creative contexts.

Importantly, this study does not claim to measure emotional impact in a psychometric sense, nor does it propose a new evaluative framework for user experience. Instead, it contributes a methodologically transparent approach for analyzing interaction in artistic systems, demonstrating how sustained attention, embodied exploration, and interpretative commentary can be treated as empirically observable indicators of engagement. In doing so, the paper responds directly to concerns regarding speculative interpretation and overgeneralization.

In conclusion, the research shows that multimodal dialogue in interactive art installations can be meaningfully studied as an embodied, sensory, and interpretative process using qualitative methods. By grounding its analysis in systematic observation and user accounts, the study offers a defensible and replicable approach to examining experiential interaction within HCI. These insights contribute to ongoing efforts to bridge artistic practice and interaction

design research, supporting more rigorous and reflective investigations of interactive systems that prioritize experience, exploration, and meaning.

Beyond its methodological contribution, the study demonstrates, through evidence gathered across three interactive installations, that meaningful engagement is primarily supported by embodied interaction and interpretative openness, with the experiential qualities of the installations playing a more significant role than continual technological innovation. The recurring patterns identified across the case studies suggest that experiential longevity, methodological reuse, and the continued relevance of interactive systems constitute important dimensions of sustainable creative practice within artistic HCI.

By consolidating insights from more than a decade of practice-based research, this study contributes both to the understanding of multimodal dialogue in interactive art and to broader discussions on sustainable creative practice within Human-Computer Interaction. It shows that rigorous qualitative methodologies can preserve the richness of embodied artistic experience while generating transferable knowledge capable of informing future research, design practice, and creative innovation.

Acknowledgments. Thank you to all the participants in these studies.

Disclaimer/Publisher's Note: The statements, opinions and data contained in this publication are solely those of the individual author(s) and contributor(s) and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. ASLERD and/or the member of the editorial board of IxD&A disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

References

1. Endter, Cordula. "Design for Elderly – A Meeting Point for Ethnography and Usability" *i-com*, vol. 15, no. 1, 2016, pp. 17-26. <https://doi.org/10.1515/icom-2016-0005>
2. K. Höök, S. Bardzell, S. Bowen, P. Dalsgaard, S. Reeves, and A. Waern, "Framing interaction design through design theory," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2015)*, Seoul, South Korea, 2015. <https://doi.org/10.1145/2702123.2702523>
3. A. Lopes, *Design as Dialogue: Encouraging and Facilitating Interdisciplinary Collaboration*. Saarbrücken, Germany: VDM Verlag Dr. Müller, 2009.
4. S. Andrews, A. Lopes, J. MacDermott, and C. Newell, "TIDE (IDEArt)," in *Proceedings of the Culture, Creativity and Interaction Design (CCID) Symposium*, York, UK, 2006.
5. N. Mounajjed, C. Peng, S. Walker, N. Bryan-Kinns, and J. Sheridan, "Threshold," in *Proceedings of the Culture, Creativity and Interaction Design (CCID) Symposium*, York, UK, 2006.

6. A. Moreno, A. Lopes, and M. Mendes, "Grains of Memory: User experience in the SandBox interactive installation," in *Advances in Intelligent Systems and Computing*, vol. 954. Cham, Switzerland: Springer, 2019, pp. 261–270. https://doi.org/10.1007/978-3-030-20444-0_28
7. S. Oviatt, "Multimodal interfaces," in *The Human–Computer Interaction Handbook*, 2nd ed., A. Sears and J. A. Jacko, Eds. Mahwah, NJ, USA: Lawrence Erlbaum, 2008, pp. 413–432.
8. S. Reeves, S. Benford, C. O'Malley, and M. Fraser, "Designing the spectator experience," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2004)*, Vienna, Austria, 2004, pp. 741–750. <https://doi.org/10.1145/985692.985786>
9. L. Candy and E. Edmonds, *Explorations in Art and Technology*. London, UK: Springer, 2002.
10. Gaver, B. (1999). Design: Cultural probes. *Interactions*. <https://doi.org/10.1145/291224.291235>
11. M. J. Muller, E. Edmonds, and J. Connell, "Living laboratories: A new form of participatory design research," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2010)*, Atlanta, GA, USA, 2010, pp. 195–204. <https://doi.org/10.1145/1753326.1753351>
12. K. Höök, M. Jonsson, A. Ståhl, and J. Mercurio, "Somaesthetic design," *Interactions*, vol. 23, no. 4, pp. 26–33, 2016. <https://doi.org/10.1145/2940156>
13. K. Höök, *Designing with the Body: Somaesthetic Interaction Design*. Cambridge, MA, USA: MIT Press, 2018.
14. P. Dalsgaard and L. K. Hansen, "Performing perception—Staging aesthetics of interaction," *ACM Transactions on Computer-Human Interaction*, vol. 27, no. 2, Article 11, 2020. <https://doi.org/10.1145/3381005>
15. S. Benford, G. Giannachi, B. Koleva, and T. Rodden, *Uncomfortable Interactions*. Cambridge, MA, USA: MIT Press, 2023.
16. E. D. Mekler and K. Hornbæk, "A framework for the experience of meaning in human–computer interaction," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Glasgow, UK, 2019. <https://doi.org/10.1145/3290605.3300455>
17. T. Schiphorst, "Felt experiences: Designing for movement awareness," in *Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI 2020)*, Sydney, Australia, 2020. <https://doi.org/10.1145/3374920.3374936>
18. R. K. Yin, *Case Study Research and Applications: Design and Methods*, 6th ed. Thousand Oaks, CA, USA: Sage, 2018.
19. V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006. <https://doi.org/10.1191/1478088706qp0630a>
20. J. McCarthy and P. Wright, *Technology as Experience*. Cambridge, MA, USA: MIT Press, 2004.
21. Dourish, P., *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge, MA, USA: MIT Press, 2001.