Designing With an Ecosystem: Reflections on Co-Designing Sensory-Informed Music Technology with Children with ASD, Families, and Music Therapists

Abhishek Karwankar
Computer and Information Sciences, University of Delaware
Newark, Delaware, USA
karwabhi@udel.edu

Evina Shingavi
MOT Charter School
Newark, Delaware, USA

Aayush Singh
MOT Charter School
Newark, Delaware, USA

Liam Stapley
Computer and Information Sciences, University of Delaware
Newark, Delaware, USA
lstapley@udel.edu

Aastha Desai
Computer and Information Sciences, University of Delaware
Newark, Delaware, USA
aasthade@udel.edu

Elise Ruggiero
College of Music, Florida State University
Tallahassee, Florida, USA
emr25b@fsu.edu

Daniel Stevens
School of Music, University of Delaware
Newark, Delaware, USA
stevens@udel.edu

Matthew Louis Mauriello
Computer and Information Sciences, University of Delaware
Newark, Delaware, USA
mlm@udel.edu

Abstract

We reflect on three years of co-designing a sensory-informed music ecosystem—uCue, ResonaVis, and CalmSet—with children with autism spectrum disorder (ASD), their families, educators, and music therapists at the Brennen School, Autism Delaware, and the Route 9 Library in New Castle County, Delaware. As we now extend this ecosystem with a public-facing web platform for parent-child dyads, built around musical activities co-designed with music therapists at the Brennen School, we use this position paper to surface the theoretical commitments, practical adaptations, and unresolved questions of ownership that have shaped our process—including ones we expect parents of children with ASD to shape further as we co-design the website itself.

ACM Reference Format:
Abhishek Karwankar, Evina Shingavi, Aayush Singh, Liam Stapley, Aastha Desai, Elise Ruggiero, Daniel Stevens, and Matthew Louis Mauriello. 2026. Designing With an Ecosystem: Reflections on Co-Designing Sensory-Informed Music Technology with Children with ASD, Families, and Music Therapists. In . ACM, New York, NY, USA, 3 pages. https://doi.org/10.5281/zenodo.22901011

1 Positionality and Project Overview

Within the Sensify Lab at the University of Delaware, our research focuses on the design of sensory-informed systems for music composition and therapy with neurodiverse populations, primarily children with ASD, their families, and the music therapists and educators who work with them. Over the years this has produced three completed contributions: uCue, a tangible interactive musical interface [7]; ResonaVis, a visualization system that lets music composers see and interpret a listener's interaction with the music during a session [8]; and CalmSet, a domain-specific dataset for affective music retrieval built from the sensory and emotional vocabulary our community partners actually use [9]. All three grew out of an ongoing collaboration with the Brennen School, Autism Delaware, and the Route 9 Library & Innovation Center in New Castle, Delaware. Figure 1 shows representative artifacts from each of these processes.

We are currently building a public web platform for parent-child dyads: a shared space where a parent and a child with ASD engage with musical activities together at home. The activities themselves are being co-designed with music therapists at the Brennen School, extending the same iterative process that shaped uCue into the home-use context, while the platform around them—its navigation, pacing, and the shared experience it creates for a parent and child sitting down together—will be co-designed directly with parents of children with ASD. Because the site is, in effect, a new design artifact built with a stakeholder group (i.e., parents) that our prior work engaged with less directly, it has forced us to be explicit about methodological commitments we had previously left implicit. This paper is our attempt at that reflection, organized around the workshop's three themes.

2 Theories: The Frameworks We Reached For, and Where They Are Strained

Two commitments anchored our work from the start. The first is ability-based design [14], which treats a person's abilities, not their

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Designing With, Not For Workshop @ ASSETS'26, Online
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https://doi.org/10.5281/zenodo.22901011

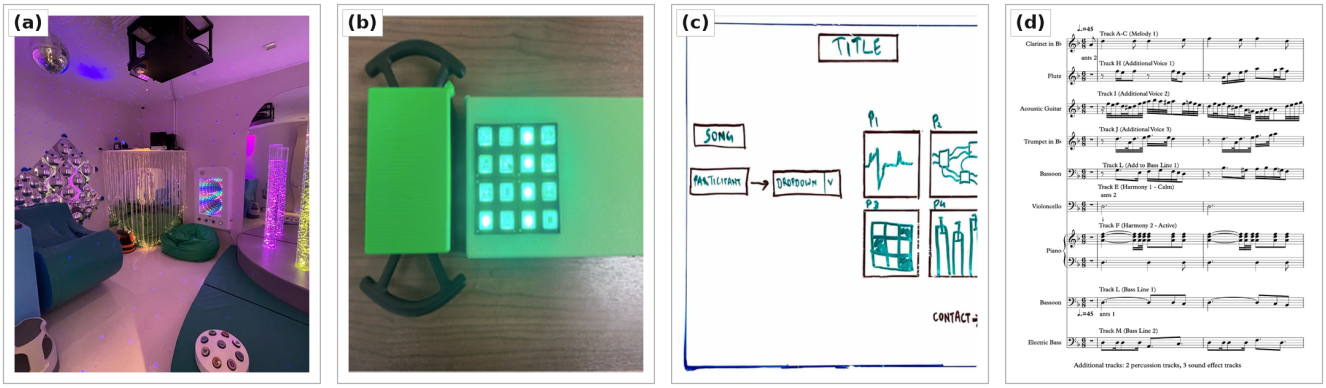


Figure 1: Artifacts from our co-design process across the three completed systems: (a) the multisensory room at the Rt. 9 Library that shaped uCue's early prototyping, (b) uCue's tangible interface, (c) lo-fi wireframe prototypes developed with composers for ResonaVis, and (d) an annotated score excerpt from CalmSet.

deficits, relative to a "typical" user, as the starting point for a system, placing the burden of adaptation on the technology rather than the user. This directly shaped uCue's tangible interface: rather than building a single fixed mode of interaction, we treated sensory and motor variability as an expected range to design across, echoing sensory-adjustable design work in participatory virtual play spaces for neurodiverse children [2]. The second is the disability rights commitment "Nothing About Us Without Us" [13], which pushed us toward involving children with ASD [1], families, and music therapists as design partners throughout our work, not only as evaluators at the end.

In practice, both frameworks strained in ways the literature does not fully anticipate. Much of the human-computer interaction (HCI) participatory design literature for autism is written around a single, well defined participant group, most often children with ASD as direct co-designers [1, 3–5, 11]. Our stakeholder network is more heterogeneous: children who use uCue, composers who read ResonaVis, caregivers and educators who sit between the two, and, for the web platform specifically, parents who will use it together with their child at home, each with different communication needs, different stakes in the outcome, and different capacity to take part in a formal co-design session. For ResonaVis we worked with two undergraduate researchers and music composers, recruited through the University of Delaware's Undergraduate Research Program, over seven weeks of weekly design sessions. The design sessions opened by eliciting how composers already reasoned about musical structure and where that reasoning broke down, before we introduced sample uCue interaction logs and explored how that data might inform composition. We treated composers as co-developers rather than late-stage evaluators throughout that process—iterating through sketching and prototyping to co-develop candidate visual representations and refine their encodings, evaluating their usefulness for compositional reasoning tasks, informed by prior work in music visualization [10]. Blended, multi-method approaches developed for children with ASD [5] gave us a starting vocabulary, but in practice, we found ourselves adapting rather than adopting most published protocols wholesale.

3 Practice: What Inclusive Collaboration Has Actually Looked Like

Our three completed projects were not co-designed in the same way. uCue's tangible interface was initially developed with the multisensory room at the Route 9 Library & Innovation Center in mind for deployment, incorporating sensory toys and objects already available there into early prototypes, together with ongoing feedback from Autism Delaware; it is now being tested as an interactive musical system for classroom contexts, with activities designed alongside music therapists at the Brennen School. ResonaVis, discussed above, followed a similarly hands-on process, working with composers rather than therapists. uCue and CalmSet's initial song libraries came from a survey of parents of children with ASD about the music their children responded to, with therapeutic and affective tags developed alongside music composers who work with children with ASD.

One adaptation came directly from our IRB process: moving from active opt-in consent in uCue's formative pilot to a waived, opt-out model for classroom deployment, so a full classroom could participate rather than a self-selected handful of families. Brennen School teachers and therapists reshaped the study itself rather than simply hosting it—pushing for a graduated device-access protocol that began with facilitator-led control, then handed it over to students. This kind of practitioner-driven, mid-course correction is exactly the tacit adaptation a published protocol would not anticipate.

We carry the same practitioner- and parent-led approach into the web platform. Its musical activities are being co-designed with the same Brennen School therapists who shaped uCue; its navigation, pacing, and shared parent-child experience will be co-designed with parents of children with ASD, since they are the ones who will sit down with their child and use it together at home. Rather than apply accessibility guidance as a checklist, we will bring prototype

[1] Although children with ASD were not directly consulted in the initial design phase, partners and subject matter experts from Autism Delaware and the Rt. 9 Library & Innovation Center (New Castle County, Delaware), who have backgrounds in child development, autism therapy, and music therapy, provided critical feedback during regularly occurring meetings

pages back to both groups and let their feedback—not conformance testing alone—decide what the site becomes.

4 Outcomes: Beyond the Publication, and an Open Question About Ownership

uCue, ResonaVis, and CalmSet already extend past their respective publications: uCue is deployed in classroom settings, ResonaVis is used directly by composers, and the underlying work has produced a pending patent [12] filed through the University of Delaware's Office of Economic Innovation and Partnerships. The web platform is the next such outcome, and arguably the one most directly owned by the community rather than the research team, since it is the artifact parents and children with ASD will interact with directly and repeatedly, together, at home.

That raises a question we have not fully resolved: what does co-ownership look like for a dissemination artifact built with community contributions, rather than for a single study or publication? We see this as directly aligned with the workshop's interest in outcomes and attribution that fall outside conventional publication credit, and we would value input from others who have navigated ownership questions around long-lived, community-facing artifacts such as project websites, toolkits, or open datasets [6].

The website also differs from our earlier contributions in that accessibility, presentation, and interaction are themselves part of the artifact being developed, rather than a layer added on top of finished research. The navigation, sensory-control, and privacy decisions described above do more than shape how the research is encountered; they constitute a design contribution in their own right, alongside the platform's role in communicating the lab's existing work.

5 What We Hope to Take From the Workshop

We come to this workshop with three completed projects built through inclusive methods; we lack a shared vocabulary to describe them; and one in-progress project—the uCue web platform—where we can make those methods explicit and co-designed from the start rather than retrofitted. We are especially interested in adapting participatory-design frameworks across heterogeneous stakeholder groups [3–6, 11], in hearing how other researchers have handled co-ownership of research outcomes that live beyond a single publication [6], and in how accessibility work can stay part of an ongoing co-design process rather than collapse into a fixed set of technical requirements applied at the end. We hope to leave with concrete practices we can bring back to our own community partnerships, and to contribute our own in return—including the places where our frameworks did not fit as cleanly as the literature suggested.

Acknowledgments

This work was supported by the National Science Foundation (NSF) via the Accelerating Research Translation Program, Grant No. 2331440, and UD Institute for Engineering-Driven Health. Any opinions, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.

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