# DanceCraft: A Whole-body Interactive System for Children with Autism

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## ABSTRACT

Children with autism often have sensory processing differences that can lead to a myriad of challenges, including difficulty with awareness of how their bodies occupy physical space. Natural User Interfaces (NUI) can help augment therapies already being implemented to support these children. We developed DanceCraft, a whole-body interface to augment dance therapy for children with autism. In a pilot study, we deployed DanceCraft to nine homes for one week for children with autism to use. We received feedback on both the system's central activity (dance), as well as elements of its design and set up, offering lessons to guide future deployments of such systems.

### Author Keywords

Whole-body interfaces; children; autism; therapy; dance; disability; accessibility.

### ACM Classification Keywords

K.4.2. Social Issues: Assistive technologies for persons with disabilities.

## INTRODUCTION

Literature within HCI has long shown that technology can extend and augment physical-world experiences. In clinical work, technological systems can augment therapy, for example, by extending the availability of a care provider or providing continued practice with therapeutic techniques at home or work. Children with autism often have sensory processing differences that can lead to a myriad of challenges, including difficulty with awareness of how their bodies occupy physical space [4]. Therapeutic activities can alleviate these sensory issues. In this paper we describe a pilot study with DanceCraft, a Natural User Interface (NUI) program (*e.g.,* [5]) designed to augment dance therapy [3]. Dance therapy helps address challenges with sensory differences such as proprioception (*i.e.,* body awareness), as well as improving the participant's mood and physical health [2,3]. A team of clinicians, dance instructors, and HCI researchers, all familiar with individuals with autism, worked together to design and develop DanceCraft, a Kinect-based application.

## DESIGN OF DANCECRAFT SYSTEM

DanceCraft is an interactive, game-like application that uses the Microsoft Kinect sensor to detect movement and a user's position, written in Processing. Dance instructors are able to record dance movements in sequence as "dances." The software saves dances as files containing both the instructor's movement and positions (via joint coordinates). A user can play these dances back and the system draws a "skeleton" of the dancer on the screen.

Each session of dance for the user begins with a warm-up, practice moves, a choreographed routine by the instructor, and a choreographed routine by the child. All of these sections of the dance are pre-recorded, with the exception of the final choreographed routine by the user. This section prompts the child to record their own movements. The session ends with all of the child's recorded dance movements played back in sequence via the "skeleton" that the child can dance alongside.

The children can use the system by selecting the appropriate day of play (*e.g.,* "Day 1," "Day 2," or "Day 3") from the main menu. Each day is themed (*i.e.,* birds, cars, and snow) with dance moves reflecting those themes. These sessions and themes were designed by the dance instructor to match the in-person classes. When a child is in front of the Kinect, they are reflected on the screen via a silhouette. The DanceCraft system included audio instructions for the dance moves and music. The audio instruction tracks were recorded by the primary dance instructor and the music tracks was selected by the same dance instructor.


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## METHODS OF PILOT STUDY

To study the DanceCraft system, we conducted a pilot study of nine families (ten children) during January and February of 2016. Overall, twelve children (5 girls, 7 boys, ages 7-12) participated in the dance class portion of the study, with two families opting out of the DanceCraft pilot study. All the children in the study had a diagnosis of autism, with 44% of the overall participants also being diagnosed with ADHD. The study was approved by the institution's IRB. Participants had two in-person dance classes with an instructor and were asked to complete the three lessons in the DanceCraft system during the week between their dance classes. Researchers conducted semi-structured interviews with the parents, which were analyzed using deductive and inductive coding approaches, allowing for new themes to emerge from the data [1]. The DanceCraft system also captured logs of usage. The data collected in this study were analyzed to better understand if and how the systems were used in the family home to help augment the dance class.

## FINDINGS

The pilot study showed that deploying DanceCraft in children's homes has the potential to be an engaging way to augment dance therapy for children with autism. The majority of the families were able to use the software and all the parents reported during interviews that they liked aspects of DanceCraft, if not the entire program.

Overall, parents reported their children to be engaged with DanceCraft due to its variety of activities. The children wanted to be able to complete the moves—as long as they were challenging, but not too challenging. Some families found aspects of the system difficult to use, for example because the program was inaccessible for some (*e.g.,* a parent using a wheelchair or because the language about dance moves was too technical).

Families managed DanceCraft use by reconfiguring their living space, as well as managing their interactions with the system. Reconfiguring their living spaces allowed these families to augment their autistic child's therapy, giving the child additional practice at dance. In addition, there also seems to be some social perks to having DanceCraft in the family living room. Siblings, parents and children, and, in at least one case, the family dog, were all able to dance together. This unintended family interaction may have some unseen benefits, worthy of further inquiry in future work.

## IMPLICATIONS FOR DESIGN

*Simplicity.* Having a simple interface helped reduce sensory overload. DanceCraft was designed to have game-like features, but intentionally not like a mainstream, commercial video games. These design elements—including features such as not needing a remote, simple design with multiple senses engaged, and not competitive—allowed children to use the system. Additionally, having the multiple channels for instruction and activity allowed for different ways of engaging with the dance moves.

*Configurability.* The DanceCraft system allowed for some variation and configurability. However, this configurability needs to extend to the physical space these systems take up. DanceCraft used the Microsoft Kinect, which had specific space constraints and needs. The sensor allowed for multiple users, but also required a large portion of the family room.

*Inclusive Support.* Accessibility of DanceCraft was limited in some unanticipated ways. First, while a child did not have a physical disability, their parent did (e.g., wheelchair user). They were not able to show their child *how* to do specific moves. Second, the dance literacy of both parents and children varied greatly. Creating infrastructure, such as learning materials to help bridge this gap and make the overall dance experience more accessible for both parents and children.

## IMPLICATIONS FOR STUDY DESIGN

*Feasibility of the System.* After taking home the system and installing it in their homes, seven of the nine families were able to use it at least twice during the week, with most families using it for at least the three sessions we requested and with three using it more than the three requested sessions.

*Understanding HCI Measures of "Engagement."* Often in HCI research, we measure (either quantitatively or qualitatively) a user's "engagement" with a technological system. Particularly when working with interdisciplinary teams, engagement must be carefully defined. Interviews shed light on how children actively interacted with DanceCraft, but also created their own work-arounds for parts of the program they found frustrating. Further consultation with therapists and future iterations of such programs would help understand the therapeutic benefits (or not) of these partial engagements, along with the social interactions when multiple family members used the system.

*Messiness of Home Deployment.* Deploying any system into a family home comes with risks—the software may not work, family members may not remember how to use the system, or the system may be used improperly. In our study, for example, two families took the system home but did not use it. However, the benefits arguably outweigh these risks, as home deployments allow the system to be used and evaluated *in situ*. While data may be messier (*e.g.,* multiple users engaged with the system simultaneously), overall, we were able to find that the system was usable in a home setting and we found potential in implementing at-home technology to augment therapy for children with autism.

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