Supporting Shy & Neurodivergent Children in Social Play

Flannery Hope Currin
The University of Iowa, Iowa City, Iowa, USA
flannery-currin@uiowa.edu

ABSTRACT

There is an opportunity to support shy and neurodivergent children in the development of critical executive function (EF) skills through social play. Through a within-subjects study at a preschool and a remote Zoom observation case study of neurodivergent children and their parents, I have identified the potential for *StoryCarnival*, a system that supports evidence-based sociodramatic play activities through e-book stories, a play-planning app, and a tangible, adult-controlled voice agent, to empower shy children to more confidently engage with their peers, to motivate neurodivergent children through various modalities, to encourage neurodivergent children to engage in symbolic play, and to afford children different types of agency in different settings. Through my future work, I hope to confirm the validity of these findings and examine the potential for *StoryCarnival* to support inclusive play in mixed-abilities groups through a large-scale deployment study and field studies.

CCS CONCEPTS

• **Social and professional topics** → User characteristics; People with disabilities; User characteristics; Age; Children; • **Human-centered computing** → Human computer interaction (HCI); Interaction devices; Sound-based input / output; Accessibility; Accessibility technologies.

KEYWORDS

shy children, neurodiversity, social play, voice agents, symbolic play

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1 CONTEXT AND MOTIVATION

Children develop and practice skills, including executive function (EF) skills, through social interactions and play [10]. EF skills are self-regulation skills such as working memory, cognitive flexibility, and inhibitory control which are necessary for goal-oriented behavior and associated with success in and beyond school [4, 47, 53]. Pre-pandemic, kindergarten teachers reported that many children begin school without sufficient EF skills [40, 49]. The Covid-19 pandemic has negatively impacted children's socio-emotional development, taking a particular toll on shy and neurodivergent children [2, 7, 36, 50, 56], which increases the need to support children who struggle to develop EF skills through playful activities.

Coplan et al. define "behaviorally inhibited" children (i.e., shy children) as those who display "reticent behaviors" (e.g., watching other children play without joining in) [16]. In other words, shy children want to engage with their peers socially, but struggle to initiate social interaction. This characteristic can make engaging in social play particularly difficult for shy children, and there is evidence that behaviorally inhibited children have an increased risk of developing anxiety disorders later in life [16]. Evidence suggests that EF skills serve as protective factors against the development of anxiety disorders (e.g., [20, 32, 55]). However, because inhibitory control (the ability to *stop* impulsive, inappropriate responses) is often a focus of EF training interventions, shy children who need support to *initiate* appropriate responses may require special consideration in play-based activities intended to promote the development of EF skills.

Neurodivergent[1] children (e.g., autistic children, children with intellectual disabilities) also often struggle with various aspects of social play (e.g., [25, 34, 46, 52]). Additionally, neurodivergent children tend to have particular difficulty with various dimensions of EF and often undergo interventions to develop their EF skills [18, 19, 24, 30, 33, 54]. Scaffolds that benefit shy children during play-based, EF-focused activities may also benefit neurodivergent children who struggle with similar aspects of social play.

Pantoja et al. [38] developed *StoryCarnival* – a web application and tangible, adult-controlled voice agent – to support typically-developing preschool-age children in sociodramatic play in the style of the *Tools of the Mind* (*ToM*), an evidence-based approach to developing a broad set of EF skills (e.g., [8, 9, 21, 22, 37]). Play characteristics targeted by *ToM* include: 1.) acting out a scene based on a pretend scenario as opposed to repeating a single action, 2.) using objects symbolically to represent other objects (e.g., using a block to represent food), 3.) coordinating play using complementary roles as opposed to exclusively playing in parallel, and 4.) continuing to explore or expand on a scenario for an extended period of time [10] (p. 145). *StoryCarnival* supports *ToM*-style play by providing a set of e-book stories which introduce four characters with complementary roles to set up play, a play planner to help children pick a role to play, and a tangible, adult-controlled voice agent called MiniBird to allow facilitators an extra, minimally-invasive avenue through which to make suggestions during play (see Figure 1).

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[1] In this work, I use identity-first language (e.g., neurodivergent people, autistic people) and person-first language (e.g., people with intellectual disabilities) based on established or emerging preferences within specific communities [11–13].

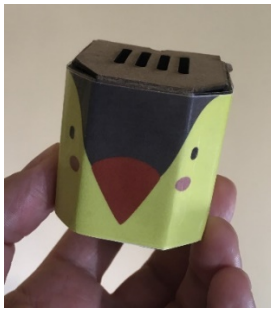

Figure 1: The MiniBird voice agent.

During an 8-week evaluation study of *StoryCarnival* at a preschool in Fall 2019, I found that three shy children were more verbally participative in play when using *StoryCarnival* supports than during *ToM*-style play without any tech supports and that the shy children were motivated to engage with their peers in order to serve as a mediator for MiniBird's suggestions for the group or in order to coordinate care-based activities centered around MiniBird [17]. In the Spring and Summer of 2021, I conducted 19 Zoom observation sessions with four families with neurodivergent children using *StoryCarnival* at home and found that different aspects of *StoryCarnival* motivated neurodivergent children to engage in the activities, the system encouraged neurodivergent children to engage in symbolic play, and children had more agency over the control of the interface and play planning at home with their parents compared to group sessions at a school (under review).

Through my dissertation, I plan to conduct a large-scale remote deployment study to improve *StoryCarnival's* accessibility and assess whether parents, teachers, and other professionals can use the system to better incorporate children who typically struggle to engage in social play in a variety of contexts. I will complement this work with field studies to identify how *StoryCarnival* could support inclusive play in groups of children with mixed abilities.

2 RELATED WORK

2.1 Technologies to Support Shy and Neurodivergent Children

Little Child-Computer Interaction work has focused on shy children. Researchers have found in single-study sessions that giving shy children a distinct, necessary, and relatively easy role compared to their playmates resulted in short-term increases in shy children's assertiveness and social acceptance [28], distinct social interaction strategies encourage shy children and non-shy children to interact with a social robot in a friendly manner [1], and while shy children showed similar patterns in their approach to a social robot and human adult interaction partner, they spent less time in close proximity to the human than the robot [51]. I broaden the scope of this work by examining how shy children can use tangible voice agents over several sessions to engage with their peers more confidently through self-assigned roles.

Baykal et al.'s recent review of collaborative technologies for children with special needs (which includes but is not limited to neurodivergent children) reported that within its corpus, there was a relative focus on technologies that are tangible/embodied, developed for use at school, for boys, for 6-12-year-olds, and for autistic children as compared to other types of technologies designed for use in different settings with different populations [5]. Much of this work suggests that computer-based interventions are particularly appropriate for autistic children because of the predictable, rule-based nature of computers (e.g., [43]). Recent work on applications of technology with neurodivergent children has branched out, from the technology enforcing a set of rules and behaving predictably, to focusing on more complex social interactions by incorporating aspects that are discrepant with autistic children's expectations in virtual environments [3], exploring the physical, liminal, and digital spaces the children occupied and the norms and constraints within an autism-focused Minecraft server [41], or using an Authorable Virtual Peer during social skills training that autistic children could create new behaviors for and control during interactions with one another [48]. I expand on this line of work by exploring the potential for a system that includes a user-controlled, tangible voice agent character to support 3-8-year-old neurodivergent children during creative, social play in which children focus more on other people and their physical environment than on the technology itself.

2.2 Child-Agent Interaction

My current line of research seeks to complement a few recent lines of prior child-agent interaction work. Prior work provided evidence of the potential for social robots and parents to support therapeutic programs for neurodivergent children at home [42], explored parents' use of voice assistants to augment their parenting and give children greater agency at home [6], and identified a need to simplify teleoperation interfaces for social robots used in therapy sessions while providing the ability to edit content on the fly [23]. I extend these lines of research by exploring the potential for adult-controlled, tangible voice agents to support both shy and neurodivergent children during play in both home and school settings and explore the agency afforded to those children by the technology in each setting.

2.3 Technologies for EF Development

Prior Child-Computer Interaction work on EF has largely focused on training or developing specific EF skills (e.g., [27, 39, 57]), sometimes targeting several skills with a battery of cognitive training games (e.g., [39, 45]). Pantoja et al.'s *StoryCarnival* [38] uses open-ended stories and social play activities driven by children and supported by a tangible, adult-controlled voice agent to encourage the broad development of EF skills targeted by *ToM*-style play. Pantoja et al. developed and evaluated *StoryCarnival* with typically-developing children at a preschool. Because of the need to support the development of shy and neurodivergent children's EF skills and particular difficulties children within those categories face related to social play, I seek to explore the potential to adapt *StoryCarnival* to scaffold this type of play for children who otherwise struggle with it.

3 RESEARCH OBJECTIVES

Based on the importance of EF development for shy and neurodivergent children, the need to support both of those populations

in social play, and the potential for *StoryCarnival* to support both of those endeavors, I seek to answer the following research questions: 1.) What is the most appropriate ecology of children, adult facilitators, and context for *StoryCarnival* in its current form, and how might the scope of its applicability be expanded? 2.) How does *StoryCarnival* use in school settings change the dynamics of play for shy children? 3.) How does *StoryCarnival* use in multiple settings (e.g., home, school, and therapy) change the dynamics of play for neurodivergent children? 4.) How does *StoryCarnival* support inclusive play in groups of children with mixed abilities?

4 APPROACH, RESULTS, AND CONTRIBUTIONS TO DATE

4.1 Supporting Shy Children at a Preschool

As a first step to address research question (1), from October to December of 2019, I assisted with a within-subjects study at a preschool comparing children's *ToM*-style play with and without *StoryCarnival* over an extended period of time [17]. Five 3-year-old children (3 girls, 2 boys) and twelve 4-5-year-old children (6 girls, 6 boys) participated in two 25-minute, researcher-facilitated, video-recorded sessions per week for eight weeklong phases. To control for changes due to children's development over time, A phases (No-Tech *ToM*) and B phases (*StoryCarnival*-Supported *ToM*) were randomly ordered: A, B, B, A, B, A, A, B. To gain an in-depth understanding of how *StoryCarnival* impacted children's play, I triangulated data from three sources: 1.) 894 open-coded observations recorded by myself, a senior Ph.D., and our advisor while watching the session recordings, 2.) quantitative measures from transcripts of each session (e.g., the number of lines and words each child, facilitator, and MiniBird spoke during each session and whether lines mentioned MiniBird), and 3.) instances of specific target behaviors (e.g., time off-task as defined by [10], symbolic use of props) coded using the BORIS video-coding software [26].

Through this analysis, I identified one 3-year-old and two 4-5-year-olds who displayed reticent behaviors (e.g., watching children playing without joining in) and spoke fewer lines per minute than their peers during No-Tech sessions. These behaviors are consistent with an emerging body of psychology literature on behaviorally inhibited (i.e., shy) children (e.g., [14–16, 29, 31, 35]), which led me to form research question (2) and analyze the impact of *StoryCarnival* on these children in more depth. All three shy children spoke more often in *StoryCarnival* sessions than No-Tech sessions, primarily as part of interactions with their peers, often motivated by a sense of care for MiniBird (e.g., asking MiniBird if it had any allergies and then helping peers make a pizza for MiniBird) or a desire to serve as a mediator for MiniBird (e.g., repeating MiniBird's speech to make sure peers heard a request, then following up on that request) [17]. This investigation contributed a novel discussion to the field of HCI on how voice agents can be used to empower shy children who may hesitate to engage with their peers without support.

4.2 Supporting Neurodivergent Children at Home with their Parents

Because of the impact *StoryCarnival* had on shy children in the evaluation study, I thought *StoryCarnival* might be particularly useful for other populations of children who struggle with social play, such as neurodivergent children. To expand in this direction on research question (1) in a COVID-safe manner, from April to July of 2021, I conducted a remote case study with four families with 3-8-year-old neurodivergent children to explore the use of *StoryCarnival* to support neurodivergent children in play with their parents at home (under review). Each family completed between three and eight 30-minute *StoryCarnival* sessions which I observed and recorded via Zoom. To gain an in-depth understanding of how parents and children interacted with the system and each other and parents' assessment of how play with *StoryCarnival* compared to other play activities, I triangulated data from 1.) 1,593 open-coded observations recorded by myself and one other researcher while watching the session recordings, 2.) quantitative measures from transcripts of each session, and 3.) responses to surveys sent to parents at regular intervals through the study.

Through that analysis, I found that during *StoryCarnival* sessions, neurodivergent children engaged in symbolic play frequently, and parents reported that children engaged in symbolic play more often during *StoryCarnival* sessions than during other play activities. I also identified multiple motivating factors that led children to engage in the activities, including "silly"/"broken" aspects of the system (e.g., making MiniBird speak sound effects such as "boom" and "crash"), and observed that children had more agency over interface control and play planning in a home setting than in a school setting (e.g., by controlling the pace at which stories played), while play with peers in a school setting may afford more freedom to play with less adult intervention. Because this study setup provided a unique window into the impact of setting on system use, I formed research question (3) with the intent to gain a more complete understanding of how *StoryCarnival* could impact play in home, school, and therapy settings. Because some of those settings include children with mixed abilities, I formed research question (4) to examine how *StoryCarnival* might change group dynamics by influencing neurotypical children's play with neurodivergent children. I also identified a need to better support neurodivergent children in roleplay and a need to lower the cognitive workload for parents using the voice agent control interface. This work contributes a description of how StoryCarnival supported children's play, design implications for supporting interactions between parents and neurodivergent children, considerations for adapting a system designed for use at school for home use, and suggestions for conducting remote studies via Zoom (under review).

Since completing those initial observation sessions with four families, I have redesigned the voice agent control interface to provide parents with easier-to-access, specific, relevant, role-based suggestions for MiniBird's speech (see Figure 2). I have also conducted remote observation sessions with two additional families and am in the process of analyzing data from those sessions.

5 FUTURE WORK

5.1 Large-Scale Deployment of *StoryCarnival*

To validate findings from my prior fieldwork and continue addressing all four research questions on a larger scale, I am preparing to make the *StoryCarnival* website and MiniBird pattern publicly

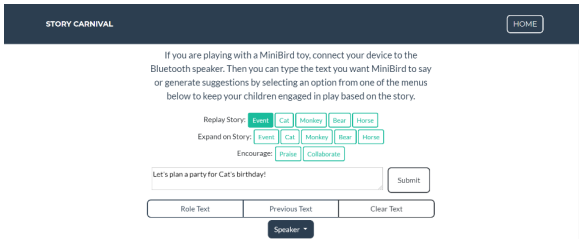

Figure 2: The redesigned voice agent control interface. Users can generate story-specific suggestions to aid in replaying the story, expanding on the stories, or encouragement of children. Replay and expand suggestions can be directed at a group or specific characters based on their roles. Touching the same option multiple times generates different text.

available to parents and professionals (i.e., teachers and therapists). I will send MiniBird kits to the first 100 professionals who request one through the website. Through this large-scale deployment, usage logs, and optional user surveys and bug reports, I plan to iteratively improve the design of *StoryCarnival* and eventually assess the impact of regular use of the system on shy and neurodivergent children's play broadly based on reports from adult facilitators.

5.2 Field Work with Mixed-Abilities Groups

When it is safe to do so, I plan to conduct field work to complement the large-scale deployment with a more in-depth investigation of how *StoryCarnival* can influence the dynamics of play within mixed-abilities groups in various settings, including groups of shy and non-shy children in school settings, addressing all four research questions. The exact nature of this fieldwork may vary based on vaccine availability for children, staffing shortages at schools and childcare centers, and other pandemic considerations. I plan to seek out responsible opportunities to support inclusive play as defined by Sobel et al. [44] in school, therapy, and home settings. Because the nature of shyness is most likely to impact behavior with peers at school (as opposed to play with parents at home), I plan to continue to focus on shy children within a school context as opposed to multiple contexts. I hope to identify ways that technology can amplify shy and neurodivergent children's agency during social play in settings that afford them different types of agency and freedom, as well as ways that technology might influence neurotypical peers' inclusive behavior and attitudes without explicit adult instruction.

6 DISSERTATION STATUS & LONG-TERM GOALS

I am in the third year of the University of Iowa Computer Science department's 5-year Ph.D. program. I am co-advised by Dr. Juan Pablo Hourcade and Dr. Kyle Rector. At the time of the doctoral consortium, I will have recently completed my comprehensive exam and will be in the process of preparing my dissertation proposal. I hope to establish a career in HCI accessibility research, specifically focused on working with individuals with intellectual and developmental disabilities. Through my completed and planned future work, I expect to contribute: 1.) a deeper understanding of how technology supports can empower shy children in play over time, 2.) design implications for supporting neurodivergent children in social play with a variety of play partners in multiple contexts, 3.) design methods for working remotely with vulnerable populations, and 4.) an analysis of how technology can support face-to-face social play without drawing attention away from other people and the physical environment.

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