Autism and Play: An Overview of the Methodological Approach and Preliminary Results

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Abstract- Recent research has discussed co-designing with autistic children in several settings. However, none of these studies have investigated the inclusive play field. This project aims to co-design and evaluate a tool to promote inclusive, collaborative play with and for autistic children in an educational context. It is structured into three phases: Contextual Inquiry, Co-Design, and Joint Engagement Evaluation. This paper aims to provide an overview of the methodological approach used within this project and the preliminary results obtained. In the contextual inquiry phase, observations and interviews with specialists revealed key themes influencing collaborative play, such as the role of structured activities and inclusive environments in promoting engagement. The co-design phase actively involved autistic and non-autistic children in iterative workshops, resulting in a multisensory collaborative play prototype. The final phase, Joint Engagement Evaluation, combined qualitative and quantitative methods, including the Joint Engagement and Reciprocity Index (JERI) and computer vision-based pose estimation using Mediapipe, to measure engagement levels during play sessions. Preliminary results indicate that structured tools and inclusive settings supported turn-taking, joint attention, and collaborative play. Future work will focus on refining the prototype and developing machine learning models to predict engagement patterns, further supporting inclusive play environments.

Keywords- Autism; Co-design; Inclusive Design; Autistic Children; Collaborative Play; Joint Engagement; Computer Vision

1. Introduction

1.1. Autism and Co-design

Co-design is a collaborative approach rooted in participatory design principles, where end-users actively contribute to the creation process, ensuring that designs meet their needs and preferences (Druin, 1999, 2002). For autistic children, co-design has proven especially valuable, as it invites them to share insights and feedback on tools intended to support their social and developmental needs (Ehn, 2008; Sanders & Stappers, 2008). In recent years, co-design has been known as an inclusive methodology in autism research (Frauenberger et al., 2017). A recent

review paper (Hijab, Banire, et al., 2023) reviews various autism-centered technologies developed with input from autistic users. The paper underscores that tools created with autistic children as co-designers tend to be more effective and relevant because they reflect the children's perspectives.

In co-design with autistic children, unique challenges arise, including communication barriers and the need for adaptable engagement strategies that respect children's varying abilities and communication preferences (Frauenberger et al., 2013, 2020). Research in the Interaction Design for Children community has advanced various methods and techniques for involving children in design processes, focusing on usability and ethical considerations (Alhumaidan et al., 2018; Mechelen et al., 2019). By recognizing the importance of ethical and practical engagement methods, researchers such as Janet C. Read have introduced effective tools like the CHECk, ActiveInfo, and Tick Box Design methods (Read et al., 2017). These tools streamline the co-design process, allowing rapid collection of ideas from children and ensuring their viewpoints are integrated into the final design, while also being mindful of their comfort and agency. Working with autistic children presents additional considerations. For example, many autistic children have unique communication needs and distinct ways of engaging with design tasks (Hijab, Al-Thani, et al., 2023; Hijab et al., 2021). Studies have shown that typical participatory design methods can sometimes reinforce deficit-oriented perspectives on autism, as they may emphasize communication challenges rather than strengths (Frauenberger et al., 2011). However, strengths-based co-design practices enable autistic children to contribute meaningfully, often with support from caregivers or therapists when direct communication is difficult (Fage, 2015; Giraud et al., 2021). As co-design with autistic children evolves, it reflects a growing shift towards inclusive research, prioritizing the unique skills, insights, and interests of autistic children as co-creators in the design process.

1.2. Autism and Play

Play is widely recognized as essential to child development, enabling children to explore their environment, build social connections, and express themselves (Gray, 2017; Weisberg et al., 2013). For autistic children, however, play often manifests differently, sometimes with a focus on sensory experiences or solitary activities, which may deviate from typical expectations. In a recent systematic review, (Khatab et al., 2024) examined collaborative play with autistic children, emphasizing the richness and meaningfulness of play preferences that may appear unconventional but are deeply significant to each child. Studies by (Conn, 2015; Conn & Drew, 2017) further illustrate that many autistic children enjoy imaginative and sensory-driven activities, which reflect their unique modes of engagement and self-expression.

Historically, much of the research on autistic play has contrasted it with neurotypical play, highlighting differences that were often pathologized, such as a tendency toward solitary play (Wing et al., 1977). However, recent research challenges this deficit-focused approach, advocating for a strengths-based view that acknowledges the value of autistic children's unique play styles (Gillespie-Lynch et al., 2017; Heasman & Gillespie, 2019). A recent study on outdoor and indoor play preferences among autistic children show that, when supported and understood, these play activities can foster significant development in creativity, sensory processing, and social interaction (Fahy et al., 2021). Moreover, acknowledging these play preferences aligns with neurodiversity perspectives that celebrate diversity in cognitive and social functioning, encouraging inclusive practices that support each child's strengths and interests. The importance of inclusive play environments has led to the exploration of "neurodiverse play" models, where both neurodivergent and neurotypical children engage together in play settings designed to meet diverse needs (Spiel & Gerling, 2021). Such environments are beneficial because they allow autistic children to participate in social interactions at their own pace and comfort level. However, in many traditional educational or play contexts, these inclusive opportunities remain limited, as facilities and structures are often designed around neurotypical standards (Jeanes & Magee, 2012; Stanton-Chapman & Schmidt, 2017).

1.3. Autism and Joint Engagement

Joint engagement, a social and interactional concept, is fundamental in developing social communication skills and building shared experiences between individuals (Ruble & Robson, 2007). For autistic children, joint engagement is particularly significant, as it can create opportunities for them to connect with others in a way that feels natural and comfortable. Engagement in child interactions has been defined through various approaches, with some studies using coding schemes based on gaze, actions, and emotional states (Pan et al., 2023). The concept of joint engagement builds on these definitions, referring specifically to a shared focus on an object or activity that involves both participants' attention and participation. It is frequently measured through indicators such as eye gaze, latency in responding to another's speech, and gaze duration (Adamson et al., 2004). For autistic children, developing joint engagement can strengthen language skills, build social communication abilities, and provide a foundation for peer

interactions (Adamson et al., 2004). Studies emphasize that when joint engagement is facilitated within supportive play environments, autistic children demonstrate improved social outcomes, including better communication and relationship-building skills. In therapeutic and everyday settings, joint engagement is a goal for supporting social interactions. (Pan et al., 2023) highlight that, particularly for children with developmental disorders, joint engagement can serve as a gateway to improved language outcomes and stronger social bonds. Integrating joint engagement into play-based activities for autistic children allows them to build skills such as turn-taking, symbolic play, and collaboration, which are foundational to social interaction. Moreover, activities that foster joint engagement align with the neurodiversity perspective, emphasizing each child's strengths and preferences in building social skills.

1.4. Problem Statement

Given the increasing awareness of the unique ways autistic children engage with their environment, particularly in social and play-based contexts, there is a pressing need to develop tools that foster inclusive and collaborative interactions. Traditional approaches to play for autistic children often emphasize deficits, overlooking the strengths and preferences that can be harnessed to create meaningful engagement opportunities. This paper addresses the challenge of how to design an interface that encourages collaborative and inclusive play for autistic children while respecting their individual needs and communication styles. By involving autistic children as co-designers, this project aims to create a prototype that reflects their insights and preferences, ensuring that the final design is both accessible and empowering. Furthermore, this paper will examine the levels of joint engagement achieved by autistic children while interacting with the co-designed prototype, providing insights into how such tools can support meaningful social interactions. The interface will be evaluated with both autistic and non-autistic children, focusing on its effectiveness in promoting joint engagement, social interaction, and feedback from the children themselves. This approach not only prioritizes the voices of autistic children but also advances a strengths-based perspective that values their contributions and experiences in shaping tools designed for their use. This paper outlines the methodology and preliminary findings of a project designed to create engaging play experiences aligned with autistic children's perspectives and preferences, aiming to foster joyful, socially significant interactions.

2. Research Methodology and Approach

This project's methodology is structured into three main phases as shown in : Contextual Inquiry, Co-Design, and Joint Engagement Evaluation. Each phase serves a unique purpose, from gathering foundational insights on collaborative play to developing and testing a prototype specifically designed for autistic children.

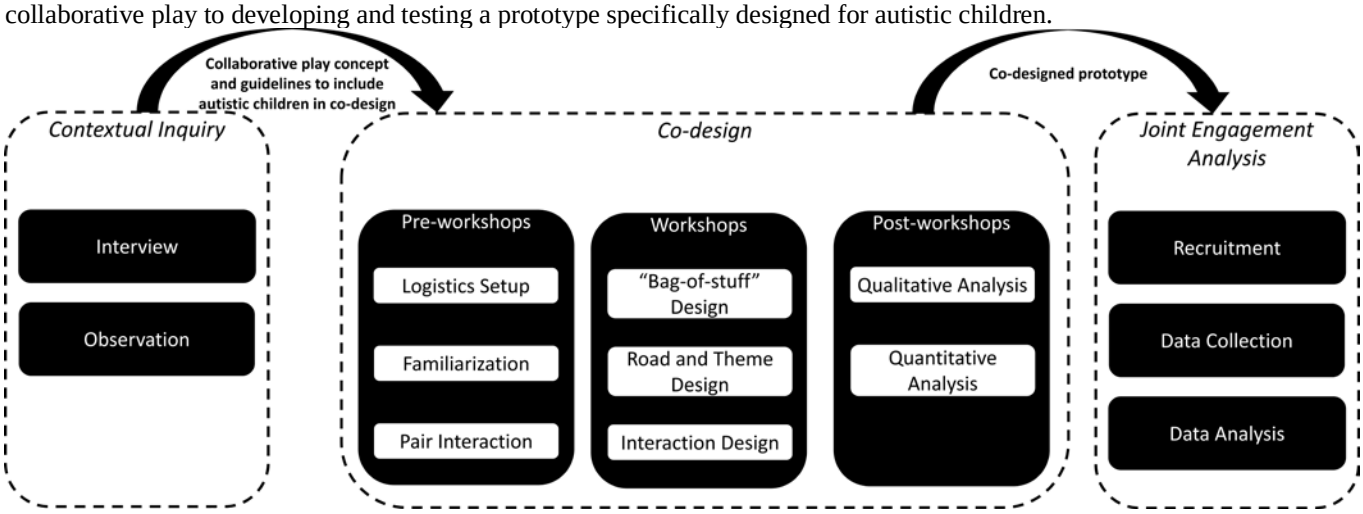

Figure 1 - Project Methodology

2.1. Contextual Inquiry

The contextual inquiry phase focused on understanding the tools, technologies, and behavioral patterns involved in collaborative play among autistic children in classroom settings (Holtzblatt & Beyer, 1997). Conducted in a center for children with disabilities and an inclusive school in Qatar, the inquiry involved interviews with teachers,

therapists, and parents, as well as observation sessions of autistic and non-autistic children in various play contexts. This phase aimed to identify both challenges and opportunities in fostering collaborative play, collecting data through semi-structured interviews and thematic analysis (Clarke & Braun, 2017). A total of 45 interviews were conducted with a variety of specialists, including teachers, speech and language therapists, occupational therapists, psychologists, and physiotherapists. Additionally, 48 observation sessions were completed, capturing activities such as sports, art, and music sessions. Observation data were coded into four main themes—Collaborative Play, Coordinated Activity, Potential for Collaboration, and Collaborative Activity—which provided insight into the children's interactions and informed the co-design phase. Ethical considerations included obtaining consent and assent, with participants assigned coded identifiers to ensure confidentiality.

2.2. Co-design

Building on the findings from the contextual inquiry, the co-design phase actively involved autistic and non-autistic children in the prototype's development. This phase was organized into three sub-phases: Pre-Workshops, Co-Design Workshops, and Post-Workshops. The pre-workshops focused on familiarizing children with the environment, the research team, and the design process. Children participated in 10 familiarization sessions, where they were observed in free play settings to understand their preferences. Based on these interactions, children were paired with their favorite toys and engaged in structured play sessions designed to foster comfort and social bonds. In the co-design workshops, children took part in three specific activities—Bag-of-Stuff Design, Road and Theme Design, and Interaction Design. In Bag-of-Stuff Design, children selected sensory features, shapes, and colors to create objects that reflected their preferences. During Road and Theme Design, they constructed roads and themes for the collaborative play prototype, which helped instill a sense of ownership over the prototype. Finally, the Interaction Design phase introduced "obstacles" that encouraged collaborative problem-solving and engagement, fostering turn-taking and joint attention. These activities were designed based on insights from specialists and previous observations to promote inclusive play.

The post-workshops phase consisted of evaluation sessions, where each pair of children engaged with the final co-designed prototype in a 30-minute free play session. Qualitative and quantitative data were gathered on collaborative play behaviors, child-child and child-toy interactions, and key skills such as joint attention and turn-taking. Video recordings from this phase were analyzed for insights into the effectiveness of the prototype in supporting meaningful social interactions.

2.3. Joint Engagement Evaluation

The final phase aimed to quantitatively measure joint engagement levels using the Joint Engagement and Reciprocity Index (JERI) and computer vision-based pose estimation. JERI, a coding scheme for assessing joint engagement quality and quantity, was employed to capture the nuances of how children shared attention with peers and reciprocated within interactions (Adamson et al., 2008). Specifically, JERI differentiates between supported and coordinated joint engagement, which allowed researchers to assess the prototype's effectiveness in fostering social connection. The children's engagement levels were categorized as No Engagement, Low Engagement, Medium Engagement, and High Engagement, based on a 1 to 7 Likert scale. The experimental setup involved an Intel RealSense D455 depth camera and two Canon RGB cameras positioned to capture multiple views of the room. This setup ensured comprehensive coverage of the children's interactions with the prototype. Video recordings were segmented into 5-second clips, resulting in over 5,699 fragments, which were annotated by two trained raters to ensure inter-rater reliability, achieving an intraclass correlation coefficient of 90%. Disagreements were resolved through consensus. To complement JERI analysis, computer vision techniques using the Mediapipe library were applied to estimate the children's body and hand key points. This data was used to create feature vectors that will aid in training machine learning models to recognize joint engagement patterns.|

3. Preliminary Results

The results of this study provide critical insights into the design and evaluation of collaborative play tools for autistic children. By systematically analyzing data from three distinct phases—Contextual Inquiry, Co-Design, and Joint Engagement Evaluation—this section highlights the interplay between environmental factors, children's preferences, and engagement levels. Each phase contributes uniquely to understanding and enhancing collaborative play, offering valuable implications for designing adaptable tools that cater to diverse neurodivergent needs and

broader contexts. The findings not only inform prototype development but also lay the groundwork for extending these tools to other settings and groups, fostering inclusivity and interaction.

3.1. Contextual Inquiry

The contextual inquiry phase (Hijab, Khattab, et al., 2024) uncovered essential insights into factors influencing collaborative play for autistic children, informed by semi-structured interviews and observations.

- Semi-structured interviews: Six primary themes emerged from the thematic analysis of interviews with teachers, therapists, and parents, organized by the "5W-H model." The themes were Actors (who participates in collaborative play), Location (settings like school and public spaces), Purpose (social, academic, and daily living skills), Type of Technology (analog vs. digital tools), Sense (sensory modes like touch and visual cues), and Process (the role of interaction, challenges, and role changes during play). Teachers highlighted collaborative play's role in supporting turn-taking, communication, and social skills. Parents provided additional context about play in various settings, including home and public spaces, highlighting the importance of real-life contexts for skill practice.
- Observation sessions: Observational data captured varied interaction levels across school and center settings, categorized as Collaborative Play, Coordinated Activity, Potential for Collaboration, and Collaborative Activity. Collaborative play, most notably observed at school, showed children developing turn-taking and communication skills with guidance from teachers. The school environment facilitated higher engagement, with structured activities promoting interaction and shared goals. In contrast, the center's sessions primarily revealed parallel play, as children tended to engage individually with toys, suggesting that structured guidance may be needed to foster collaborative play.

3.2. Co-design

The co-design phase (Hijab, Al Aswadi, et al., 2024), comprising pre-workshops, co-design workshops, and post-workshop evaluation, yielded a collaborative play prototype, shaped by children's preferences and interactions.

- Group formation and toy preferences: Children were grouped based on observed toy preferences, resulting in tailored pairings that fostered compatibility. Through the familiarization phase, children revealed preferences that guided grouping and prototype design elements, such as "press-to-play" and puzzle-based activities.
- Collaborative play tool design: The “Bag-of-stuff” included sensory-rich toys and elements reflecting children’s choices in categories like color, shape, and texture. For example, center children preferred animal shapes, while school children leaned towards car themes, resulting in unique sensory features for each location. The road and theme design phase allowed children to construct their play pathways, engaging deeply with choices around obstacles that encouraged interaction and collaboration. By accommodating both solitary and collaborative preferences, the design provided flexibility for varying engagement styles.
- Interaction and engagement patterns: Interaction design focused on joint activities that required two children to work together, such as moving obstacles on a road or assembling puzzle pieces. Observations revealed that children transitioned from solitary to parallel play, ultimately reaching collaborative engagement with guidance from specialists. Tools like “open-the-gate” or “clear-the-way” supported turn-taking and cooperative problem-solving, essential skills for collaborative play.

3.3. Joint Engagement Evaluation

The analysis of joint engagement using the JERI score and Mediapipe data offered quantifiable insights into engagement levels.

- JERI scale data: The JERI analysis revealed that Low Engagement was predominant across groups, though certain groups displayed notable instances of Medium and High Engagement. Several groups exhibited more active interactions, suggesting that specific group dynamics or activity types may foster engagement. These findings indicate potential pathways for refining activities to increase engagement, particularly by focusing on elements that contributed to Medium Engagement levels in select groups.
- Mediapipe data: The data were extracted from Mediapipe revealing 146,192 frames. Yet, some of the

frames include only data of one child. After data cleaning to ensure only complete frames were analyzed, 92,803 frames remained, representing reliable engagement interactions.

- Mapping JERI to movement patterns: This preliminary analysis provides a foundation for a machine learning model that could predict engagement levels based on body movement data. Mapping JERI scores to Mediapipe data revealed that groups with higher engagement scores also demonstrated more complex body movements, suggesting a correlation between physical activity and engagement levels. Groups with predominant Low Engagement showed fewer dynamic movements, indicating a possible link between reduced physical engagement and lower interaction quality. Patterns identified in the JERI-Mediapipe mapping demonstrate how movement complexity varies with engagement scores, offering a nuanced understanding of how children's physical interaction with the play tool corresponds to their engagement quality.

4. Discussion

This study integrates a structured methodology—contextual inquiry, co-design, and joint engagement evaluation—to create collaborative play tools specifically for autistic children. These tools, grounded in participatory and co-design principles (Druin, 1999; Sanders & Stappers, 2008), reflect the children's preferences and communication styles, demonstrating the potential to address similar needs in other neurodiverse populations. The inclusion of tools like the Picture Exchange Communication System (PECS) to involve non-verbal participants (Hijab, Al-Thani, et al., 2023) underscores the adaptability of the methodology for children with diverse communication needs, such as those with Down syndrome or speech delays. Expanding this framework to address broader sensory and cognitive profiles, including those with sensory processing disorders or ADHD, can enhance its utility across multiple contexts.
The approach also aligns with strengths-based perspectives, moving away from deficit-oriented views of neurodivergence (Frauenberger et al., 2013; Gillespie-Lynch et al., 2017). By emphasizing the unique skills and preferences of children, the methodology supports the creation of tools that are both inclusive and empowering. The design of inclusive play environments, where neurodivergent and neurotypical children interact meaningfully, further aligns with neurodiverse play models proposed by Spiel and Gerling (2021). Such environments enable social connection while respecting each child's pace and style, offering opportunities for mutual learning and collaboration.
Additionally, the use of joint engagement evaluation, combining qualitative and quantitative data (Adamson et al., 2008; Pan et al., 2023), demonstrates a scalable model for examining engagement patterns. These methods could be adapted to study other populations and settings, such as mixed-neurotype classrooms or therapy sessions, ensuring that tools are refined to promote inclusivity and interaction.

4.1. Implications

The findings from this study highlight practical and meaningful insights for educators, therapists, and researchers aiming to support neurodivergent children through collaborative play.

- For Educators
  The findings emphasize the importance of structured yet adaptable activities in supporting neurodivergent students. The modular design of the "Bag-of-stuff" prototype, which reflects the principles of co-design (Ehn, 2008), allows educators to tailor activities to diverse needs. For instance, tactile and auditory elements can support sensory-sensitive students (Conn, 2015; Conn & Drew, 2017), while simplified tasks are effective for children with cognitive delays. By fostering turn-taking, communication, and shared goals, educators can create inclusive learning environments, enabling neurodivergent and neurotypical students to engage meaningfully with one another (Stanton-Chapman & Schmidt, 2017).
- For Therapists
  Therapists can use the co-design principles demonstrated in this study to craft interventions that align with individual needs and preferences. By incorporating communication strategies like PECS (Hijab, Al-Thani, et al., 2023) and movement-based activities, therapists can enhance engagement and interaction. The findings that complex movements correlate with higher engagement levels (Pan et al., 2023) suggest integrating physical activities into therapy to promote social skills like turn-taking and collaboration. Such strategies align with the neurodiversity perspective, emphasizing strengths and individual preferences over deficits (Gillespie-Lynch et al., 2017).
- For Researchers

This study's integration of qualitative themes, such as sensory modes and processes (Clarke & Braun, 2017), with quantitative tools like the JERI scale (Adamson et al., 2008) and Mediapipe data offers a replicable model for engagement analysis. Researchers can adapt these methods to study other neurodiverse populations, such as children with ADHD, to identify how engagement patterns vary across contexts. The methodology also provides a foundation for creating adaptive play tools that adjust in real time, informed by a combination of user input and machine learning models (Holtzblatt & Beyer, 1997). Furthermore, examining inclusive play models (Spiel & Gerling, 2021) can advance research on fostering neurodiverse interactions in educational and community settings.

4.2. Limitation and Future Work

The methodology utilized in this study focusses on co-design that engage both autistic and non-autistic children in the design process but also revealed certain limitations. The insights generated, while valuable, are derived from a single project context, limiting the broader generalizability of the findings. Although the study spanned two distinct locations in Qatar, allowing for observations in different settings, the applicability of the methodology across more diverse environments and populations remains untested. Future work will focus on refining and enhancing the co-design methodology by critically evaluating the structure of co-design sessions. This includes ensuring activities are inclusive and tailored to accommodate diverse sensory needs, communication styles, and levels of participant agency. Adjustments will aim to make the methodology more flexible and adaptable to a wider range of participants and contexts while preserving its core emphasis on genuine collaboration. Additionally, future research will extend the application and evaluation of the co-designed prototypes to other subsets of the autism community. This will involve assessing the tools' effectiveness and adaptability in varied settings, contributing to a deeper understanding of how co-design principles and outcomes can be applied broadly. These efforts are essential for advancing inclusive design practices and ensuring that co-design methods and tools are accessible and impactful across different contexts and populations.

5. Conclusion

This study demonstrated the potential of a co-design approach in fostering collaborative play among autistic children, using structured, interactive tools to enhance engagement. Through contextual inquiry, co-design workshops, and engagement assessment, we identified effective methods for promoting turn-taking and joint attention. Observations showed that structured settings and tailored play tools contributed positively to engagement levels, with Mediapipe and JERI score mapping indicating a correlation between physical interaction and sustained engagement. Future work will focus on finalizing the joint engagement evaluation and building a machine learning model to help specialists better understand joint engagement in autistic children's play, advancing our ability to support inclusive, engaging play environments.

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