

A Mixed Methods Study: Culturally Responsive Tangible Near Field Communication Brick Play for Facilitating Communication and Language Development in Autistic Young Children of West African Descent

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DOI: [10.54337/aau.icdvrat26.16](https://doi.org/10.54337/aau.icdvrat26.16)

Abstract

Despite advances in assistive and digital health technologies and research, there is a paucity of technology-mediated, child-led interventions that remain culturally neutral, with relevance for autistic young children of West African descent. This paper assesses the effectiveness of culturally-tailored Near Field Communication (NFC) brick play in promoting communication and language development (CLD) of autistic young children of West African descent living in England. Findings from a pilot explanatory sequential mixed methods intervention across multiple cases in home environments indicated increased joint attention and improved CLD. This study proffers a renewed conceptualisation of CLD, as emerging through culturally situated interaction.

1. Introduction

Autistic characteristics in young children aged three (3) to five (5) years of West African descent living in England often involve challenges in communication and language development (CLD), important for socio-cultural participation and early learning. Early interventions for autistic young children often discount cultural contexts of autism, especially within Human-Computer Interaction (HCI) technologies (Lorusso et al., 2018), compounding cultural and contextual factors and limiting access to culturally responsive interventions. A mismatch between autistic children's lived and living experiences.

Despite significant advances in HCI, accessibility appears to be inconsistently addressed, often excluding users, especially within systems and environments, whose cultures do not conform to standard known interaction assumptions. This can reduce accessibility and effectiveness for this particular demographic. Play-based interventions which reduce barriers for persons with diverse cognitive, sensory, or tactile needs demonstrate significant potential in promoting engagement, communication, and behaviour change. Similarly, child-led tangible play can reduce barriers for autistic young children, enabling CLD to emerge through dialogic (Wegerif, 2011) interaction rather than instruction.

This paper introduces NFC brick play, a tangible, accessible, adaptive, child-led, play-based intervention for autistic young children of West African descent, designed to support CLD through culturally responsive, embodied interaction. The study adopts an explanatory sequential mixed methods design (Cresswell & Plano Clark, 2018) to evaluate the intervention's effectiveness, over six weeks of dyadic interactions, in enhancing engagement and CLD. The study contributes empirical evidence to demonstrate how culturally relevant interventions promote dialogic interaction, reframe users' engagement, and impact communication and language development (CLD) of autistic young children of West African descent.

2. Background and related word

2.1. Background

Evidence is of a widening gap in the support of autistic young children aged three (3) to five (5) years, whose differing cultural backgrounds compound their CLD issues in educational and home environments. Of note are opportunities to create meaningful engagement and dialogic interaction with the combination of NFC-augmented tangible construction objects, such as specifically selected Lego® Duplo® bricks. During child-led play, physical interaction with NFC-enabled bricks and preset toys affords flexible ways of interaction, triggers digital responses to games with cultural underpinnings when activated, extending the flexibility of play and offering opportunities for engagement, joint attention and interaction, and CLD.

2.2. Tangible Interaction in Early Autism Interventions

Tangible user interfaces (Ishii and Ullmer, 1997) and embodied interaction (Dourish, 2001) inform HCI, yet remain limited in child-led play-based health and education sectors for autistic young children of West African descent. Autism interventions show potential support in joint attention, affordances of flexible multimodal interactions (Farr et al., 2012), and reduction of cognitive load. Although game-based, interactive systems support participation and motivation, most systems remain screen-centric or lack adaptability to diverse cultural contexts.

2.3. Cultural Responsiveness in Assistive Technologies

Development of assistive technologies is often within culturally dominant frameworks. These may often mismatch with the lived experiences of diverse users. Utilising traditional (passive), and culturally responsive (CR) NFC bricks (i.e., activated) to create affordances for combining tangible interaction, accessibility-first design, and adaptive child-led play (Frauenberger et al., 2016) positions NFC brick play in the reframing of interactional design priorities.

In early childhood development, socio-cultural differences influence play, dyadic interaction, and CLD styles. Emerging research highlights a need for culturally responsive and inclusive design approaches that prioritise accessible, adaptive, and contextual relevance. However, there is a scarcity of work which explores culturally grounded, tangible interventions for autism support.

3. Methodology

3.1. Research Design

The six-week pilot study adopts an explanatory sequential mixed methods design, combining quantitative methods with qualitative insights.

3.2. Participants

Participants were six autistic or suspected to be autistic young children of West African descent living in England, aged three to five years, and their parents or carers. Dyads in each case study participated in the child-led NFC brick play weekly intervention for 20 minutes, over six weeks.

3.3. Data Collection

Data were collected in two main phases through the lens of neurodiversity and a new conceptual framework for CLD in interventions for autistic young children of West African descent in their home environments.

Data collection prioritised depth, combining pragmatic ethical approaches to HCI and inclusive design by initially employing survey questionnaires, pre-intervention semi-structured interviews, and documentary evidence from professionals. Then it employed video-recorded observations during the intervention, post-intervention semi-structured interviews, and documentary evidence for post-intervention activities.

Out of the six participants, three carried out cross-over research to ensure rigour.

3.4. NFC Brick Play Intervention

The NFC brick play toolkit comprised a set of 80 specifically chosen modular construction toys (i.e., Lego® Duplo® bricks and pre-set toys. Nine (9) of the bricks were augmented with NFC sticker tags, pre-programmed with purposefully developed age and culturally appropriate online activities and games. The NFC bricks complied with the six principles of tangible user interfaces developed by the main researcher. When manipulated during play, the NFC-tagged bricks and preset toys triggered purposively developed digital cultural responses, including interactive feedback, game-based scenarios and audio prompts (i.e., CR NFC bricks).

Traditional (passive) NFC bricks were construction bricks, preset toys, and inactive NFC-augmented bricks. CR NFC bricks were activated NFC bricks using a smartphone or tablet, and the combination of traditional NFC bricks and visual cue cards (some of which depicted cultural content). Other resources in the NFC toolkit included the intervention protocol and intervention schedules to enable parents and carers to facilitate the intervention. The active and passive NFC bricks were designed to be accessible, cognisant of cognitive and sensory needs, and adaptable to cultural contexts. It supported dyadic interaction, verbal and nonspeaking communication, and joint attention.



Figure 1: Photograph of a selection of passive NFC-tagged bricks and preset toys, and an activated NFC brick read by a smartphone depicting purposively designed online content.

3.5. Data Analysis

Four cases produced data for the study to answer the research questions. Francis et al.'s (2019) adapted version of Parten's play stages, Mundy and Newell's theory, and CLD domains were used in analysing the pre-intervention data. Quantitative analysis (e.g., Bayesian analysis) was employed for the video-recorded and transcribed multimodal data during the intervention. Post-intervention, Francis et al.'s (2019) adapted version of Parten's play stages, Mundy and Newell's theory, and CLD domains were used in analysing the data.

Pre- and post-intervention semi-structured interviews captured parents' perspectives on the intervention's effectiveness, usability, accessibility, and cultural relevance. Video-recorded observations of dyadic child-led NFC brick play provided additional data, were triangulated with professionals' documentary evidence.

4. Results

4.1. Key Outcomes

Some findings suggested that the NFC brick play intervention increased cooperative and associative play and reduced prolonged disengagement episodes over the intervention period. Similarly, receptive language and pragmatic communication showed improvements (see Bayesian analysis below).

Culturally Responsive NFC (Active)

Traditional NFC (Passive)

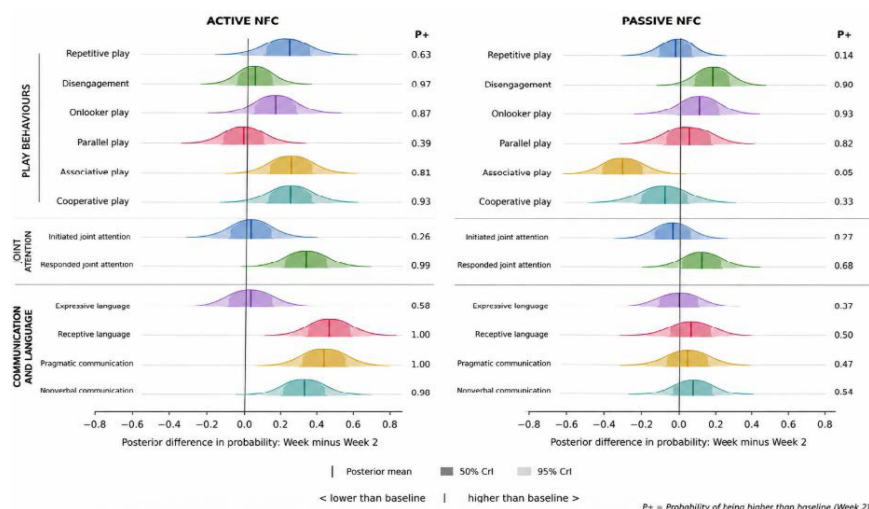


Figure 2: Bayesian posterior distributions derived from Beta-binomial estimates for play, joint attention, communication, and language behaviours.

Bayesian analysis, Forest plot of play, Joint attention, Communication and language variables, as well as Significant Spearman correlations among play, joint attention, communication and language variables, showed overall evidence of improvement in the CR NFC domains compared to the traditional domains.

5. Discussion

5.1. Results

The findings suggested that CLD should be culturally situated, bringing to the fore the role of family and culture through cultural responsiveness. Culturally responsive tangible systems can offer

environments that reduce barriers to engagement, enhance dyadic dialogic interactions, change behaviours, and enhance CLD in early autism interventions. Supporting embodied, child-led interaction, the system enables CLD to emerge through meaningful engagements rather than through an individual's set of skills or structured tasks.

CLD emerged as a mediated process through interaction among the autistic child, parent or carer, NFC bricks, the visual cue cards, and the home environment, validating the reconceptualisation of CLD in interventions for autistic young children of West African descent in home environments.

6. Conclusion and future work

The study presents a culturally responsive NFC-enabled tangible intervention that supports CLD in autistic young children of West African descent and challenges normative, linear perspectives of CLD. It contributes to emerging understandings of CLD as a multimodal, relational, and culturally situated process, demonstrating how tangible technologies and symbolic supports facilitate communicative participation.

6.1. Scalability and Future Work

Future research will investigate the sustainability of effects, whether changes persist beyond novelty, scalability across diverse cultural contexts, and the intervention's integration into wider healthcare and wellbeing frameworks. Further investigation will be made on embodied communication, multimodal interaction, and culturally situated communicative practices

Acknowledgements: The LEGO Foundation provided representative figurines of a skin tone similar to the cultural demographic of the participant children. We also acknowledge all participant families and Autism and Digital Technology Ghana (AutismDTgh)'s wider autism network.

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