



# Let's Play: Co-designing inclusive school playgrounds with neurodivergent children

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## ABSTRACT

School playground design does not always reflect the needs of the children who play there, particularly neurodivergent children. This leads to exclusion and limited opportunities for skill development and peer relationships. This research engages children with neurodivergent conditions, who are rarely asked for their opinions, to conceptualise their vision of their ideal school playground. It demonstrates what is required in play environments to make them inclusive and why neurodivergent children should be included in research.

This qualitative research involved two groups of children aged 10–12. Seven 'predominantly neurodivergent' (ND) students and six 'predominantly neurotypical' (NT) students, across two public, government-run schools in Brisbane, Australia. Play-based workshops used a co-design methodology to create play prototypes, drawings and journals, alongside interactions with a sensory sculpture on the school playground.

Guided by the social model of disability and a strengths-based neurodivergent approach, thematic analysis revealed what play features were necessary to support more inclusive play. Participants developed four key design principles from play features that included sensory, social, challenge and nature as priority areas for inclusive playground design. Further, Biophilic, Salutogenic and Prospect-Refuge theories validate what play features are essential to sustain ND children's involvement at play. These elements fostered physical, social, and emotional inclusion, enabling children to play for longer, promoting positive social outcomes.

Affordance theory underscores the value of these features in meeting neurodivergent children's needs and enhancing their play experiences. This research highlights opportunities for more inclusive playgrounds and for designers to create environments that support diverse users.

## 1. Introduction

Play offers essential physical, cognitive, and emotional benefits (Frost & Sutterby, 2017). However, many children face limited access to play, restricting opportunities to build key skills and peer relationships at school (Gray, 2017). Urban development has further reduced play-time, impacting social and emotional growth, making inclusive school play environments more vital than ever (Walsh, 2016).

While inclusive community spaces like 'All Abilities Playgrounds' have grown in Australia (Stafford, 2017), public schools have not kept pace—largely due to risk and safety concerns (Jambor in Walsh, 2016). Many school playgrounds lack challenge, diversity, and opportunities for risk, hindering development (Aminpour et al., 2020). This decline in unstructured, stimulating play contributes to rising anxiety and obesity

(Frost & Sutterby, 2017). Risky play is essential for brain development, resilience, and skill-building for all children, regardless of neurotype (Hart, 1997).

Current playground designs often fail to meet the needs of those who use them, especially neurodivergent (ND) children. These children tend to have fewer peer interactions (Yuill et al., 2007) and face both environmental and personal barriers—like overwhelming noise, poor spatial design, and unmet sensory needs (Woolley, 2013). Sensory Processing (SP) conditions can make ND children's play experiences challenging, but when those environments support self-regulation, children can thrive and engage more meaningfully, self-regulating their behaviour (Schoen et al., 2014). Without inclusive design, they risk social exclusion, low self-esteem, and loneliness (Woolley, 2013).

This research highlights the importance of inclusive play

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environments that respond to the needs and preferences of neurodivergent children. It identifies key features that enhance engagement, offering guidance for creating playgrounds that are accessible, supportive, and equitable. The purpose of this research is to explore which play features most effectively support inclusion and wellbeing at school, and how equitable research methods can elevate neurodivergent voices in the fields of inclusive design and education.

Finally, children's active engagement developing play prototypes in co-design workshops are explored. Sensory (e.g., swinging, spinning), social (e.g., seating), challenging (e.g., treehouses, climbing), and natural elements (e.g., rock hopping, nature) emerged as key features supporting inclusive play and wellbeing. The theoretical framework draws on Affordance Theory, as well as Salutogenic and Biophilic theories, to inform inclusive design principles. These insights reveal the 'right' play features—those that support self-regulation, improve behaviour, and enhance wellbeing, with positive impacts extending across the broader school community.

## 2. Background

### 2.1. Environmental barriers and sensory processing conditions

Opportunities and barriers can invite or preclude social interactions due to personal, physical, structural, or organisational features. A ramp can be a necessary structural addition to a playground, but attitudes can still deny social interactions. Neurodivergent children who have Sensory Processing conditions are impacted by environmental barriers that affect behaviours and emotions (Tomchek & Dunn, 2007), excluding them from school play experiences. Without considering alternative, quiet, withdrawal areas, like caves and tunnels, away from central play zones, environments can be overwhelming for children with sensory conditions. The senses; smell, sound, touch, sight and taste, alongside others, less well-known such as, proprioception (bodily awareness) and vestibular (balance and spinning), help children engage and regulate experiences from the environment effectively (Goodman-Scott et al., 2016). To self-regulate, children develop specific self-stimulating techniques (stimming) which, include, rocking, spinning, and twisting fingers, and are essential for their coping mechanisms and self-control (Pfeiffer et al., 2018). Sensory challenges are prevalent, but not limited to, children with Autism Spectrum Conditions (ASC) and Attention Deficit Hyperactive Difficulty (ADHD), with between 40–88 % exhibiting sensory challenges (Critz et al., 2015). Anxiety, depression and sensory challenges are not always visible, yet are equally prevalent in schools (Holt, 2007). Environmental barriers to play significantly impact children's development, with current research linking SP and anxiety (McMahon et al., 2019). The physical, social and cognitive benefits from play are well-researched (Keller & Hudson, 2013) and these are essential in preparation for social skills as children mature (Hughes, 2012). When access to play is denied, those skills are not acquired. Having play features in an environment that facilitates interactions, acknowledges how ND children might wish to play. Forming social connections is important for these children but not always easy, highlighting the benefits of facilitation with suitable environmental features.

### 2.2. Co-design with Neurodivergent children

Co-design as an empowering, person-centric approach, employs scaffolds and creative tools in workshops to facilitate equitable participant interactions (Kerr et al., 2023; Rieger, 2023). It sits within the participatory framework and refers to an act of creative collaboration (Sanders & Stappers, 2008). This approach provides opportunities that offer multiple perspectives from the user toward defining innovative solutions. Co-design studies on playtime with neurodivergent children in schools are scarce, but some play-based participatory studies included neurotypical children (Aminpour et al., 2020; Caro et al., 2016), while

others had a health and well-being focus (Scharoun & Mews, 2020). Another participatory study produced a play artefact with children with ASC (Merter & Hasirci, 2018), and several neurodivergent co-design studies have been related to intervention and classroom technology (Frauenberger et al., 2017); (Garzotto & Gonella, 2011).

The language regarding neurodivergence rather than disability was aligned with Judy Singer's (1998) terminology, from a strengths-based perspective. The intention was to reframe how children with conditions are generally and negatively labelled and the aim was to universally defend that they are always individually different. ND children need to be involved in shaping and redefining their world acknowledging their diverse needs. Voicing their concerns builds capacity and contributes to shared decision-making (Robertson & Simonsen, 2012), in return, their choices are respected and heard (Derr, 2015). The equity afforded by including neurodivergent children in research through co-design approaches has dismantled barriers (Frauenberger et al., 2012), revealing experiences and unexpected responses different from those of designers and researchers. More flexible, open and inclusive engagement by designers adapting communication styles may afford greater opportunities for expression (Rajapakse et al., 2019). Where users are non-verbal, it is up to the designers to seek alternative actions, look for emotional or gestural cues or sounds, understand the individual's perspective, and 'show, not tell' (Robertson & Simonsen, 2012). This way, neurodivergent children retain power through their choices and expressions.

### 2.3. Theoretical framework

This research employs the social model of disability which allows participants to be seen on their own terms, not defined by societal or medical constructs (Oliver, 2013). Affordance theory (Gibson, 2015) guides the exploration and how children's behaviours are shaped by the environment. For neurodivergent children, who may face bullying and exclusion, it is crucial to identify environmental barriers and play features that provide alternate opportunities to support inclusive play, aligned to individual needs. Gibson's concept of affordances refers to the possibilities for action that an environment offers to an individual. For instance, the affordances of playground equipment, like swings and slides, are shaped by the design of those elements as experiences within the layout, and arrangement of the entire playground. Affordances are perceived differently by each individual, depending on their abilities, intentions, and context (Chemero, 2018). Thus, what one child might perceive as an opportunity for play, another might find stressful or irrelevant, based on their needs and experiences. Affordances are key to understanding how external structures can support or inhibit behaviours, particularly in spaces where interactions are constantly changing, like playgrounds. By considering the needs of users, designers can create environments that support positive interactions and reduce stress through considered features (Cushing & Miller, 2020). Affordance theory is examined alongside the health and positive benefits of Salutogenic and Biophilic theories. Salutogenic design focuses on health-promoting features (Antonovsky, 1987; Cushing & Miller, 2020) emphasising emotional and physical benefits. Biophilic features promote a connection to nature, such as green spaces, and offer restorative benefits, reducing anxiety and depression (Barakat et al., 2019). Integrating natural elements improves attitudes and behaviours by enriching the sensory experiences of the environment. Children, especially those impacted by urbanisation, benefit greatly from natural play spaces that provide opportunities for reflection and relaxation (Caro et al., 2016). This idea is supported by Heft (2007) and demonstrated when children are naturally drawn to spaces that meet their functional needs. Other features may consider emotional responses through Prospect-Refuge theory (Appleton, 1975; Cushing & Miller, 2020), allowing children to play from a high point while observing activities below; particularly valuable for children with Autism or Sensory conditions. These features enable parallel play alongside others, where children can feel safe and

included without direct interaction, encouraging socialisation in a non-threatening way (Cushing & Miller, 2020).

### 3. Methodology and Methods

The objectives in this qualitative research are to discuss the outcomes of the co-design workshop process. Also, what play prototypes were created to support inclusive school play from a neurodivergent perspective with feedback provided from a neurotypical viewpoint. Furthermore, how inclusive design principles for children with Sensory Processing challenges and neurodivergent conditions were developed. This highlighted how co-design as the methodology, built capacity and developed a trusting and respectful relationship from the outset (Robertson & Simonsen, 2012).

A co-design methodology was essential because neurodivergent individuals have diverse and unique needs. Some children face social challenges and limited peer connections, others require structure, repetition, and routine. Co-design has transformed children’s involvement in design by emphasising user perspectives (Sanders & Stappers, 2008). It challenges traditional hierarchies, promoting equal participation and enhanced engagement for ND children to tell their story (Derr et al., 2015).

Two co-design and two educational approaches were used. The first co-design method was IDEAS (Interface Design Experience for the Autistic Spectrum), (Benton et al., 2012), which used visual supports and templates tailored to neurodivergent children. The second, Cooperative Inquiry (Frauenberger et al., 2011), a flexible and creative, child-led approach that was adapted to participants’ needs and behaviours, ensuring equitable participation.

The educational TEACCH method (Mesibov & Howley, 2003), provided visual cues, schedules and structured routines, so workshop expectations were visually apparent. The second approach, Kuypers’ (2013) Zones of Regulation, based on Cognitive Behavioural Therapy, helped children manage emotions and interactions in the workshops, through traffic light colours indicating emotional level.

The 3 research questions are presented below.

1. What do children with neurodivergent sensory conditions identify as important in a play space to support their play?

2. How might such neurodivergent play spaces meet the expectations of typically developing children; thereby operating as a socially inclusive play space?
3. How could a process of co-design effectively engage and add value to both groups of children?

#### 3.1. Setting and participants

This research took place at two public state schools in Brisbane, Australia. Four co-design workshops across two participant groups, were conducted over twelve weeks at the schools, detailed in Fig. 1. Originally intended as Group One, neurodivergent students and Group Two, neurotypical students, ethical recruitment meant that these groups conflated, having a mix of both students, aligning with the national inclusive education policy (Commonwealth Government, 2021). The principal study group (School 1) were seven ‘predominantly neurodivergent children’ (Group One), aged between 10–12. A one-off workshop was conducted for feedback from School 2 (Group Two), of six ‘predominantly neurotypical children’ of similar age, who may have had concomitant, neurodivergent conditions.

#### 3.2. Methods

To answer the research questions and what play features would support and benefit ND children, we employed a qualitative approach. The research used engaging, play-based materials tailored to neurodivergent traits, with fun activities and surprise items (fidget toys, balloons) to maintain attention and manage behaviours. The following section explains the objects, materials and processes in detail.

Participant interactions were observed and video recorded on the playground and with the tactile bunny provocation, detailed in 3.2.2. Inside the workshops, children worked individually or alongside others with avatars to construct play prototypes, including, drawing, reflective journals, and individual journey mapping. The Responsive Toolkit, described in 3.2.3, was offered as a prompt if needed.

Parental consent was obtained respectfully before each workshop to ensure equity and prevent coercion. Consent was orally sought from each child prior to each workshop. Discomfort and power imbalances were monitored throughout and risk was minimised through fun, play-

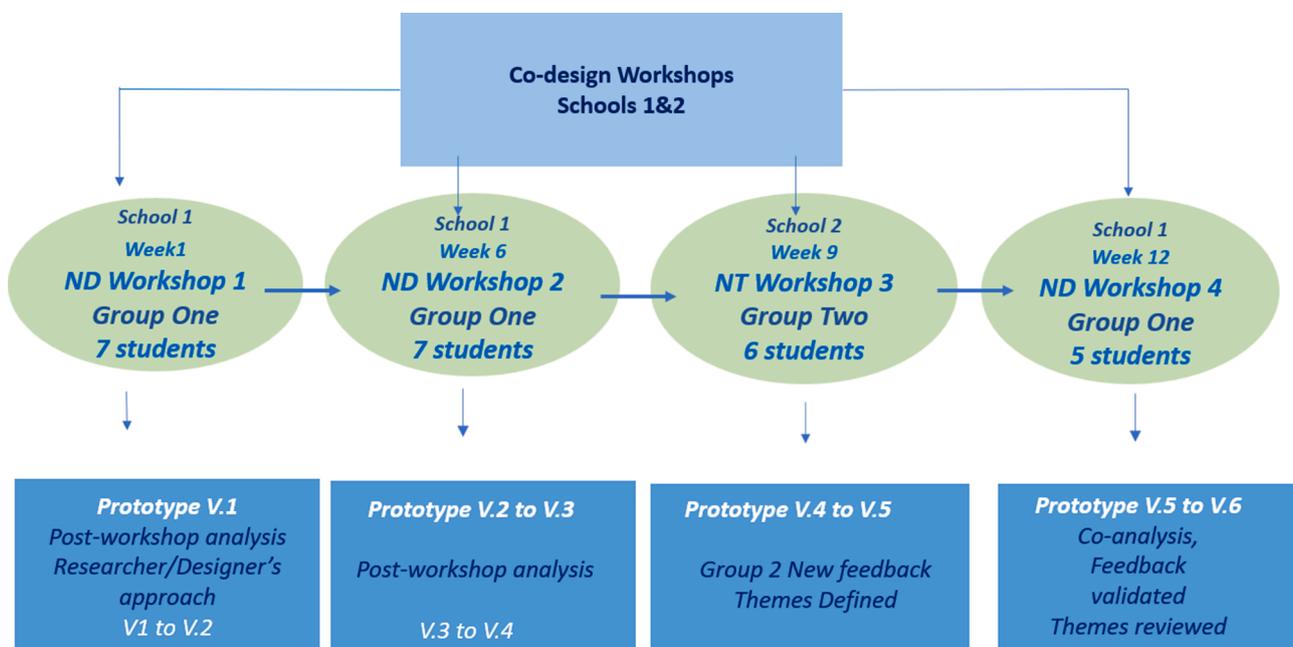


Fig. 1. Research design.

based activities. Ethics approvals: QUT (2000,000,837) and Department of Education, QLD (550/27/2380) were attained.

### 3.2.1. School 1, ND workshop 1

In Workshop 1, Group One (seven neurodivergent children at School 1) engaged in activities both inside the classroom and on their familiar school playground. This familiarity reduced anxiety and supported a sense of control and ownership (Brereton et al., 2015; Kerr et al., 2022) helping to identify preferred play elements without outside influence from peers or adults. To initiate workshop motivation, questions were framed around favourite play features and memorable play experiences.

### 3.2.2. Tactile bunny

The children engaged with the tactile bunny sculpture, a sensory provocation 1.6 m high, seen in Fig. 2, designed by the researcher. Children were encouraged to draw on the reversible sequin fabric which provoked immediate interactions and collaborations among the group. This provocation prepared their mindset for ideation and primed ideas for prototype development inside the workshops.

### 3.2.3. Co-design workshop engagement

Prototype development began in the classroom through construction, drawing, and journaling, documented via video, audio, photos, and notes. To support ideation, students used the Responsive Toolkit (Fig. 3), which offered two components: the ‘Sound of Biting Unicorns’ (reflective and aural items like balloons, drums, and a music box) and the ‘Sensory Box of Chocolates’ (tactile prompts like Velcro, bones, and fabric). The toolkit combined familiar and ambiguous materials to spark engagement and broaden discussion (Frauenberger et al., 2011). Some items were easily recognisable, while others were more open-ended with uncommon objects, like tool parts and washers.

Children were guided to explore the materials, seen in Fig. 4, and reflect on what made them feel happy, calm, or challenged during play. Questions such as “What helps you stay cool and calm when things don’t go as planned?” and “What kind of space makes you feel better?” supported this exploration. Emotional support items like bubble wrap and sensory boards were available around the room to aid self-regulation (Wan Yunus et al., 2015). Play features on the prototypes were refined or removed based on group consensus by the workshop’s end.

### 3.2.4. Post workshop 1

#### Reflective Journals

A reflective journal allowed children to share ideas from home,



Fig. 2. The Tactile Bunny.

supporting those less engaged in group settings. After Workshop 1, journal entries and feedback informed updates to Playground Prototype V.1. Thematic analysis (see 3.3) initiated early theme development and guided changes for Playground Prototype V.2, which was reviewed with students in the next workshop for co-analysis and agreement.

### 3.2.5. School 1, ND workshop 2

#### Avatars

To boost engagement, the researcher created mini clay avatars for each child, introduced at the start of Workshop 2 (Fig. 5). They were named after their interests, and served as playful distractions to help avoid triggering adverse play memories. Children used them to map preferred play areas, guiding discussion and informing revisions that led to Playground Prototype V.3.

#### Individual Play Journey Maps

The Responsive Toolkit supported children in creating personalised play maps, allowing them to express preferences and experiences. It also gave less dominant or non-verbal children space to share sensitive or adverse encounters at their own pace.

### 3.2.6. Post workshop 2

After ND Workshop 2, the Playground Prototype V.3 prototype was analysed alongside the ideas that emerged from workshop discussions and iterated into the Playground Prototype V.4 prototype. Individual play journeys offered opportunities for each child to express their unique features without pressure from peers and were thematically analysed separately.

### 3.2.7. School 2, NT workshop 3

Workshop 3 was a one-off session with Group Two (six neurotypical students from School 2). They provided feedback on Playground Prototype V.4 developed by School 1’s ND group. Using sticky notes, they suggested revisions without removing existing features, respecting the original group’s ownership and intent. The same research questions explored whether the space felt inclusive or needed changes. Group Two used futuristic animal avatars (Fig. 6) and the Responsive Toolkit to design their own play journeys. Their input helped redefine themes and shape Playground Prototype V.5. Providing the same activities to both groups ensured equity across the research.

### 3.2.8. School 1, ND workshop 4

In the final Workshop at School 1, the feedback from Group Two (School 2) was discussed for their review and co-analysis. Group One accepted the three amendments that culminated in the final Playground Prototype V.6. As a final workshop activity, students selected one play feature and described their rationale for locating this on a Google Earth Map of their school and playground environment.

## 3.3. Data analysis

Children’s responses were determined through their emotional experiences shared in workshops and social interactions on the playground, including from sensory provocations, like the tactile bunny. These shared encounters enriched the data, analysed as part of an ongoing, interconnected process. Creswell’s (2016) qualitative framework guided the analysis, helping to uncover deeper, sometimes unexpected insights from each participant.

Data were assessed for credibility, transferability, dependability, validity, and confirmability (Nowell et al., 2017). This was done individually by the researcher, collaboratively with participants, and reviewed by the supervisory team after each workshop to ensure dependability (Creswell, 2016). Triangulation occurred during coding, with findings and play prototypes presented back to participants for validation. In some cases, direct quotes from children supported the findings. NVivo software was used to verify data after coding and theme development.



Fig. 3. The responsive toolkit.



Fig. 4. Co-design workshop in action.

An inductive thematic analysis (Braun & Clarke, 2019) using multimodal methods ensured a consistent and rigorous approach (Nowell et al., 2017). This encouraged reflexive interpretations through visual and textual analysis (Rose, 2016) and included consideration of sounds, gestures and non-verbal expression to tell the story. Affordance Theory was employed to uncover user experiences, identifying cues and affordances in the play environment. These findings highlighted how the scale, position, and preferences of features varied between participants and demonstrated how children of different abilities engaged with their surroundings. Individual and group prototypes were analysed to understand these differences and to ensure equity across all contributions.

Data sources included transcripts, video and audio recordings, images, researcher notes, photographs, reflective journals, drawings, and low fidelity play prototypes. These diverse data sets supported the

development of themes and enabled a deeper understanding of how specific play features impacted individual needs and behaviours (Creswell, 2016). Children’s identities, expressions, and interactions were documented through notetaking and observation, capturing both public and private aspects of play. The analysis reflected a range of experiences—positive, negative, social, and intimate. Recognising diverse communication styles encouraged less verbal children to participate and boosted their self-esteem through group collaboration. Ethics guided the research by addressing power dynamics and centring the child-led nature of the workshop. Data analysis informed each prototype iteration, which participants validated. Child-led quotes further confirmed the findings, ensuring authentic representation of preferences and insights.



Fig. 6. Group two avatars.



Fig. 5. Group one avatars.

## 4. Results

### 4.1. Play features

#### Group One

The results provided key insights into enhancing inclusive sensory play spaces, focusing on children’s experiences, sensory needs, social acceptance, and well-being. ND Group One proposed features that were fun, elevated places that involved challenge and risk. This was in reaction to discussions stating that school playgrounds are boring, and children desired more places to sit, talk, and relax alongside active challenging features, as in the following.

- spinning and swinging features
- high, challenging places to climb and sit
- nature
- music
- imaginative elements

#### Group Two

Feedback from NT Group Two settled on similar features as Group One, agreeing the Playground Prototype V.4 ‘looked fun’, and that features were inclusive for their interactions. They did not create a separate prototype but added sticky note suggestions as feedback to create V.5. The following suggestions from Group Two participants were taken back to Group One for their consideration and to establish if they wanted to accept or reject these changes:

- open grassy running area.
- firepit to ridge, or near sandpit for safety.

- pathways, concrete area for wheelchairs and handball.

Both student groups preferred a mix of imaginative and traditional playground features based on their personal play encounters and desires of an ideal play environment, as in the robot face and the punchbag featured below in Fig. 7.

### 4.2. Playground Prototype Development Versions 1–6

The following iterations show the distinct stages of prototype development from Playground Prototype V.1 through to V.6. It reveals the changes made to play features during or post-workshop due to analysis across group discussions, priority of preferences or overlap between similar features.

Fig. 8

#### 4.2.1. Playground Prototype V.1

At the end of each workshop, individual play ideas were merged into a collaborative prototype. After Workshop 1, Group One’s feedback was analysed and used to revise the design, which they validated the following week. Playground Prototype V.1 included 18 features but felt overcrowded and lacked clear pathways. It combined sensory and active elements (e.g., hamster wheel, ball pit, swings) with overlapping functions. A punch bag, associated with aggression, was replaced by high-energy sensory features like climbing (proprioceptive), spinning, and swinging (vestibular) to support self-regulation and provide healthy outlets for stress and anger. These similar features and activities burn energy, provide feedback, and aid in self-regulation.

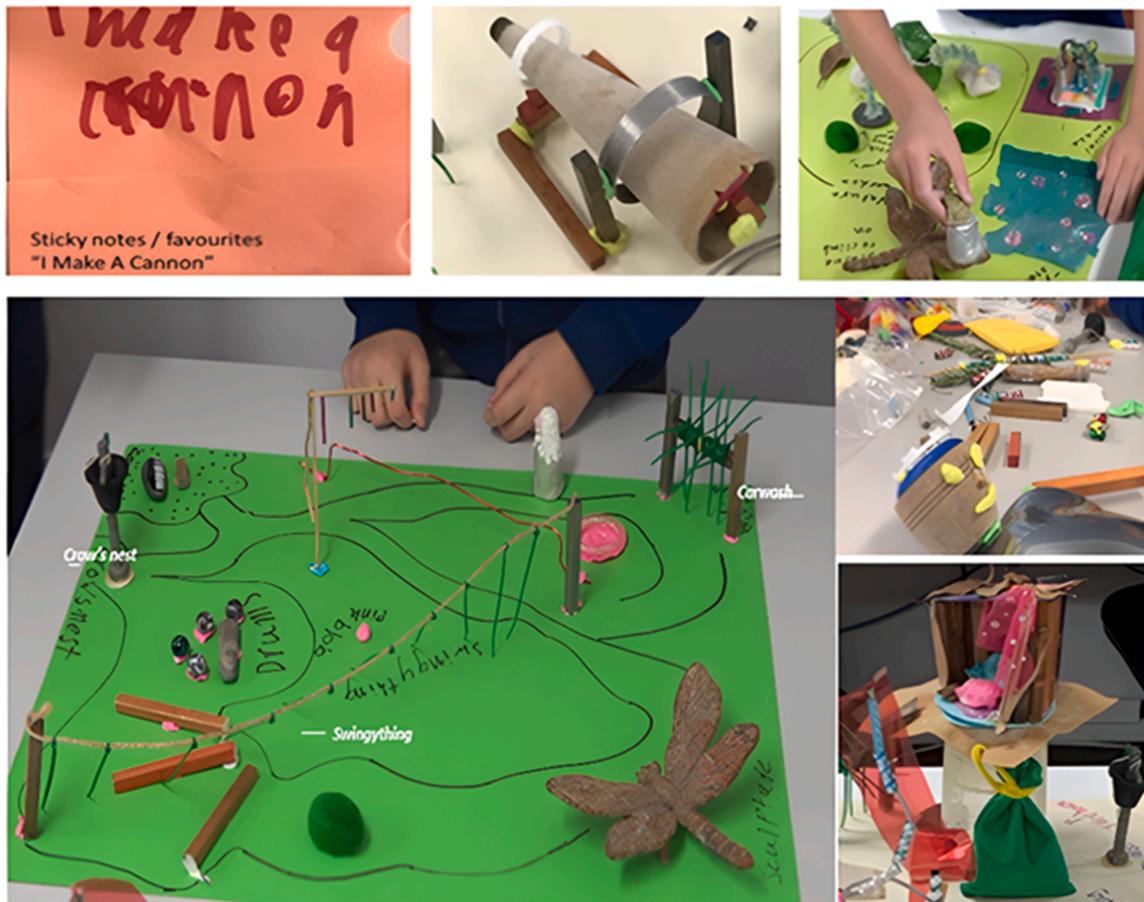


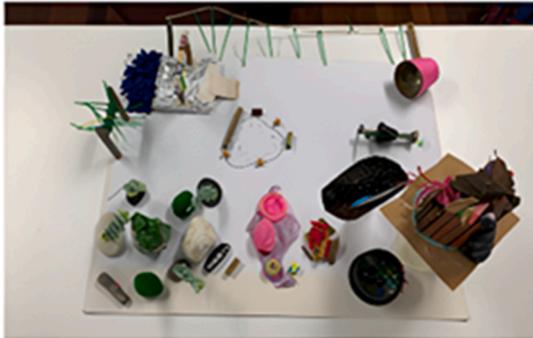
Fig. 7. (Clockwise from top): Cannon, telescope, wonderland maze, robot face, punch bag, individual play journey with unique features.



**Prototype V.1 (in workshop 1)**



**Prototype V.2 (post-workshop 1)**



**Prototype V.3 (in workshop 2)**



**Prototype V.4 (post-workshop 2)**



**Prototype V.5 (in workshop 3)**



**Prototype V.6 (post-workshop 4)**

**Fig. 8.** Playground prototype development versions 1–6.

#### 4.2.2. Playground Prototype V.2

The researcher/designer reviewed features and workshop data independently to produce a refined playground prototype. This reduced the features to 13, according to children's preferences, similarities and overlap within features validated by the children in Workshop 2.

#### 4.2.3. Playground Prototype V.3

By the end of Workshop 3, extra features were suggested, including a sandpit, firepit, dual swing-set, and an 'open grassy area' that extended to include an elevated treehouse area. A 'high ridge' was created for children to 'sit and watch', encouraging parallel play and assisting anxious children to feel included in interactions. The high ridge improved access to the treehouse and the nature mountain area. Following the workshop, feedback was analysed and incorporated into Playground Prototype V.4, which now had 17 features.

#### 4.2.4. Playground Prototype V.4

Playground Prototype V.4 was shown to Group Two, a mostly neurotypical group from School 2, to gather independent feedback and explore how inclusive the design was for all children. These students were chosen specifically to avoid influence from existing friendships or peer dynamics. Using the Responsive Toolkit, they also created individual play journeys. One child placed a soccer field adjacent to the playground to avoid disrupting other play. Another, drawing on her experience with a brother who has Down syndrome, designed raised seating and private enclosures to support resting and quiet time.

#### 4.2.5. Playground Prototype V.5 (Group two)

Group Two provided three suggestions on Playground Prototype V.4 using sticky notes: new pathways for better access, an open grassy area behind the ridge, and relocating the firepit near the sandpit. This feedback was incorporated into the Playground Prototype V.5.

4.2.6. Playground Prototype V.6

The amendments from Playground Prototype V.5 were presented to School 1 for their feedback. Group One accepted the three changes suggested by Group Two, resulting in Playground Prototype V.6 encompassing 20 features. All play prototypes can be examined in further detail in Research Data Finder; [https://doi.org/10.25912/RDF\\_1687237421302](https://doi.org/10.25912/RDF_1687237421302)

4.3. Reflective journals

Reflective journals, shown in Fig. 9, were used at home with family members to inspire discussions during workshops. This led to creative ideas for enhancing play prototypes, such as a vending machine, a 'fly like a butterfly' wall, and a 'pop-it race' inspired by a popular toy.

4.4. Themes

Children's responses emphasised how features like spinning, climbing, and challenging activities foster inclusion, socialisation, and sensory feedback, impacting well-being. Preferred sensory features supported self-regulation, biological needs, and full engagement within the environment. Nature spaces facilitated both quiet reflection and active play. Reflection from the student feedback and prototype

developments revealed the following six themes which emerged during the workshops, highlighting the interconnectedness of physical, social, and sensory interactions with play features.

1. Playgrounds Are Too Safe and Boring
2. Sensations and Sounds to Make You Feel Good
3. Challenging Play Features: "Why do I feel better when I climb up high?"
4. Nature
5. Quiet Seating and Social Play
6. Unusual, Fantastical, and Unexpected Features: "Under the slide is a good place to hide."

4.5. Emergent Design principles

The results acknowledge play features and affordances in providing what is required to meet sensory and social needs for more inclusive school play environments. By analysing children's play experiences, the key themes and affordances reveal the play features that promote greater inclusion for ND children. This research reveals four crucial design principles: sensory experiences, challenging opportunities, social interaction, and natural elements, which underscore the need for an enriched environment that supports all children to play together. From

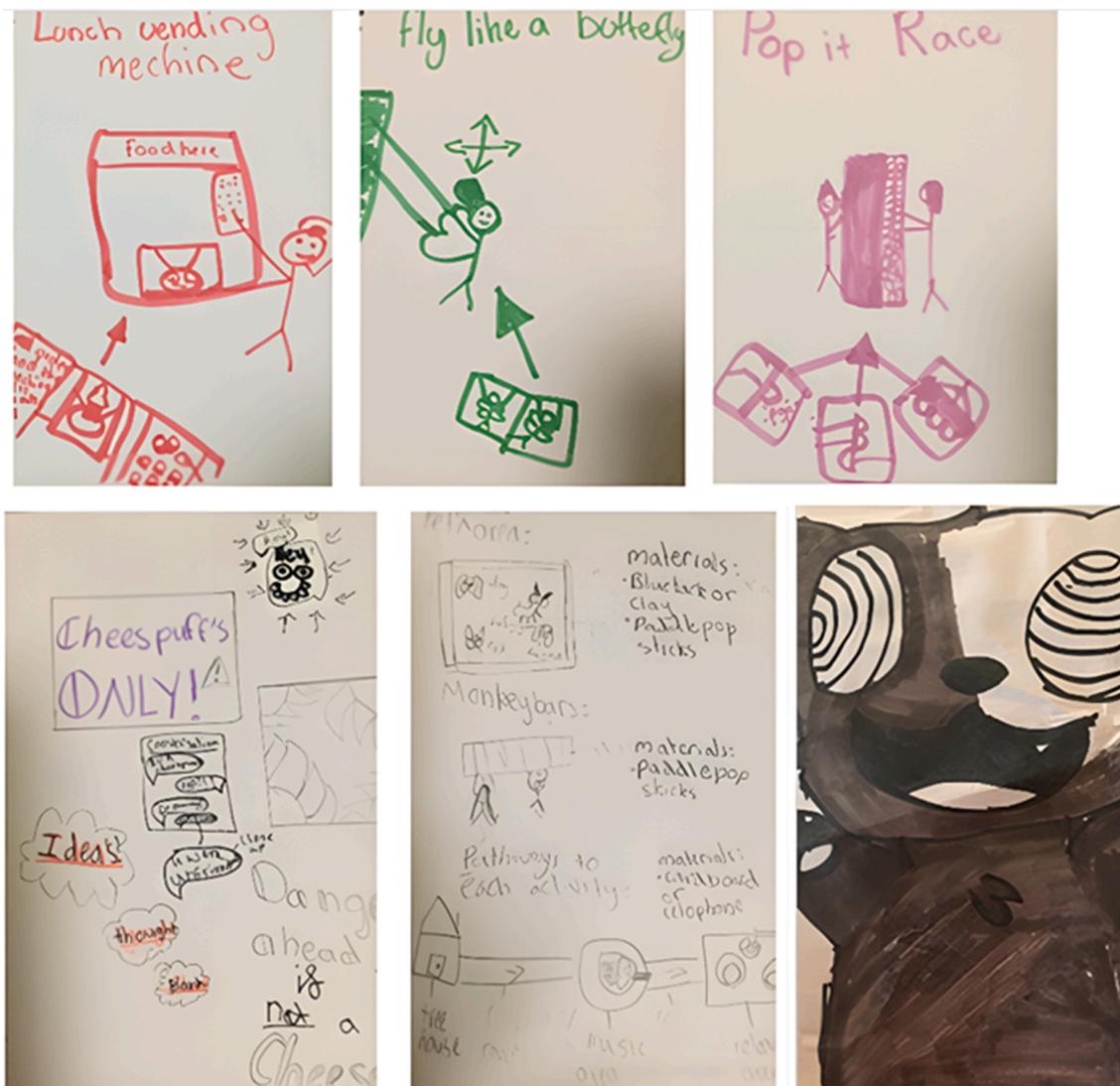


Fig. 9. Reflective journal drawings (clockwise from top left).

this, it becomes apparent that features like Prospect-Refuge (safe space to observe or withdraw) and Biophilic elements (natural surroundings) are essential options to support engagement for neurodivergent children. These findings demonstrate that sensory experiences and how ND children wish to play are important to consider in defining the design principles to create more inviting spaces. Secondly, once they feel welcome in a play area, with features that have sensory affordances, they are more likely to have positive experiences, make social connections and stay there longer, advancing Salutogenic design.

## 5. Discussion

This research underscores the importance of inclusive playground design from a neurodivergent (ND) perspective. Rich sensory environments with diverse affordances support children's emotional regulation, physical activity, and cognitive engagement. While both neurodivergent and neurotypical children may share preferences for certain play experiences, ND children face greater barriers due to sensory sensitivities, social challenges, and environmental exclusion (Goodley & Runswick-Cole, 2010).

The co-designed play prototypes developed in this research reveal clear and recurring themes: spinning, swinging, climbing, imaginative zones, and natural spaces, consistently emerge as meaningful play areas. These features not only invite engagement but also provide vestibular and proprioceptive feedback, which are critical for regulating stress and sustaining attention (Schoen et al., 2014). Whether activating the body through dynamic movement or offering calm retreat, the selected elements correspond directly with children's sensory profiles and emotional needs.

Four inclusive design principles have been identified: sensory, challenging, social, and natural spaces. These principles are grounded in affordance theory, reflecting the ways in which children perceive and act upon environmental features based on their individual capacities and needs (Gibson, 2015). They align with Salutogenic design (Antonovsky, 1987; Cushing & Miller, 2020) which focuses on environments that promote health and wellbeing, and Biophilic principles (Barakat et al., 2019), which highlight the emotional and cognitive benefits of natural, green spaces. Additionally, the concept of Prospect-Refuge (Appleton, 1975; Cushing & Miller, 2020) offers insight into the spatial preferences of those who seek sheltered vantage points that allow them to observe play before joining in. Together, these principles offer a robust framework for inclusive playground design from a position of empathy. They help to ensure that school playground engagement is a balance of stimulation and calm, challenge and comfort, social connection and solitary retreat.

Affordances play a central role in how ND children engage with play environments. They interpret and use features based on their sensory and regulatory needs, confirming Gibson's (2015) theory that affordances arise from the relationship between environment and user. Self-directed engagement—through swings, spinners, or climbing—supports neurotransmitter release (Duvall et al., 2017), facilitating sustained attention and emotional balance. The degree of involvement for each feature depends on what the child requires, allowing the feedback to engage, calm, settle, or stimulate their sensory requirements. This becomes apparent when traditional sensory playground elements like swings are removed in schools due to safety concerns (Wan Yunus et al., 2015). However, these features are critical for ND children to self-regulate through proprioceptive or vestibular feedback responses.

Conversely, features such as plastic slides can deter engagement when they produce negative sensory input, such as static shocks (Olsen, 2015). Designers must therefore carefully evaluate which elements support or inhibit participation, ensuring features offer functional and emotional significance for all users. This draws attention to what play features provide Salutogenic benefits and increased overall happiness and wellbeing when interacting with those elements.

Children in this research often describe their school playgrounds as 'boring', reflecting how risk-averse policies in public schools limit opportunities for challenge and exploration (Gray, 2017). Despite safety regulations, children across both groups actively seek out higher-risk elements—like flying foxes and hamster wheels—for the sense of fun, mastery, and peer validation they provide (Woolley, 2013). At both schools, the flying fox handles had been removed, as per education guidelines, with no alternatives in place, and one sand pit was filled in, due to health concerns. However, participants across both groups provided unprompted suggestions to improve safety (e.g., firepit barriers) highlighting their capacity to assess and respond to risk and affirming their role as competent contributors to research and design processes.

Adult concerns about safety often lead to over-supervision of ND children, restricting their autonomy in play (Holt et al., 2017). However, taking risks supports self-regulation, confidence, and behavioural development. Reframing risk as beneficial, rather than harmful, is vital—not only for the child's growth but also for the broader school environment (Snow et al., 2019). Schools in Queensland already trial, 'Loose Parts and Nature Play' programs that include controlled risk, such as tree climbing licences and firepits, fostering independence and self-confidence (Walsh, 2016). Similar initiatives developed through the Australian Institute of Play in state schools in Logan, Australia (H. Moser, personal communication, July 25th, 2022), have successfully reduced negative school behaviours and promoted social development.

Children's preferences for seating, quiet zones, and high vantage points in this research suggest an increasing need for play environments that support relaxation and social groups—particularly post-COVID-19. Pandemic-related isolation disproportionately affects ND children, exacerbating anxiety and reducing social interactions while restricted at home (Kelly, 2023). Post-COVID-19 saw an increase of over 60 % in mental health implications impacting young children aged 10–14 (Biddle & Gray in Caisley, 2021). The inclusion of Prospect-Refuge design elements offer safety while observing others at play and supports children who experience anxiety or social uncertainty (Yuill et al., 2007). These features enable inclusion without the pressure of direct participation, particularly for children on the Autism Spectrum (Frauenberger et al., 2017) affording positive play experiences. Social connection remains central to inclusive play as ND children often struggle to initiate or sustain peer interactions (Stafford, 2013), so playgrounds must include features that invite communication and cooperation. The co-designed prototypes demonstrate how structures like 'treehouses on high ridges' create natural points of engagement while respecting varying sensory needs. These features support both Salutogenic and Biophilic principles—facilitating emotional wellbeing and drawing on the restorative benefits of nature (Derr, 2015). Whether climbing a tree or sitting quietly in a garden space, children prefer multiple types of engagement, confirming the therapeutic value in natural environments.

Co-design plays a crucial role in capturing the nuance of ND children's needs. In this research, children articulate how specific features help them regulate emotions—like using a punchbag to release frustration 'without hurting anyone'. These responses demonstrate how thoughtful design can enable safe self-expression. Co-design fosters trust (Benton et al., 2012), autonomy, and mutual respect, aligning with ethical and inclusive research practice (Robertson & Simonsen, 2012). It has changed the way children have been included in the design process, more equitably, by understanding the complexity of their perspectives (Sanders & Stappers, 2008). It provides children with meaningful opportunities to shape their environments and inform empathetic, Salutogenic, and inclusive design solutions (Cushing & Miller, 2020).

To summarise, inclusive school playgrounds must move beyond compliance with safety to respond meaningfully to children's lived experiences. The 'right' play features—those that stimulate, calm, challenge, and connect—emerge clearly through this research. When designed with and for children, these features support not only sensory and emotional needs but also strengthen social inclusion and overall wellbeing across the school community.

## 6. Conclusion

This research makes a meaningful contribution to inclusive school playground design by centring the lived experiences and sensory needs of neurodivergent children. At the intersection of inclusive education, design, and wellbeing, the research demonstrates how co-design enables ND children to articulate what supports their engagement, regulation, and social connection during play. By foregrounding affordances that include sensory, social, natural, and challenging features, the findings reframe school playgrounds not just as recreational spaces, but as critical environments for inclusion, wellbeing, and equity.

The research affirms that ND children are not only capable of participating in research but also offer essential insights when given appropriate, equitable methods like co-design. This engagement validates the role of ND children as experts of their own experiences, and it challenges traditional exclusionary practices in school playground design. Moving beyond mere physical access, the identified features support emotional regulation, reduce anxiety, and foster social belonging—needs often overlooked in standardised play environments.

These findings offer practical guidance for educators, designers, landscape architects, and policymakers to develop more inclusive, Salutogenic, and Biophilic play environments. Embedding these principles into design practice can shift the focus from risk aversion and normative behaviour models toward responsive environments that meet diverse neurodevelopmental needs.

Current literature on sensory processing and neurodivergence often remains grounded in clinical or medical frameworks, limiting broader societal understanding and acceptance. By adopting a cross-disciplinary, child-led approach, this research calls for a shift towards inclusive, strengths-based design solutions. Such an approach has the potential to inform education, health, and planning policy—fostering environments that not only accommodate difference but celebrate it.

Looking forward, this research encourages a reimagining of school playgrounds as inclusive ecosystems that nurture self-regulation, social connection, and wellbeing. Future research should continue to centre neurodivergent voices, expand inclusive design frameworks, and advocate for systemic change in how play environments are conceived, funded, and implemented across schools.

## Glossary

**Affordances:** Affordance is the relationship between the environment and how that environment is used and what is offered to an individual in that environment.

**Biophilic:** Biophilic design integrates a connection to natural elements and processes in the built environment that promote health and positive responses.

**Co-design:** Co-design as a method refers to an act of creative collaboration where users are involved in a process to share knowledge toward finding design solutions. Codesign often builds on the Scandinavian tradition of participatory design

**Neurodiverse:** Characterised by autistic or other neurologically atypical patterns of thought or behaviour; not neurotypical.

**Neurotypical:** Not displaying or characterized by autistic or other neurologically atypical patterns of thought or behaviour.

**Prospect-Refuge:** The theory of 'prospect and refuge' seeks to describe why certain environments feel secure and thereby meet basic human psychological needs, providing the capacity to observe from a position of safety and comfort, without being seen.

**Salutogenic:** Salutogenesis is a stress resource-orientated concept, which focuses on assets, strengths, and motivation to maintain and improve the movement toward health.

**Sensory Processing:** Sensory processing refers to the way a person interprets and responds to sensations in the environment. It deals with how the brain processes multiple sensory modes, such as proprioception, vision, auditory system, tactile, olfactory, vestibular system,

interoception, and taste.

## CRedit authorship contribution statement

**Shelly Kelly:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization.  
**Jeremy Kerr:** Writing – review & editing, Writing – original draft, Supervision.  
**Janice Rieger:** Writing – review & editing, Supervision.  
**Debra Flanders Cushing:** Writing – review & editing, Supervision.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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