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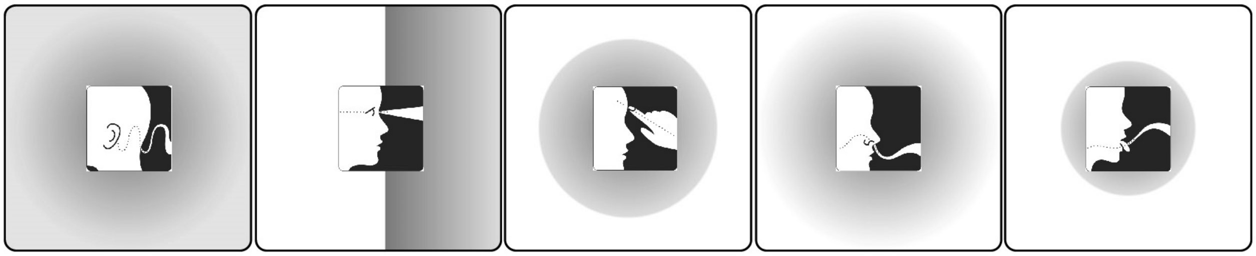
Team Members *Giyoung Park, Upali Nanda, Jonathan Essary, Lisa Adams, Melissa Hoelting, Sean Ahlquist*



Sensory Wellbeing for Adolescents with Developmental Disabilities: Creating (and Testing) a Sensory Wellbeing Hub

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Challenge

Childhood experience can significantly impact children's development and result in long-term consequences. Developmental disabilities—such as autism spectrum disorders (ASD), cerebral palsy, Down syndrome, and fetal alcohol syndrome—involve early onset of physical and/ or cognitive impairments and often accompany abnormal sensory processing. Hyper- or hyposensitivity due to sensory processing anomaly can lead to overstimulation or missing sensory cues from the environment or others around, which can make daily life more challenging, especially for those on the autistic spectrum whose sensory processing can be more deviated from neurotypical populations' (Joosten & Bundy, 2010). Brown and Dunn (2002) identify four quadrants of sensory profile by individuals' sensitivity and how they respond to stimuli. *Sensory avoiding* and *sensory seeking* indicate active response compared to *sensory sensitivity* and *low registration*. Individuals with autism can be sensitive to high illumination and sound levels, natural elements can have positive effects (Gaines, Bourne, Pearson, & Kleibrink, 2016). Additionally, compression has a soothing effect (Field, 2010; Grandin, 1992). Schools are more stimulating than children's other environments such as home (Fernández-Andrés, Pastor-Cerezuela, Sanz-Cervera, & Tárraga-Mínguez, 2015), and such challenges could interfere with students' learning and delay their preparedness for workforce. One in 59 U.S. children has ASD (Baio et al., 2018), and about one-third of young adults with ASD are unemployed and not enrolled in post-secondary education (Wei, Wagner, Hudson, Yu, & Shattuck, 2015).

At Lane Tech College Prep High School in Chicago, close to 60 diverse learners with developmental disabilities in the age group of 14-21 struggled with sensory equilibrium in the course of their special education program. The school identified the need for a sensory room, which was taken up by [Citizen HKS]() as a pro bono project. A sensory room could alleviate overstimulation by reducing the amount of sensory input, and it could also help both hyper- and hyposensitive diverse learners re-engage with the surrounding using sensory interventions (Cuvo, May, & Post, 2001; Shapiro, Parush, Green, & Roth, 1997). Yet, we soon realized that the research on the efficacy of sensory rooms was thin, and assessment of sensory rooms' efficacy was limited. For example, *affordances* are plausible relationships between a user and a physical object (Gibson, 1979); and *sensory affordances* can help people perceive sensory information (Hartson, 2003). This concept is very relevant to sensory processing and can be used to examine how users engage with a sensory room and its sensory interventions. Moreover, it isn't always possible to have a sensory room available to meet the sensory needs—then, what happens when they leave the room? Are the effects sustained?

Aim

We reframe the challenge: Can we design a prototype that is scalable to be implemented in various learning environments, flexible to host a wide range of sensory affordances, and able to support mainstreaming? Can we assess the efficacy of various sensory affordances provided in the hub in addition to the efficacy of the hub as a whole? Can we link individuals' sensory profiles and their intervention usage and propose an informed menu of design choices for specific individuals? And finally, can we investigate if and what enhancements this project contributes to?

This study aims to create and test the efficacy of a sensory wellbeing hub prototype for adolescents with developmental disabilities, especially those with autism spectrum disorders (ASD). The objectives are to:

1. Create a prototype that can be easily adapted for the unique needs of diverse learners.
2. Examine the usage of the hub and its sensory interventions to identify:
    a. Diverse learners' and staff's hub usage patterns.
    b. Most frequently used sensory interventions.
    c. Sensory intervention usage by students with vs. without ASD.
    d. Associations between sensory profiles and sensory intervention usage.
3. Assess the effect of the hub on students', parents', staff's wellbeing and staff's job satisfaction.

Approach

The study team undertook an integrated design-research approach where design and research were closely interwoven and iterative, rather than the traditional approach of research, design phases, and then post-occupancy evaluation. The design-research approach is best exemplified in a simple triple-diamond of the diverging and converging cycles that expanded the double-diamond approach by Design Council (2015).

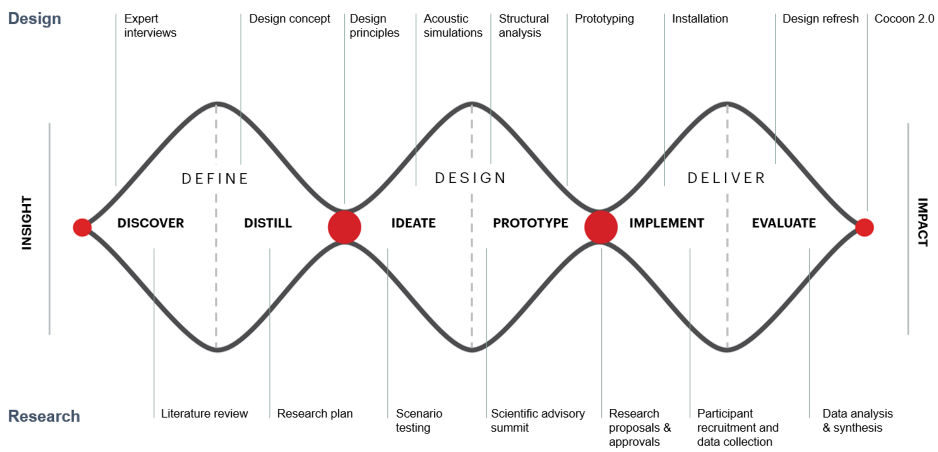


Image: Triple-diamond approach this study used.

Method

This study used a mixed-methods approach including literature reviews, surveys, focus groups, field observations, sensor data, and archival hub-visit logs, and student records during an academic year after the installation of the hub. A combination of rapid prototyping and simulation techniques was used for the design and fabrication.

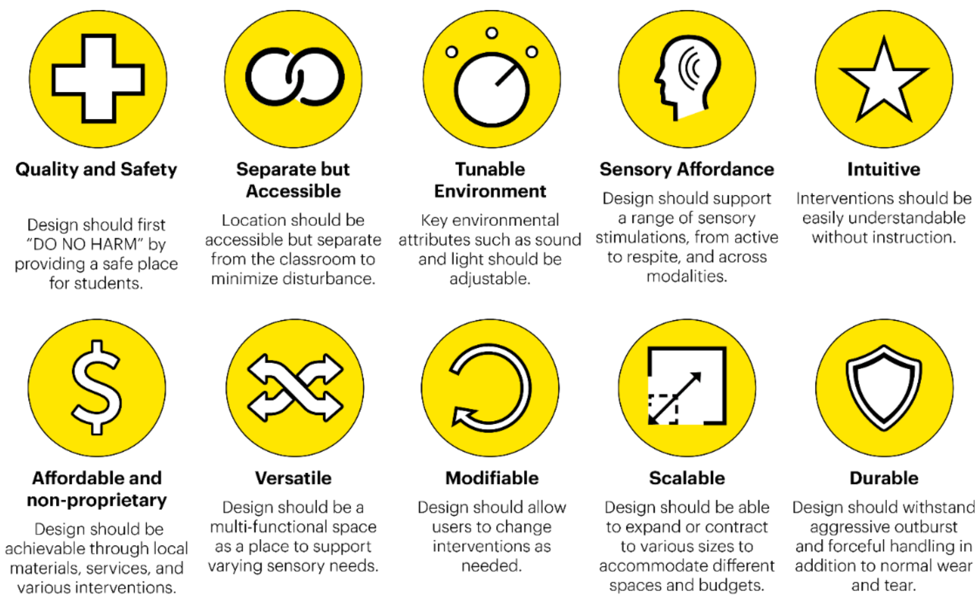
An extensive literature review was conducted to understand current best practices on creating environments for individuals with abnormal sensory processing. Sensory room, developmental disabilities, autism or ASD, and sensory processing were among the keywords used to search relevant studies. The study team also interviewed over 30 experts in the field of special education or sensory processing to get a preliminary understanding and develop a conceptual response. A day-long scientific advisory summit was then organized and invited six global experts, designers, and researchers to share insights, feedback on design concepts, materiality, sensory intervention selection and engagement, and advise on design principles. A full-size mock-up was installed in the 2,000-sq.ft. design lab at HKS. The summit participants reviewed the hub design using the full-size mock-up, and expert considerations were synthesized and incorporated into the design principles. Computational design and in-house fabrication, strategic design partnerships, simulations, and scenario testing supported the design process.

Meanwhile, research approvals were sought for the occupant research piece via a third-party institutional review board (IRB) and Chicago Public School's research review board (RRB). Upon research approvals, parent consent was acquired prior to data collection. A series of pilot tests was performed to refine data collection methods. A *Well-Being of Young People with Special Education* questionnaire (Sabri, Rotheroe, & Kazimirski, 2015) was deployed to the consented students (N = 25) in the first and the second semesters after construction to see changes over time, and *Adult/ Adolescent Sensory Profile* surveys (Brown & Dunn, 2002) were distributed once in the first semester. Additionally, *Positive And Negative Affect Schedule* (PANAS;

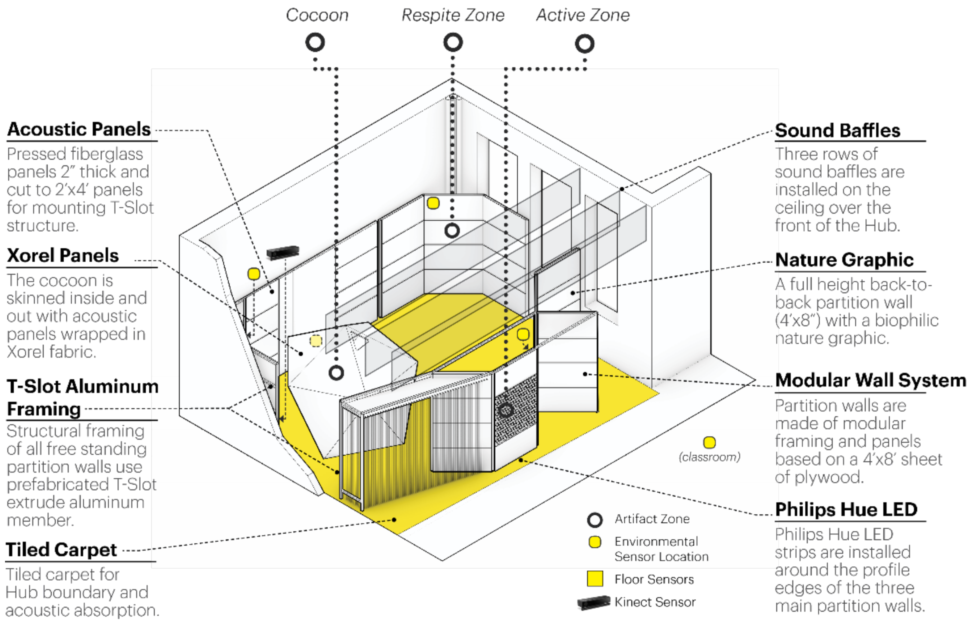
Watson, Clark, & Tellegen, 1988) was deployed to parents and staff; and Brayfield-Rothe Job Satisfaction (Brayfield & Rothe, 1951) survey was sent to staff to assess indirect effects of the hub on caregivers and staff. Emotional states were assessed using the metric from Thompson (2011), and students were shadowed when they visited the hub for one week. Some datasets were collected over a few months or longer. In addition to data analysis using aggregated datasets, individual-level analyses were performed to create *PlaceRx*—that is, a set of recommendations of sensory interventions and/or affordances tailored for each individual. Recommendations would differ between normal and distressed situations if individuals sought different sensory interventions by situations.

Results

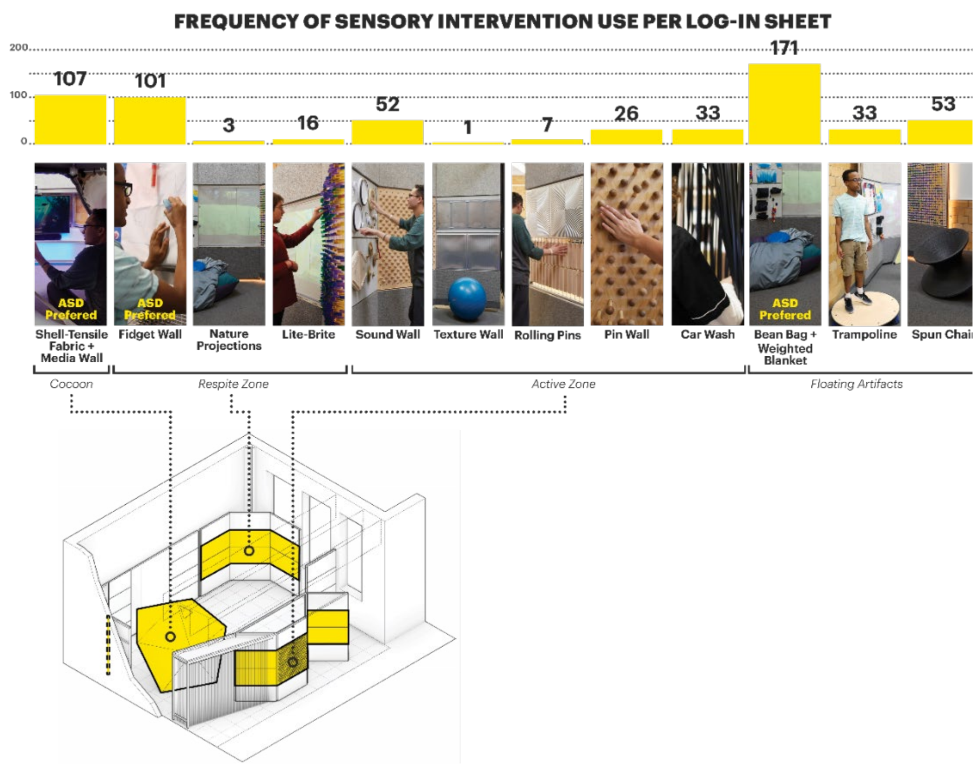
The final sensory hub was a demountable prototype consisting of three zones: active and respite zones and the cocoon with tensile fabric seating & an interactive media wall. The following design principles summarize our learnings from the literature review and the scientific advisory summit:



The overall structure uses a modular aluminum framing system as illustrated below. The cocoon reflected the prospect-and-refuge theory (Appleton, 1975) and was designed computationally with 3D-printed nodes. The cocoon design will be open-source for public soon. A tensile-fabric seating was installed inside the cocoon. Located within a classroom without full separation from it, acoustic design was challenging to better accommodate hypersensitivity to sound. Sound baffles and sound absorptive materials were actively used. Acoustic simulations aided sound baffle design and location selection.



All interior design elements were designed with specific sensory affordances in mind to offer a range of choices for diverse learners with hypo- and/or hypersensitivity. The sensory interventions and their usage by the students are illustrated below:



Summary of our findings from the year-long study are as follows:

1. There was large variability in how students used the hub, which suggests the need for a personalized approach—a one-size-fits one.
2. The cocoon serves as a micro-environment that reduces sound and illumination levels compared to the rest of the hub and the classroom where the hub was located. Sound levels were lower by 3 dB(A).
3. Some students obsessed over the smallest anomaly and that can become a stressor for them.
4. Tactile interventions—especially the ones involving compression—were the most sought.
5. The most used sensory interventions overall were the beanbag & weighted blanket, the cocoon with tensile fabric & media wall, and fidget wall that included aquadoodle, fan, and small bags filled with different grains.
6. Sensory intervention usage varied by ASD vs. non-ASD students and by scheduled and unscheduled visits. all, students with ASD used beanbag & weighted blanket, aquadoodle, and the cocoon with tensile fabric & media wall most often. Students without ASD used the beanbag & weighted blanket, the cocoon with tensile fabric & media wall, and the sound wall (musical instruments) most frequently.
    a) Only students with ASD used the aquadoodle, and they more likely used it during scheduled visits when students were not highly stressed than scheduled visits.
    b) During unscheduled visits, students with ASD used the beanbag & weighted blanket and the cocoon with tensile fabric & media wall more. This implies when under stress, students prefer more relaxing or calming elements, with a strong tactile component, specifically with compression qualities.
7. Sensory intervention usage varied by sensory profile.
    a) Students with higher sensory avoiding scores and low sensory seeking scores used the cocoon with tensile fabric & media wall more often. This implies that the cocoon zone provided respite for hyper-sensitive students with the lower lighting and sound levels as well as compression.
    b) Students with high sensory seeking scores used the beanbag and weighted blanket more often. This is counterintuitive and needs to be validated with a larger sample and/or focus groups. A potential explanation is that hypersensitive students need gradual dosage of compression for the whole body engagement.

c) Students who reported hyposensitivity (low registration & sensory seeking) used aquadoodle more often. Those who reported high sensory avoiding scores also used the aquadoodle more. These associations suggest aquadoodle may support a wide range of sensory needs.

d) Students with lower scores in low registration used spun chair more often. This implies that spun chair may not provide salient sensory stimulation for those who have a higher threshold to register a stimulus.

8. Students' wellbeing in school showed a trend of improvement between the two semesters suggesting a cumulative effect. Students with ASD reported better emotional wellbeing in the second semester than the first semester contrast to no changes among students without ASD.
9. Hub usage may be subject to school's policy of hub usage, staff's comprehension of sensory interventions, and students' and teachers' perception of who can visit the hub.
10. Unobtrusive measurement via Kinect cameras/ floor sensors provide an untapped opportunity to document the behaviors of vulnerable populations with cognitive disorders.

The project resulted in three key deliverables:

1. A prototype kit-of-parts sensory wellbeing hub that can be deployed in a range of learning environments with a core set of design principles.
2. A research report that provides:
    a) Key insights on how sensory wellbeing can be achieved in a one-size-fits-one approach with a range of sensory affordances.
    b) Efficacy of sensory interventions by measuring impact in real time.
3. A tool to use insights from sensory profiles and hub & sensory-intervention usage to create PlaceRX—a prescription for each student that can help their caregivers seek and/or create similar affordances outside the hub.

Application & Next Steps

Designers are encouraged to incorporate the following design guidelines when applicable:

- Incorporate sensory interventions that vary in the amount of stimulation and/or can be adjustable.
- Balance proximity to the classrooms with physical separation to allow easy access to the hub while maintaining effective acoustic and lighting control.
- Incorporate sound-absorbing materials as much as possible to reduce sound levels.
- Provide ways to adjust illumination levels such as dimmable lighting and curtains.
- Select durable materials.
- Create a flexible and adaptable system so that staff can replace underutilized or damaged sensory interventions.
- Leverage tactile and compression elements.
- Minimize potential irritants such as small buttons on a remote controller, sharp edges, narrow grooves, etc. These can be challenging for those with impaired motor skills or vision impairment or may prompt obsessive behavior.
- Design sensory interventions that are intuitive for both students and staff.
- Provide a hands-on orientation for staff and a manual for use so that design intent can be linked to policy and procedural actions.
- Consider observing and documenting how students use the hub to assess the efficacy of the design. The data can also contribute to PlaceRx—a prescription of sensory elements for each student during different states and how they can be found in real life (outside of a controlled environment).

The cocoon with a newly prototyped structure and a free-standing tensile fabric structure were displayed at SXSW EDU Playground in March, 2019. Preliminary findings have been presented at the International Association of People-Environment Studies (IAPS) and the Academy of Neuroscience for Architecture (ANFA) conferences in 2018. The findings were shared with Lane Tech College Prep High School and will be presented at the Environmental Design Research Association (EDRA) conference in May, 2019.

The next step for the project is the evolution of the cocoon and deployment into a range of environments. A set of guidelines for sensory wellbeing hub with a comprehensive part list for the kit-of-parts will be published to aid learning environments globally. Going forward, we see sensory wellbeing as a core mandate of ALL built environments. This team will continue to delve deeper into how the senses come together.

References

Links to related content

The Sensory Well-Being Hub at Chicago's Lane Tech College Prep High School: http://stories.hksinc.com/ideas/sensory-wellbeing-hub-lane-tech-place-respite-diverse-learners/

Cocoon 2.0: Designing Respite Space for a Cacophonic World: http://stories.hksinc.com/ideas/cocoon-2-0-designing-respite-space-cacophonic-world/

Date completed

January 31, 2019

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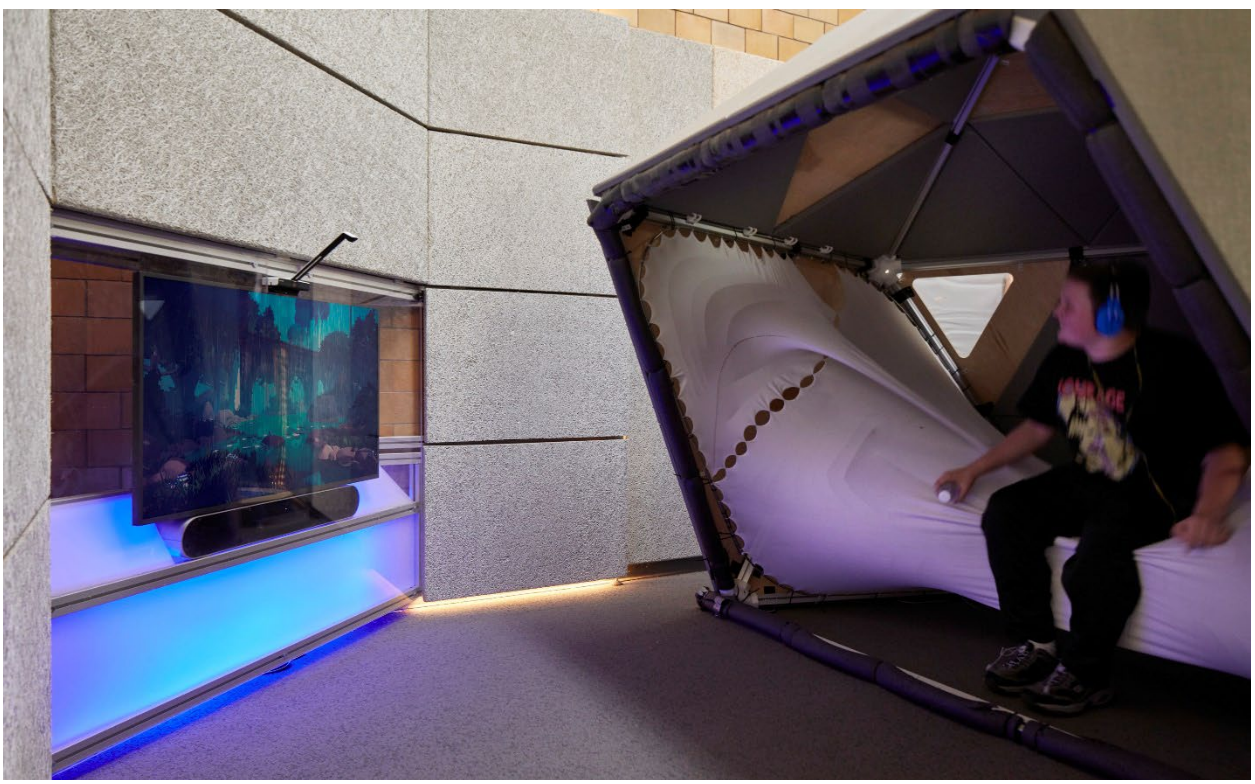
Photographs of the sensory wellbeing hub

A view of the sensory wellbeing hub from the classroom.



The cocoon with tensile fabric seating and an interactive media wall.

(From left) Active zone including metal texture panels, rolling pins, musical instruments, wooden pin wall, and additional metal texture panels.

(From left top) Respite zone consisting of aquadoodle, a fan, grain bags, a beanbag with a weighted blanket (on the floor), projected biophilic images, and Lite Brite.