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Design for a Spectrum

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Abstract:

Autism Spectrum Disorder (ASD) is a growing disorder across the world. ASD affects around 1 in every 68 children in the United States (Block, 2018). This disorder results in significant social, intellectual, and behavioral changes within a child, and create challenges for a child with ASD to learn and develop like children without ASD. No two cases of ASD are alike which is why it is called a spectrum disorder. This adds an extra challenge to designing spaces for children with ASD to inhabit and thrive. These children frequently suffer from sensory processing deficits in which they have a hard time processing different stimuli happening within an environment. In an ideal situation, a space would be designed to accommodate each unique symptom while also helping build a tolerance for other stimuli in the environment.

What are some of the main characteristics of children with ASD? What is the best way to define the severity of these characteristics? What types of interventions can take place to help manage these characteristics without completely controlling the environment? What is the best way to test the effectiveness of these interventions?

This project will identify some of the key characteristics that a child with ASD expresses. Environmental color, hues placed in the environment on architectural surfaces or through the addition of interior elements, will be discussed in the context of antecedent intervention, or interventions that are put in place before a behavior occurs to either reinforce it or discourage it. These interventions are both additive and subtractive in nature. The result of this project will be a resource brochure with different design categories that parents can use to find different environmental interventions that have to do with the corresponding categories.

Design for a Spectrum: Characteristics of Children with Autism Spectrum Disorder and Environmental Interventions

Introduction

Autism Spectrum Disorder (ASD) is a growing disorder across the world. ASD affects around 1 in every 68 children in the United States (Block, 2018). The diagnosis of ASD has increased over the past 20 years although some argue that the disorder is becoming more prevalent while others say the rise in education about the disorder is contributing the increase in cases. This disorder results in significant social, intellectual, and behavioral changes within a child, and create challenges for a child with ASD to learn and develop like children without ASD. No two cases of ASD are alike which is why it is called a spectrum disorder. The autism spectrum can range from individuals who are considered high functioning and nearly indistinguishable from a person without ASD to individuals who expresses severe life-threatening behaviors.

There is no known cure for ASD which is why a diverse range of interventions are crucial. It is also important to start these methods or interventions as early as possible during a child's development. Additionally, when deciding where to execute these interventions it is important to consider where the child spends most of their time.

Significant to this investigation is the challenge of designing spaces for children with ASD to inhabit and thrive further confounded by the disorder's extreme variability. Sensory processing deficits, difficulty processing different environmental stimuli, is a common challenge. In an ideal situation, a space would be designed to accommodate each child's unique sensory deficits while also helping build tolerance for other stimuli in the environment.

The purpose of this project is to provide to parents and educators of children with ASD a resource of color-based antecedent interventions that can be implemented in a home or school environment to influence certain behaviors related to ASD. This is achieved by identifying specific ASD-related behaviors and understanding how the environment can trigger or redirect these behaviors. Then, proposing different color-related environmental modifications that are focusing on three main categories: zoning, attention, and reward.

The long-term goal of this project is to digitize this resource while also adding additional design categories such as acoustical or lighting interventions. The immediate outcome of the project is a brochure format that can be distributed at a doctor's office or clinic or mailed to the users.

ASD

"Autism spectrum disorder (ASD) is a developmental disability caused by a difference in the brain" (Autism Spectrum Disorder (ASD), 2022). Because this is a spectrum disorder, there are a wide range of behavioral, learning, and social outcomes that disadvantage these children in their early years and throughout their lives.

Below is a list of different ASD related behaviors categorized by either communication or physical behaviors.

Behavioral

- Obsessive attachment to objects
- Outbursts of screaming or aggressive behavior
- Fascinated by specific objects

Learning

- Strong need for order or routine
- Difficulty focusing on specific task
- Does not follow simple commands given once

Social

- Repeating words or phrases
- Delay in learning how to speak or speaking in an atypical tone of voice
- Difficulty communicating
- Unaware of surroundings, oblivious to dangerous situations

ASD and the Environment

For children, most of their time is spent either at home or in a learning environment. Author and mother of child with ASD, A.J. Paron-Wildes writes: "If their [people with ASD] designed world and their environmental experiences are totally different from ours [people without ASD], then their environmental

design requirements are completely different as well" (Paron-Wildes, 2014). Parents of children with ASD are searching for ways to help their children feel more comfortable in the complex environments that we inhabit.

In the home environment, activities that a child with ASD does are a part of their daily routine as well as part of the families daily routine. These daily routines can take place in many different areas of the home such as their personal room, bathroom, or family kitchen. Of all these spaces, the child's bedroom is the one place that is their own. "The bedroom is a safe space they can retreat to when the outside world seems scary" (Wise, 2019). Different interventions may also be implemented around the home to promote different actions of the child's daily routine. The child may be given more choices while at home and are more likely to socially engage and interact with others (Fernández-Andres, Pastor-Cerezuela, Sanz-Cervera, & Tarraga-Minguez, 2015).

In the school environment there have been different initiatives that have been implemented to help a child with ASD in the classroom setting. One example is the installation of a sensory hub that includes a sensory cocoon, media wall, color-changing lights, beanbag, spun chair, fidget wall, nature projection, and textured wall. According to the study, the sensory cocoon, media wall, and fidget wall were the most visited elements in the hub while there was less engagement with the spun chair. "People with hyposensitivity might not register the chair due to its light gray color" (Park, Nada, Adams, Essary, & Hoelting, 2020).

ASD and Color

Children with ASD have a different relationship to color than some typically developing children. Things like color obsessions and color sensitivities are common behaviors of children with ASD. Although there is little experimental investigation in the claim that color perceptions and cognition is atypical in children with ASD there are significant amounts of anecdotal evidence from parents and educators that children with ASD may perceive color differently to typically developing children (Franklin, Sowden, Burley, Notman, & Alder, 2008).

There are three different ways this project will address color in the environment for children with ASD; color discrimination, color sensitivity, and color preferences and aversions.

Color Discrimination

Color discrimination is the ability to discriminate between different colors. Whether that be different hues, different saturations, or different shades of a color. In one study, "participants searched for a red "F" target hidden among pink "F" and red "E" distractors. There was a significant interaction between group and condition, such that the superiority of the performance of the ASD group increased as target-distractor similarity increased. Thus, children and adults with ASD showed an enhanced ability to discriminate among visual features" (Holtzclaw, Klinger, Klinger, Merrill, & Barber, 2011). The idea that most children with ASD can discriminate different colors is helpful when using different colors as tools in an environment.

Color Sensitivity

Children with ASD are known to be hypersensitive to tactile, auditory, and visual input. (Grandgeorge & Masataka, 2016). Hypersensitivity is the reaction to stimuli that is overexaggerated or overresponsive. A study in which the saturation of colors was adjusted and a group of typically developing children and children with ASD were tasked to match the new color (saturated) with the previous color proved that the group with ASD was more sensitive to changes in color saturation than the comparison" (Holtzclaw, Klinger, Klinger, Merrill, & Barber, 2011). This suggests that some children with ASD are sensitive to even the slightest amount of color change. This means that it is important to recognize how colors are being used in a space to make sure that there is the proper amount of balance.

Color Preferences and Aversions

Color preferences and aversions are common in children with ASD. One study identifies that "Children with ASD were certainly likely to avoid yellow and, conversely to favor green and brown" (Grandgeorge & Masataka, 2016) while another claims that "color obsession with green has been abundantly reported" (Grandgeorge & Masataka, 2016). There are certain attributes of a color such as value (lightness or darkness) and intensity (vivid or dull) that potentially play a role in the child choosing their favorite. The idea that yellow has the highest luminance or brightness could potentially trigger the

hyper-sensitive child. While there is no real trend in a favorite or least favorite color for children with ASD, each child individually expresses different feelings towards colors. This makes colors an effective tool to use color as a motivational tool for a child with ASD.

Antecedent Based Interventions

Antecedent based interventions or ABI's "are strategies that involve modifying the environment to reduce undesirable behaviors" (What is an Antecedent-Based Intervention in Applied Behavior Analysis?, 2022). ABI's are influenced by the environment. Therefore, if we modify the environments that the undesirable takes place in, the undesirable behaviors may be reduced or eliminated. ABI's are implemented in an environment before the behavior takes place to help cut out the behavior. For example, some children with ASD have a strong need for order and behavioral outbursts occur when that routine is altered. For such child, an ABI would allow the child to choose their "first" learning center in the classroom to visit instead of forcing a different routine and triggering the outburst. This gives the child with ASD the power to choose and feel like they are making an important decision for themselves. Color can be effectively integrated into these ABIs, potentially eliminating undesirable behaviors, empowering children, and facilitating their growth and independence.

Color as Zones

Learning centers in classrooms are frequently developed by teachers to structure activities. These learning centers may facilitate sensory play, independent work time, or other activities that allow children to work independently. This allows the teacher to occasionally work with a small group of students while the rest of the class is doing activities in a less structured manner. "A large portion of time involves less structured learning and social activities; arguably the areas children with ASD have deficits in" (Association, 2013). Therefore, there is a need for ways to cue a child with ASD to do different activities on their own which promotes independency. Color can be used to create a visual cue to a child with ASD when a certain task is to be completed or they are to move to a different location. This can be done in a variety of ways whether that is through a blue rug in the reading center that informs the child with ASD that blue means read or a yellow zone outside on the sidewalk next to the street that notifies a

child that the yellow zone signifies to slow down because there could be danger ahead. Both of these ABI's directly impact a ASD related behavior, one being the inability to recognize a dangerous situation and following simple directions.

Color to capture attention

Like the colored zones, color can also be used to capture the attention of a child with ASD. A red flag that is waved by the teacher when the class is getting too noisy that signifies to the children to stop what they are doing and listen. Children with ASD are sensitive when it comes to colors as many are hypersensitive to the changing environment. This ABI directly impacts the ASD related behavior to follow simple directions.

Color as Reward

Reinforcers are a common technique used when interacting with a child with ASD. As stated earlier, children with ASD desire a routine so that they feel more independent. When they complete a task in their daily routine such as brushing their teeth, they are rewarded with a star sticker. We can also use the color preference to be a reward to a child as well. Color can be used while toilet training a child with ASD. Things such as changing the color of the water in the toilet to be a child's favorite color or adding a colored photo on the wall in the bathroom to encourage the child to use the toilet are two different ABI's that can be implemented as a reward.

Literature Review

To have an impact on someone's everyday life we must look at where they spend most of their time. Between the ages of 6 and 18 most people are in a school environment more than they are in a home environment. For this reason, the most effective interventions that can be made are in the school environment and in the home environment.

Color can have a profound impact on human behavior although children are often assumed to like and to function well in environments with highly saturated hues of red, green, and blue or gender biased shades of pink for girls and blue for boys. Many of our everyday environments can be overstimulating with the variety of colors that are in our lives. (Paron-Wildes, 2014) concluded that most children with ASD feel overwhelmed and overstimulated in places with vibrant colors and loud sounds.

This can even be a restaurant full of a child's favorite things that may be fine for other children. She also mentions that even brightly colored children's toys can be overwhelming for them. Paron-Wildes indicates from direct observation that most high and low functioning children with ASD are easily overstimulated, and this can be a result of too many colors in a space. By knowing this information, we can filter out colors in an environment to make a child with ASD more comfortable in a space.

Mostafa (2008) found that color can be very helpful to children with ASD when used to indicate different spatial zones. The visually distinctive landmarks such as different hues, helped the child feel comfort and to gain a sense of orientation while also allowing them to navigate the spaces independently using the different colored landmarks. (Mostafa, 2008) indicates that visual cues such as color contrasts in their [children with ASD] environments can signal to them an action to either continue or stop.

Colors can sometimes be difficult for a child with ASD to process. They may have different reactions to colors than a typically developing child may have to the same colors. Although colors many times just make a space more visually appealing, for a child with ASD color can create a sense of calm.. As stated previously, too many colors can be overwhelming for a child with ASD but color is necessary to create visual queues for a child with ASD. (Gaines, Bourne, Pearson, & Kleibrink, 2016) concludes that natural colors are calming to individuals with ASD. This literature indicates that many individuals with ASD have a hard time processing bright contrasting colors, so neutral, soft colors and subtle patterns are preferred. However, (Gaines, Bourne, Pearson, & Kleibrink, 2016) also suggests that individuals that are hypo-sensitive need contrasting colors to visually identify different things for example, a light-colored wall and a dark chair.

While growing up, children are asked about their favorite color and many times their responses are predictable based on the child's gender. (Franklin, Snowden, Burley, Notman, & Alder, 2008) found that children with autism were less accurate in their abilities regarding color memory and color search across red, green, and yellow color regions. Additionally, the researchers found that color discrimination was lower for these children. For parents and educators, these research findings suggest that identifying accurately colors that trigger behaviors or are "favorites" could be more difficult. This can make it

challenging for parents and educators to pinpoint a color related behavioral outburst. By starting with a neutral space and slowly adding in different hues in a variety of ways, a caretaker may be able to identify a bothersome color to the child.

Overall, to most people, color is just seen to make a space look more visually appealing. Having too much color in a space can be overwhelming but too little color can be visually unappealing. For a child with ASD, color is much more than aesthetics. Color can be a trigger to a behavioral outburst or make a child feel uncomfortable in a space but, color can also be a tool. A tool to calm a child during a behavioral outburst or allow a child with ASD to be more independent by using different color cues.

Methods

The nature of this project and the goal of creating a tool for parents and educators required a critical assessment of the literature from both educational sources as well as design research journals and parenting publications. Both scholarly literature and parental experiences are important to understand the needs of children with ASD.

Phase one of the project began with the identification of ASD-related behaviors and operational definitions. Peer-reviewed literature guided the following steps: Operational definitions were created for both color theory and for ASD-specific behaviors. Common terms used by academic researchers and parent researchers were identified and the layperson-oriented definitions were crafted. These definitions provide a foundation for the resource document described in Phase three.

Phase two of the project includes the development of a color-based intervention list. Specific research findings connecting behavior change to color were listed and organized by ASD behavior category. Design strategies were developed for each category of the research findings.

Phase three of the project was the assembly of the ASD Environmental Intervention Resource. A Resource document, *Color Works*, has been created for parents and educators of children with ASD, an introduction section that discusses the purpose of the resource and its intended use. A paper resource

that introduces the idea of color in space and some possible environmental interventions that parents can implement in their child's space as well as educators in their classrooms.

helpful definitions

Hue:
Hue is another word for color.

Value:
Value is the amount of light (white) or dark (black) in a color.

Saturation:
Saturation is the vividness of a color.

Warm colors:
Warm colors are associated with the sun and fire. These colors evoke warm feelings in people. Warm colors include red, yellow, and orange. Warm colors are typically advancing colors.


Cool colors:
Cool colors evoke a calming or soothing feeling. Cool colors include green, blue, and violet. Cool colors are typically receding colors.

Recede:
Recede is to move away. When a color is receding it helps the space feel larger.

Advance:
Advance is to move towards. When a color is advancing the space typically feels smaller.

Antecedent Intervention:
Antecedent interventions are strategies that involve modifying the environment to reduce undesirable behaviors.

Zoning:
Zoning involves creating separate areas within a space.



ways to introduce color

Below are some ways that color can be introduced into a space.

- Plants	- Accent wall
- Toys	- Rugs
- Books	- Furniture
- Personal artwork	- Light fixtures
- Colored paper or fabric	- Curtains
- Borders	- Shelving accessories
- Colored tape	- Pillows
- Storage bins	- Blankets

additional resources

American Academy of Pediatrics
<https://www.aap.org/en/community/aap-sections/developmental-and-behavioral-pediatrics/>

Autism Learn
<https://www.autismlearn101.com/>

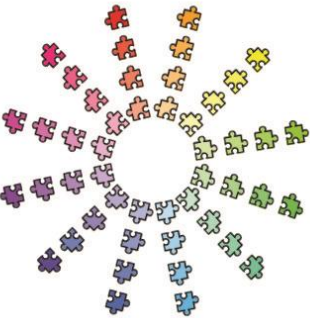
Autism NOW
<https://autismnow.org/>

Bloom and Grow
<http://www.bloomandgrow.com/>

My Autism Team
<https://www.myautissteam.com/>

color works

A guide for parents and educators



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introduction

Color in a space is all about balance. Too much color can overstimulate an individual while too little color can create a sense of confusion. For some children with Autism Spectrum Disorder, many of their senses are hyper sensitive making it challenging for them to function in our overstimulated world that we live in.

This guide is a resource for parents and educators to understand some basic terminology of color, provide different ways that color can be introduced in a classroom or home setting, and suggest different color-based environmental interventions to implement.

Figure 1 Front side of environmental intervention resource

categories of interventions

This resource offers three different antecedent intervention types to implement into a space to reduce or eliminate an undesirable behavior. The three main categories suggested below are using color to create zones, using color to capture the attention of a child, and using color to reward a child.

zoning

Color can be used in a space to create separate zones where different activities are taking place. The activity can be taught and then associated with a color so the child knows what activity takes place where. This promotes independence and simple direction following.



Zones can be created by adding colored rugs to a space



Zones can be created by painting a surface to help divide up a single space



Avoid using only one color in a room. This can create confusion and lack of visual depth

attention

Color can be used to capture the attention of a child with ASD. This can create visual cues when different behaviors need to stop or continue. Using colors in this way can catch the attention of a child before getting into a potentially dangerous situation.



Adding a color to a door can capture the attention of a child before the door is opened



Colored lights can be used to capture the attention of a child with ASD. The different colors can be associated with different actions



Avoid using too many contrasting colors in a space as they can be distracting to a child with ASD

reward

Color can be used as a reward to incentivise a specific behavior. Implementing your child's favorite color in a space in order to encourage a behavior is one way to use color as a reward for the child.



Special colored furniture in a space can be used as a reward



Provide a special place or area that is filled with the child's favorite color for them to engage with



Using too many colored rewards in a child's environment may increase distraction and make it harder for the child to focus

environmental modifications

Below are a variety of environmental modifications that parents or educators can implement in a space.

avoid

Here are some examples of modifications that should be avoided in a space.

Figure 2 Back side of environmental intervention resource

The primary goals were to create a document that was:

- Easily produced and distributed

A two-sided document that could be printed on legal size, mailed in a business envelope, and taped to a refrigerator door or viewed online.

- Written for parents and educators, not researchers or design experts

The resource is written using common language with a section dedicated to helpful definitions to further understand basic concepts of color theory as well as examples of different types of color schemes.

- Range of intervention difficulty

The interventions range from simple solutions such as adding a rug into a space to painting a portion of a wall. The resource provides solutions that can fit a variety of budgets. The provided

interventions range from temporary solutions for a family in a temporary home or a teacher in a temporary classroom as well as more permanent solutions.

Discussion

By creating this resource, it has become evident that most spaces people encounter every day are comfortable to the typically developing child but potentially overstimulating to a child that is hypersensitive to the environments around them. And, despite all the research and people invested in helping children with ASD live full lives, the unique expression of ASD behaviors makes problem solving difficult. It is important to start small when implementing changes into a child's environment to pinpoint what exactly it is that is triggering them.

There are a variety of ways that environments can be altered to fit a child's needs. It is important to bring attention to fact that different people react differently in spaces. There are a wide variety of design elements to implement in a space to make it more welcoming and inclusive to all people.

There are limitations to this investigation and in the tool, Color Works. First, not all of the recommendations were fully tested for effectiveness with children on the autism spectrum. These strategies were gathered from existing literature on color theory and color behavior. The numerous anecdotes provided by parents and educators highlight the trial-and-error necessity. This can be done by slowly adapting the environment by adding colors or removing colors. It is important to observe which colors the child is reacting to in a positive versus a negative way.

Future opportunities include the development of a website supporting the parents and educators of children with ASD. A place to update information, share discoveries, and offer support would bring much needed emotional support to these families. Additional research is needed to test the behavioral outcomes and extend the research into other aspects of the built environment including lighting, views, and thermal comfort.

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