UNIVERSITY OF CINCINNATI

Date: October 30, 2007

I, Lisa Marie Timman**,**

hereby submit this work as part of the requirements for the degree of:

Master of Design

in:

The School of Design in the College of Design, Architecture, Art, and Planning

It is entitled:

Asking to Play: Using a Visual Support to Model the Social Skill of Asking to Play for Children with Down Syndrome.

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asking to play

Using a Visual Support to Model the Social Skill of Asking to Play for Children with Down Syndrome

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A thesis submitted to the Division of Research and Advanced Studies of the University of Cincinnati in partial fulfillment of the requirements for the degree of

2007

Master of Design

In the School of Design
of the College of Design, Architecture, Art, and Planning

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abstract

This project considers a body of research about play, inclusion, and the characteristics of children with Down syndrome balanced with first-hand feedback from parents. These findings were used to explore a multi-sensory (visual and tactile) solution for modeling the steps of asking to play for children with Down syndrome who have limited verbal skills.

The proposed solution is an educational toy that explores three-dimensional form, color, shape, pattern, and texture to enhance communication and reinforce secondary learning concepts like color and shape recognition, object manipulation, and sequencing. A follow-up practice component is essential to the concept, allowing the child to build confidence through rehearsal.

The visual support was tested at an annual *Buddy Walk,* where both typically developing children and children with Down syndrome were observed. Key findings from this event, project limitations, and implications for further research are outlined in the evaluation section of this thesis.

acknowledgements

"The mind is not a vessel to be filled
BUT A FIRE TO BE KINDLED."

— Plutarch, Greek biographer
philosopher and priest of Apollo (45-125 A.D.)

My graduate research and study is a launch for new beginnings, opportunities, and the pursuit of lifelong learning. Many people have contributed to my success in getting to this point. I would like to express my gratitude...

...to ***my parents***, my greatest teachers, for always believing in me, supporting me— for making it easier to be a student and a mom.

...to my children *Ruthie and George*— for teaching me what is important in life and reminding me of the importance of play— for reminding me *how* to play.

I extend a very special thank you to my husband *Chris*—

For his sacrifices.
For his encouragement.
For listening.
For showing me tremendous patience, love, and support.

To my committee members—
Robert Probst, for his guidance in design and life perspective;

Dennis Puhalla, PhD, for keeping me on track and focused.

B*onnie Patterson, MD* (Cincinnati Children's Hospital Medical Center) for being generous with her time, her expertise with children with Down syndrome, and for giving me this opportunity to work with the medical community.

I would also like to thank the *School of Design faculty, J. Chewning* and *Craig Vogel*, and *the graduate student body*.

Scott Lincoln and the staff at the *Rapid Prototyping Center* of DAAP worked many hours toward the realization of my prototypes. For that I am extremely grateful.

Dr. Melinda Chalfonte-Evans, PhD (Cincinnati Children's Hospital Medical Center) was a tremendous resource in the area of speech pathology and children with Down syndrome.

...to *Gary Rogers* of Exhibitgroup/Giltspur for advising on material and the generous donation.

...to the *Miami Valley Down Syndrome Association* (MVDSA) for the opportunity to present my work at the annual Buddy Walk.

...and to the *MVDSA members, parents, and children* who participated in my research and provided me with feedback.

To my entire *family* and *friends*.

To my mother-in-law, *Mary Fischer*, for sharing her first-hand experiences, for listening to my ideas, and for her valuable advice.

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EVALUATION

Research suggests that children with disabilities are less likely to ask to join in play, often times relegating them to passive observers or solitary players. Many times, this reticence can be attributed to lack of modeling and lack of self-confidence. Children with Down syndrome who are non-verbal, or who have limited verbal skills require sufficient modeling to demonstrate alternative methods for communicating the desire to play, and to gain understanding and confidence in performing in social situations. Adequate modeling followed by practical application can reinforce this social skill and facilitate social inclusion during play.

It is generally agreed that children with Down syndrome are highly visual learners. Auditory instruction has proven to be less effective and in such cases the child is less likely to retain the information. As such, modeling and demonstration methods are likely to be more effective if there is a visual component. In addition, multi-sensory appeal (incorporating a tactile quality, for example) will help sustain subject matter driven by visual content.

This thesis begins to address the following question:

What type of **visual support** will facilitate **social inclusion** by **MODELING** techniques for **asking to play** for children with **DOWN SYNDROME,** ages 6-10, who have **limited verbal skills**?

In order to better understand the significance of the task, it is necessary to define the term inclusion as it is used in this context, and establish the importance of play with specific implications for children with disabilities. It is also important to gain understanding of the disability Down syndrome in order to later identify design considerations relative to typical characteristics and needs of children with this disability.

In order to fully understand the importance and meaning of inclusion during play, it is first necessary to define the term inclusion and provide the historical context within special education with which the term is being used. While the use of the term in special education discourse is relatively new, the debate for inclusion in the United States dates back to the 1800s. Central to the issue was deciding whether children with disabilities should be educated alongside typically developing children, and how this would be done. The supporting arguments for the opposition of inclusion, as well as its proponents, remain a source a controversy over two centuries later. Legislative acts like the Education for All Handicapped Act (renamed to Individuals with Disabilities Education Act [IDEA] in 1990) have brought tremendous visibility to the issues of inclusion and the status of special education in public schools.

There is undoubtedly a great deal of work still to be done in ensuring an authentic inclusive environment; however, the considerable progress, especially following the 1960s, should not be overlooked. Legislation, training, and collaboration have all contributed to making the curriculum in schools accessible to children with disabilities. As inclusion continues to evolve in the classroom, facilitating inclusion beyond the classroom walls must become equally important and visible for professionals, teachers, parents, designers, and communities. This section will provide the historical context surrounding the evolvement of inclusion, establish its importance substantiated by legislative acts, and argue that inclusion in a social setting is of vital importance.

The term inclusion and the stipulations of IDEA (amended in 1997) mandate that all children are entitled to a ‘free and appropriate education’ in the ‘least restrictive environment.’ The least restrictive environment stipulates that children be least removed from the regular classroom setting with access to the same environment and resources (Mastropieri and Scruggs, 2004, p. 7). This is in contrast to the self-contained classrooms that dominated special education practice and ideology for decades. Self-contained classrooms favor 'segregation over integration'— the prevalent terminology applied up until the 1960s. Prior to the deliberation of segregation, it was first questioned if people with disabilities could be educated at all. As early as the 1500s, Europe led the way toward special education with efforts to educate the deaf and blind. Despite these initiatives, people with disabilities were stigmatized and isolated from society. These early efforts eventually helped to promote compassion for individuals with disabilities and served as a catalyst for more substantial special education programs and legislation. The successes of these early programs supported the notion that people with disabilities could be educated (Osgood, 2005, p. 22).

During the 19th Century, at the same time the nation was seeing a sizable growth in the number of institutions for people with disabilities, public schools in the U.S. were emerging in large urban areas. By 1900, public schooling was prevalent. Tremendous diversity, including children with a wide range of disabilities, was exhibited among children enlisting in public schools (Osgood, 2005, p. 22). As a result, schools had to identify measures to handle such diversity. It was argued that segregating individuals who were disabled would benefit both the students' and the schools' effectiveness. The act of segregation led to the need for a system of labeling students. The process prior to mental testing was considered oversimplified, inconsistent, and prejudiced. Once mental testing was introduced, the process was claimed to be too rigid. Supporters of segregation argued that too much time would be devoted to children with special needs in a regular classroom setting and competition would be unfair. They believed that typically developing students would have an unfair advantage. In addition, it was widely supported that the curriculum would be too difficult and the children would face inevitable and relentless teasing.

In contrast, others argued that the policy of segregation was more out of convenience for teachers and schools. The already strenuous job of teaching would be exacerbated with integration (Osgood, 2005, p. 28). It was in Boston, in 1847, that graded schooling emerged, and would later become the trend throughout the U.S. Whereas children in the graded approach were said to advance at a predictable pace with peers of similar ages, the segregated setting for students with disabilities remained "un-graded," where a mix of ranges in abilities and ages were grouped together. The ineffective identification process made it easy for schools to exclude individuals. Despite its support, the practice of segregation was still called into question (Osgood, 2005, p. 26).

During the 1940s, state involvement with planning and funding in special education increased. Legislative acts set a precedent that was expanded and advanced by the Kennedy administration. The Civil Rights movement during the 1960s framed the discussion of inclusion within an ethical and moral context. Issues of social inequality in schools became a chief concern. A significant federal court decision of 1954, Brown vs. Board of Education (Kansas) established that "separate but equal" education was illegal, and that it was "unlawful to discriminate against any group of people" (Mastropieri, 2004, p. 10).

While the Civil Rights movement largely focused on the interests of African Americans, this ruling had significant implications for individuals with disabilities. The increased government role in special education meant increased funding and public awareness. As a result, the current practices of segregation were scrutinized more than ever. An article written by Lloyd Dunn, in 1968, challenged conventional practices (Osgood, 2005, p. 66). In addition, Section 504: The Rehabilitation Act of 1973, specified, "recipients of federal funds cannot discriminate on the basis of disability" (Mastropieri, 2004, p. 11). This act covered both education as well as the workforce. By 1975, the Education for All Handicapped Children Act was the inception of a major shift from segregation to mainstreaming.

The primary difference between mainstreaming and inclusion is that mainstreaming implies the primary and appropriate setting for a child with a disability is in the special education classroom. A child that has "earned" mainstreaming may be pulled out to participate in the general education classroom on a part-time basis. In contrast, inclusion entails that the child's primary setting for education should be in the general education classroom and should be least-removed from that environment. The child, when justifications exist, may be pulled from the general education classroom to receive supplemental or support services (Mastropieri, 2004, p. 7).

Special Education has evolved tremendously over the last century and considerable progress has been made. Legislation has brought forth policies to enable inclusion in the classroom and provide funding for special education services. Despite the challenges of inclusion, there is evidence of its benefits for students with disabilities, as well as typically developing students. Inclusion has been found to reduce the stigma associated with disabilities and promote awareness and compassion. Also, typically developing children often develop leadership roles, as they may serve as a peer mentor in the classroom.

Inclusion is currently the ubiquitous term used in special education policy. It is commonly used to describe access to the general education curriculum for students with disabilities, while being educated alongside typically developing peers. Increased interaction between children with disabilities and those typically developing makes the need for developing and honing social skills especially important.

It is critical that inclusion be looked at from a broader point of view and extended beyond classroom walls and access to the curriculum. Social inclusion is deserving of equal attention, specifically social inclusion during play, as there are important developmental implications, especially for individuals with disabilities. A unique set of challenges, in addition to those previously stated, are brought forth with inclusion during play, while similarly requiring the collaboration of teachers, professional, parents, students, and communities. The following section describes the importance of play and the implications of social inclusion during play for children with disabilities.

Earlier opponents of integration were concerned with inclusion for fear that children with disabilities would be made fun of. Conversely, it seems that inclusion facilitates peer acceptance and helps to lessen the stigma. It could be argued that more opportunities for typically developing children to socialize and work alongside children with disabilities would lead to increased awareness and compassion. Play has been referred to by Friedrick Froebel, as "the work of the child," thus making inclusion during play especially critical.

Play is believed to develop foundational skills that are significant a child's cognitive, social, and linguistic development. Various types of play encourage problem solving, critical thinking, negotiation, collaboration, and prepare children for later roles as adults. Children with disabilities may have limited access to play and social inclusion and therefore may be deprived of fundamental growth. A lack of authentic play experiences can have detrimental effects on a child's development and social competence, resulting in a child feeling learned helplessness.

The recent legislation, described in the previous section, validates the importance of inclusion for children with disabilities. However, social inclusion during play still proves to be a challenge in numerous environments that include and transcend the classroom. This section outlines the importance of play, the current issues with social inclusion, and the implications for children with disabilities.

The importance of play to the social, motor, and cognitive development of children is widely accepted among many theorists and early childhood educators. Many credit Froebel (1782-1852), with pioneering this concept. Froebel's ideas served as a catalyst for a kindergarten movement that emphasized play in the curriculum (Kuschner, 2001, p. 276). Froebel devised activities known as the *Gifts and Occupations*. These activities seemed to be rooted in a mathematical and architectural framework, where the manipulation and construction by the child moved from points to solids— part-whole relationships (Kuschner, 2001, p. 279). It was this manipulation of materials that accentuated the play of children. Kuschner cited Froebel (1887), stating, "Play is the highest phase of child development...The play of childhood are the germinal leaves of all later development" (Kuschner, 2001, p. 276).

Since the Froebel era, many theorists have supported the significance of play to child development. Jean Piaget and L.S. Vygotsky are among these theorists who have helped establish the value of play. Central to Vygotsky's theory is the belief that learning is social— where children evolve through interaction with peers, parents, and teachers (Judge and Parette, 1998, p. 50-51). Vygotsky's research on sociodramatic play suggests that this type of social play leads to increased vocabulary, self-regulation, and a transition of private speech to internal thought (Elias and Berk, 2001, p. 217-218).

It is also during pretense that children are able to symbolize actions, objects, and thought. This symbolization process among peers during play requires negotiation, collaboration, and problem solving. According to Bergen (2002), "It is more likely that pretend play engages many areas of the brain because it involves emotion, cognition, language, and sensorimotor actions, and thus it may promote the development of dense synaptic connection" (pg. 2). Further, studies have shown that pretend play increases mathematic and linguistic development, as well as the capacity to form mental representations (Bergen, 2002, p.2).

According to Piaget's assertions, children are active learners, manipulating and exploring their environment, reflecting on this knowledge, and making assumptions about what they have learned. Characteristic of his theory is the emphasis on object play and its implications for cognitive development (Judge and Parette, 1998, p. 50-51). Piaget proposed a series of stages that seem to suggest a progression from one type of play to the next. The stages include functional, symbolic constructive, symbolic dramatic, and games with rules. Other theorists, including Vygotsky, Parten, and Smilansky also identify games with rules as a developmental play stage. Parten refers to this stage as cooperative group play (Kuschner, 2006). Social play often involves both implicit and explicit rules. Vygotsky contended that complying with these rules (including during pretend play) contradicts children’s natural inclinations, furthering their ability to self regulate (Elias and Berk, 2001, p. 218).

Children with disabilities may encounter limited opportunities to engage in play and interact socially among peers. Because research shows that play can facilitate linguistic development, communication and social skills, and cognitive functioning, children with disabilities may miss out on a crucial window of opportunity for development. As play is often defined as being self-motivated, children with disabilities may experience play differently from typical peers.

For children with disabilities, play activities tend to be heavily teacher-directed or initiated, solitary, and occur less frequently. The type of play may not allow for freedom of creativity and may require the child to be a passive participant (Judge and Parette, 1998, p. 52-53). Also, too much emphasis may be given to sensorimotor actions. Children may also feel frustration from unrealistic expectations or developmentally inappropriate games, toys, or activities (Lane et al., 2000, p. 12). The child may lack control over the type of play, the rules, or the decision to end play (Judge and Parette, 1998, p. 52-53). Such dependence, in contrast to their typical peers, and a lack of active engagement may cause learned helplessness (Lane and Mistrett, 1996; Judge and Parette, 1998, p. 52-53). It has been argued that “such learned helplessness may lead to indifference and apathy in children as young as two years of age” (Lane et al., 2000, p. 13).

In addition, an emphasis on instruction and therapy may replace opportunities for play. Rarely is play incorporated into therapy sessions designed to augment deficiencies or place emphasis on skill development. Even in cases where toys are incorporated into the therapy, there is often a focus of developing a skill, emphasizing the child’s deficiency, as opposed to their abilities (Lane et al., 2000, p. 16). An array of research presents evidence supporting the importance of play to cognitive, social, and linguistic development. Thus, it should be a priority to ensure that play is accessible to children of all abilities.

Legislative acts, such as IDEA, substantiated the importance of social inclusion. Despite these acts, social inclusion during play remains a challenge for children with disabilities. Physical disabilities may hinder children from actively engaging in play (Lane and Mistrett, 1996). Such limitations may result in passive participation, watching peers from a distance, and a smaller amount of social play relative to solitary play. In addition, as Sapon-Shevin et al. (1998), points out, “Mere physical inclusion does not guarantee social inclusion, and many students with disabilities...continue to be islands” (p. 42). The Circle of Friends, Making Action Plans, and similar programs have been geared towards fostering relationships and facilitating social acceptance. Despite the good intentions of these programs, children with disabilities are often on the receiving end of such support, but seldom is the connection mutually beneficial. In other words, children with disabilities are often being helped, but are rarely given the opportunity to be the helper. Consequently, children with disabilities may be reduced to passive participants (Sapon-Shevin et al. 1998).

The implementation of a rule that stated “You can’t say you can’t play.” (inspired by the work of Vivian Gussian Paley) was tested in a study conducted by Sapon-Shevin et al. (1998). What they concluded was that often times children with disabilities did not ask to play. If a child did not ask to play, there was no need to turn him or her down. As such, to this regard, the rule itself was futile (Sapon-Shevin et al. 1998). This demonstrates that children with disabilities may require more modeling and demonstration to learn how to initiate play (Lane and Mistrett, 1996; Sapon-Shevin et al. 1998).

Inclusion at home can be equally challenging. While parents of typical children often facilitate and participate in play with their child, parents of children with disabilities may manage the play, rather than facilitate. Parents may need to be educated on strategies for how to facilitate play with a child with a disability. Additionally, with innumerous therapy sessions, the scarcity of time is often viewed as a constraint by most parents. It may also be possible that parental roles shift, where parents are less likely to be play companions, and instead become coordinators of their children’s medical needs (Lane and Mistrett, 1996; Lane et al., 2000, p. 13).

The role of typically developing siblings may also be unique, partnering with parents to help care for the child, or conversely, behaving standoffish or even resentful. Siblings may serve as models that are different from adults and peers, offering distinctive insights and perspective (Burke and Montgomery, 2000, p. 232; Jones and Schwartz, 2004, p.188). Knott et al. (1995) contend “Children develop a style of social exchange with their siblings, which they subsequently use with their peers” (p. 965). This is an important consideration since it is estimated that approximately eighty percent of children with disabilities have typically developing siblings (Burke and Montgomery, 2000, p. 227). This evidence suggests the type of modeling exhibited by siblings may increase social competence, communication skills, and social awareness among children with disabilities.

The desire to engage in play seems almost inherent to young children. Children unable to access play as the result of a disability, handicap, or impairment may feel frustration, low self-esteem, and learned helplessness. Play deprivation can lead to further deficits in important developmental areas.

The demands placed on parents of children with disabilities may make it difficult for parents to engage in play as a partaker or to facilitate play at home among siblings. The role of the sibling should not be overlooked in the development of children with disabilities. Siblings are in a unique position to demonstrate social interaction, gain knowledge, and offer a new perspective and approach. Social inclusion in the home setting can lead to the development of important social skills that prepare children with disabilities for other settings in the school and community.

With research supporting the importance of play, designing strategies for inclusion during play for children with disabilities should be a main concern. Such strategies should enable children to engage in authentic play experiences. Children with typical abilities are independent in their play activities, and thus can actively participate in play. In contrast, children with disabilities are often relegated to passivity. For children with disabilities to experience real play, they should be able to initiate, exert control, choose play partners, and cease playing at will.

Challenges to social inclusion can apply to a broad range of disabilities. This thesis project specifically addresses the typical characteristics and needs of children with Down syndrome. An overview of Down syndrome and identification of specific characteristics of this disability are given in the next section.

Down syndrome (DS) is a genetic birth defect that is not unique to any one nationality, race, ethnicity, or socioeconomic class. Contrary to misconceptions of being a rare occurrence, approximately 0.125% of children are born each year with DS, making it one of the most common types of birth defects. Each year in the United States, 5500 children are born with DS, and 250,000 U.S. families have at least one child with DS (Tocci, 2000, p. 11).

DS results from an extra copy of the chromosome 21 during cell division. During the fertilization process in normal cell division, 23 chromosomes from the sperm join with 23 chromosomes from the egg. Thus, normal cells in the body contain 46 chromosomes, or 23 pairs. When the chromosome 21 does not separate properly, one cell will have an extra copy of this chromosome. The cell with the extra copy, combined with another cell with this chromosome, will result in 3 copies. This is referred to as Trisomy 21, another term for DS (Tocci, 2000, p. 24-31).

Figure 1. Young male child with Down syndrome.

Individuals with DS usually have a distinct appearance. Dr. John Langdon Down was the first to characterize the physical features, giving DS its name. Typical characteristics include a broad, flat face and upward slanted eyes. Children with DS often have a smaller head, ears, nose, and mouth. Hands and fingers are usually smaller in size as well (Tocci, 2000, p. 11-13).

While generally benign, some physical characteristics may impact development in other areas. For example, low muscle tone, very typical of DS, may hinder development in language and motor function. Typically developing individuals are able to relax and contract their muscles, referred to as "partial contraction" (Tocci, 2000, p. 13). In partial contraction, muscles are never fully relaxed. With individuals with DS, muscles are more relaxed than usual and therefore can be difficult to control. Because of this, children with DS may experience a delay in mastering such tasks as sitting, standing, or walking.

Because all areas of the body are affected by low muscle tone, including the tongue, the development of language may also be affected. It may be difficult for the individual to form sounds. Also, the smaller size of the mouth may cause the tongue to feel and appear larger than normal. The size of the tongue and mouth coupled with low muscle tone can lead to a delay in language (Tocci, 2000, p. 13-14).

Delays in speech can also be the result of hearing loss, developed by approximately fifty percent of infants with DS. This results in the child being unable to hear, and conversely, to form some sounds (Tocci, 2000, p. 42). In addition to hearing loss, seventy percent of children with DS have some type of vision problem, ranging from nearsightedness, cataracts, and astigmatisms (Tocci, 2000, p. 44-46).

Developmental delay varies from mild to severe, with the majority falling between mild to moderate (Tocci, 2000, p. 15). Learning is generally at a slower pace and children with DS "may have a shorter attention span and less motivation" than other children (Tocci, 2000, p. 48). Learning new skills requires that they be "practiced in shorter, more frequent lesson periods" (Tocci, 2000, p. 48). Visual memory is better and they are typically highly visual learners, with auditory processing being their weakest. Even more effective learning can result from something that is multi-sensory. Having a tactile component can increase the likelihood of processing and retaining the information (Patterson, 2006). According to Tocci, "Physically touching an object can also help a child with Down syndrome learn concepts" (2000, p. 48).

In the school environment, children with DS are likely surrounded by typically developing children (Tocci, 2000, p. 52). Social inclusion becomes a more prominent concern once a child with DS becomes of school age. Around the ages of seven and eight, children with DS begin to figure out that they are "different" and the social gap begins to widen (Patterson, 2006). Acquiring social skills becomes increasingly important as a result.

The following list highlights the key findings from secondary research conducted:

- Classroom inclusion is beneficial to both typically developing students and students with disabilities.
- Inclusion helps to reduce the stigma associated with children with disabilities.
- The importance of play is widely accepted and believed to develop foundational skills that are significant to a child's cognitive, social, and linguistic development.
- Play encourages problem solving, critical thinking, negotiation, and collaboration and prepares children for later roles as adults.
- Children with disabilities may have limited access to play and social inclusion and therefore may miss out on fundamental growth opportunities.
- Children with disabilities are often passive participants in play.

Children with disabilities often
DO NOT INITIATE OR ASK TO PLAY.

- A child should be able to initiate, exert control, and choose play partners.
- Children with disabilities may require sufficient modeling and demonstration to learn how to initiate play.

- Physical characteristics of DS include having a smaller head, ears, nose, mouth, hands, and fingers.

- Low muscle tone is common among individuals with DS and may range from mild to severe.

- Low muscle tone can affect motor skills and can contribute to delayed speech.

- Approximately 50% of infants with DS develop hearing problems.

- Approximately 70% of children with DS experience some type of vision problem.

- For children with DS, auditory processing is their weakest processing and memory.

- For children with DS, information that is multi-sensory or tactile may increase the likelihood that it will be retained.

CHILDREN WITH DS ARE PRIMARILY VISUAL LEARNERS.

To better understand the social challenges faced by children with DS, family members of the Down Syndrome Association of Greater Cincinnati (DSAGC) and the Miami Valley Down Syndrome Association (MVDSA) were contacted. A request for participation was sent out to each member of both organizations. This request explained the nature of the project and the possible avenues of research. At the time of initial contact, the specific focus of this thesis project was undetermined. The feedback from the family members was later used to define specific issues of concern, identify contributing factors, and ultimately to focus the research in an area of greatest interest and need.

Participation of family members involved correspondence through email exchange, completion of two questionnaires, and availability for discussions over the phone and possible in-person meetings. Interested members completed a preliminary questionnaire, covering broad topics of social inclusion and play. The preliminary questionnaire did not specify an age group, as it was intended to help identify patterns and trends associated with social inclusion visible at different levels of development. The responses would later help to establish an age range where research would be focused. A follow-up questionnaire was subsequently sent to participants, where parents were asked to assess their children in specific areas relating to social skills and behavior. Specific topics included: greetings/introductions, interrupting (for assistance or to join play), asking to play, turn taking, sharing, and compromising.

There was a considerable response from members expressing interest in the project. Members consistently stated concerns for their child in the area of social play and development, validating the efforts of this project. One member stated that the challenge for her daughter in making friends and engaging in play “involve issues which have deeply concerned me since [she] was a baby— and I still struggle with them daily.”

Another member wrote this response to my earlier email requesting participation:

> *I have a daughter [Carly], age 10, who has Down syndrome. My daughter has limited verbal skills and the speech she does have is hard to understand. We are interested in the 'making friends' part of your strategy. [Carly] is standoffish in groups. She always seems to want to stand apart and observe rather than enter in, even when the activity is something she enjoys. It also occurs when she has previously indicated that she wanted to "play" with the particular individuals involved. Part of the problem could be her inability to communicate effectively, but at this point I don't want to theorize in that you may want to draw your own conclusions? We feel that it is a major issue in her development and look forward to being involved with your study if that is possible.*

Consistently echoed by parents was the desire for their child to initiate play. Like [Carly's] mom, several participants hypothesized that communication barriers were preventing their children from initiating play. The children who have limited verbal skills had a history of not being understood. Because of this, it is reasonable to suggest that they lacked the confidence to approach a group and ask to play. Expressing concerns for her son [Aaron], a participant responded by saying, "My concern is that his speech delay will make it difficult to find friends." Another member said of her eight-year-old daughter [Katie], "Language is her big challenge so she will play more alone than with others. I really want this to change."

Parents were also interested in working with their children on introductions and greetings, and interrupting (especially to join play.) When asked about interrupting to join a playgroup, [Katie's] mom said, "She is a bit standoffish and doesn't really interrupt much. If she does, it's not because of communication. In other words, she doesn't say, 'Can I play?'"

It is important to note that names of members and their children have been omitted or changed to protect the privacy of participants.

The initial contact to group members generated enough interest and response to obtain valuable feedback and validated the area of research as a worthy one. Parents seemed to agree that social play was an important issue, and expressed concern that a lack of social play engagements were affecting their child's development. Among the participants, there was an overwhelming tendency for children to engage in solitary play or observe play from a distance. Several instances showed that a child would refrain from asking to join in play, even after indicating a desire to do so. Parents speculated that limited verbal skills influenced their child's reluctance to ask to play. Key concepts are identified below.

- Parents were concerned that a lack of play experiences was affecting their child's development.
- Parents observed their child engaging primarily in solitary play, or as passive observers.
- Parents observed that their child did not initiate or ask to play and expressed the desire for this to change.
- Parents speculated that limited verbal skills might be a reason that the child does not initiate play.

The results of the questionnaires, while providing many answers, sparked new questions:

How might these parents get their children to initiate play?

How can a child ask to play if they have limited verbal skills and a pattern of not being understood?

Primary and secondary research were conducted simultaneously. Combining the two types of research ensured authenticity of the project— voicing the experiences of those directly affected, while being backed by scholarly research. Findings resulting from both primary and secondary research were then discussed with Dr. Bonnie Patterson, MD, of the Cincinnati Children's Hospital Medical Center (CCHMC). Further advisement in the area of speech pathology came from Dr. Melinda Chalfonte-Evans, Ph.D., a speech/language pathologist at CCHMC. Both have over 20 years experience in the area of DS.

There is adequate evidence supporting that inclusion for children with disabilities among typically developing peers is beneficial to all students, helps to reduce the stigma associated with having a disability, increases awareness, and encourages compassion and empathy. Classroom inclusion is mandated by law, which further supports its validity. While there are guidelines for inclusion in the classroom, inclusion during social play (in the lunchroom or on the playground, for example) may require more collaboration from teacher, parents, students, and professionals.

Research supported the importance of play as a foundation for important development among children. Play is argued to enhance cognitive, social, linguistic, and mathematic development. Through play, children learn to negotiate, compromise, take turns, and self regulate. Research also acknowledged the importance of authentic play, in which the child is able to exert some control. Children should be able to initiate play and choose play partners. Studies show that children with disabilities frequently do not initiate or ask to play. Conversely, they may wait to be asked, passively observe from a distance, or engage in solitary play. These findings echoed observations from parents' responses to the questionnaires. Parents consistently reported that their child would choose to observe play, rather than initiate or ask to join. This passivity would occur even after indicating a desire to play, or with an activity that the child enjoys. A common concern among parents was that language delays were prohibiting their child from initiating play. This raised the question, "How does one *ask* to play if they are non-verbal, or have limited verbal skills?"

This thesis project considered the characteristics and needs of children with DS, one of the most common types of birth defects. There are some distinct characteristics of DS. These include small physical features, such as the head, nose, ears, mouth, hands, and fingers. Vision and hearing problems are commonly associated with DS. Low muscle tone is also common among individuals with DS and can range from mild to severe. This can affect motor function and speech. In severe cases, it can be difficult for the individual to lift objects.

Delays in speech can also be attributed to hearing problems. Children with DS are considered to be highly visual learners, while auditory processing remains their weakest area of memory. Children with DS may process more and retain information that is presented in multi-sensory manner, and may benefit from a tactile experience.

Based on feedback from parents, the range of greatest interest and need fell between the chronological ages of six to ten. Also, as previously stated by Dr. Patterson, the social gap begins to widen around these ages. These children falling within this age range with limited verbal skills or who are non-verbal are assumed to have a developmental age of two to four years old.

Based on key findings in both primary and secondary research, it was determined that:

- Limited verbal skills were likely hindering children with DS from initiating play.

- Sufficient modeling was necessary to show children how to ask to play and children with DS would benefit from demonstration. A practice component would allow the child to learn the steps that are modeled and build confidence.

- Dual-modality— combining gesture with verbal modalities could increase the chance of successful communication for a child with limited verbal skills.

It was also determined that the solution should:

- Have a strong visual to demonstrate asking to play.
- Have a tactile component to increase the effectiveness of communication.
- Not require heavy lifting.
- Should not require complicated manipulation.
- Feel comfortable with respect to the size of the child's hands.
- Contain a large graphic and sufficient text size for maximum legibility.
- Target children with DS with a chronological age range of six to ten, and a developmental age range of two to four years.

project overview

The task of this thesis is framed by the following research question:

What type of visual support will facilitate social inclusion by modeling techniques for asking to play for children with Down syndrome, ages 6-10, who have limited verbal skills?

The proposed solution employs a series of five still images that depict the steps of asking to play. These images, linked together, create a story for the child that models the skill to be acquired. Each image is contained within a puzzle piece. Images are loaded into the piece through an image slot, enabling the exchange or personalization of the images. The five-piece puzzle connects linearly, allowing the story to read from left to right when assembled. Color, shape, pattern, and tactile surface provide subtle cues to the correct sequencing of the puzzle.

The puzzle and image sequence is intended to provide a strong visual support modeling the desired behavior and should be followed up with an opportunity for practice. Practice may occur with a facilitator, such as a teacher, parent, sibling or peer. Gradually, the facilitator becomes further and further removed, resulting in the child executing the steps in a real situation.

The following sections detail the project and design objectives, and provides an in depth look at the final design solution and process for the 3-D form, graphics, and content/script of this thesis project.

project objectives | *Intended Learning Outcomes*

The following outlines the intended learning outcomes of this thesis project for the child:

- The child will recognize subtle cues of shape, color, pattern, and texture to successfully assemble the puzzle.

- The child will begin to develop an awareness of sequence to the story.

- The child will able to read the story, with or without help, or be able to follow along with the images as the story is read to them.

- The child will begin to identify with the character in the story.

- The child will begin to recognize the sequence and chronology of the storyline and use this to successfully assemble the puzzle.

- The child will recognize the combination of verbal and gesture modalities in order to maximize effectiveness of communication.

- The child will be able to practice the steps in the sequence, through role-playing or other method determined by parent, teacher, or peer facilitator.

- The child will begin to understand how to ask to play.

- Through practice, the child will develop self-confidence to ask to play.

- The child will continue to perform the steps of asking to play with facilitator further removed.

- With sufficient practice and discussion, the child will be able to ask to play during free play in the classroom, outside on the playground, or in the child's neighborhood without the help of the facilitator.

Down syndrome

There are several parameters that influenced the design process. These include the specific needs and characteristics of children with DS and the principles of Universal Design.

The following chart shows the characteristics of children with DS and the corresponding design objectives.

	Characteristics of Children with Down Syndrome	*Design Objective*
COGNITIVE	Strong visual memory and processing	Visual should be priority of communication. Images should be impactful and engaging. Communication should be clear. Text should be minimal.
COGNITIVE	Multi-Sensory learner	Tactile component with strong visual will increase effectiveness of communication and retaining of information.
COGNITIVE	Chronological Age (6-10 years) Developmental Age (2-4 years)	Design should target typically developing 2-4 years old. Design should reinforce color recognition (typically seen at age 3). Design should reinforce shape recognition (typically seen at age 3). Text should be minimal and should target pre-school level. The puzzle should be durable and able to withstand rough handling, spills, etc.

Figure 2. Chart identifying cognitive characteristics of children with Down syndrome and corresponding design objective.

	Characteristics of Children with Down Syndrome	*Design Objective*
PHYSICAL	Low muscle tone	Form should not require lifting. Pieces should be able to connect by sliding together. Interlocking mechanism of puzzle pieces should not require sophisticated motor function.
PHYSICAL	Low vision	Image size, color, and contrast should maximize legibility. Typeface should be appropriate for increased legibility. Text size and color should be conducive to maximum legibility.
PHYSICAL	Small hands and fingers	Overall puzzle pieces should fit comfortably in child's hand and be easy to manipulate. The puzzle should be durable, able to withstand rough handling, spills, etc.
BEHAVIORAL	Low attention span and lacking motivation	Puzzle should not contain more than 4-5 steps. Puzzle should be engaging, enjoyable, and aesthetically pleasing. Colors should be bright and appealing. Text should be minimal. Communication should be clear. Color, shape, pattern, texture, text, and image treatment should aid in communication— not be distracting.

Figure 3. Chart identifying physical and behavioral characteristics of children with Down syndrome and corresponding design objective.

Universal Design

The nature or design of the environment, product, or activity may intrinsically exclude individuals with different types of disabilities. During the 1990s, the discussion of accessibility was presented as a design problem. A multi-disciplinary team of architects, designers, and engineers worked together to establish universal design principles ensuring equal access to environments and products. The following chart provides the physical principles that guided the design process. This chart will be referenced in the final design section.

Universal Design Principle	*Explanation of Principle*
Equitable Use	Design allows users equal access, avoids segregating or stigmatizing anyone.
Flexibility in Use	Accommodates a wide range of individual preferences and abilities.
Simple and Intuitive	The design is easy to understand.
Perceptible Information	The design communicates information effectively through different modes—pictorial, tactile, and verbal, and regardless of sensory abilities.
Tolerance for Error	Design minimizes hazards and adverse consequences of accidental and unintentional actions.
Low Physical Effort	Design can be used efficiently and comfortably and with a minimum of fatigue.
Size and Space for Approach and Use	Size and space is appropriate for approach, reach, manipulation and use, regardless of user's body size, posture, or mobility.

Figure 4. Universal Design Principals*, Council for Exceptional Children, 2005.*

Justification

There were several factors considered in determining the puzzle as an appropriate medium for the social story. The form that the images would be contained in needed to be engaging, hold the attention of the user, and be enjoyable. It needed to be conducive to effective communication of the images; it should not be distracting. In the spirit of play, it was decided that puzzle pieces would contain the individual images, respectively, and link together to create the entire story.

The puzzle is a way to engage the child, appeal to his or her interests and provide a hands-on learning experience. Also, it is likely to be a recognizable format. The familiarity of operating a puzzle will ideally aid in the communication of the story. Conceptually a puzzle format makes sense because it quite literally links together the concepts. The child can become an active participant in piecing the information together. With the overwhelming evidence outlining the benefits of play, there are other advantages of using a puzzle to present the information. The puzzle will encourage the development of motor skills, problem solving, and cognitive functioning. Additionally, the puzzle introduces part-to-whole relationships.

Piecing the puzzle together also gives the child an immediate victory, helping to build confidence. The quick reward of success sets the tone for a positive learning experience by reinforcing a sense of achievement and ability. The final design and rationale is shown in this section. A more detailed explanation of the design process follows.

Size

The sizes of individual puzzle pieces are 5" in height. The widths of the puzzle pieces vary according to the shape connection pieces, but average to be 6.75" and maintain a consistent image area of 4" by 4". The sizes of the puzzle pieces are substantial enough to accommodate a large visual, while still allowing ease of use and comfortable handling. The 1" thicknesses with beveled edges create a toy-like feel that engages the child and makes it easier to grasp and manipulate. The size, thickness, and sturdiness suggests and reinforces a degree of importance to the child. The assembled puzzle spans 30". This allows the puzzle to be completed comfortably on a tabletop or on the floor.

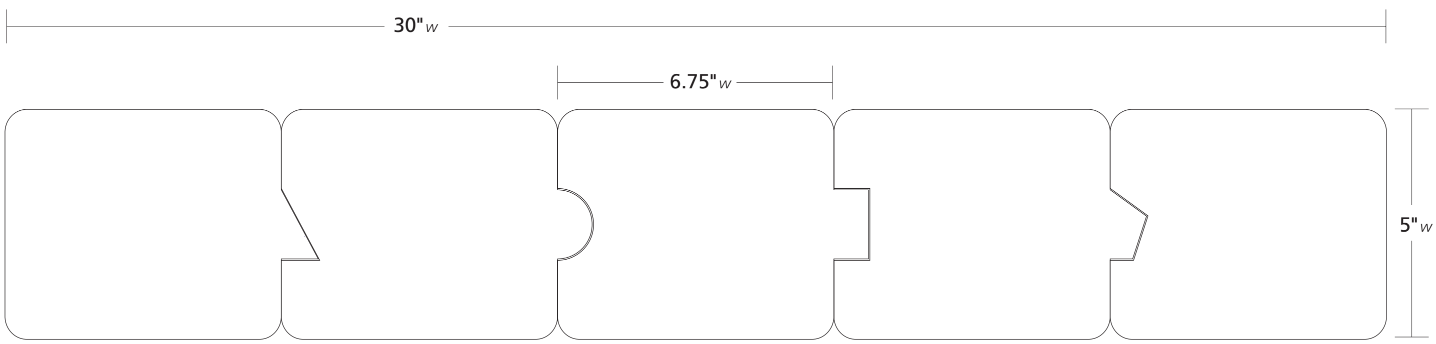


Figure 5. Puzzle dimensions.

Figure 6. Single puzzle piece showing 1-inch thickness.

Image window and slot

An image slot is located on the bottom edge of each puzzle piece, allowing images to be removed and exchanged. This feature allows users to customize the puzzle with images of their own child, or focus on new skill sets as others are mastered. A window is cut out of the front face of each puzzle piece to reveal the image. The image is recessed approximately 1/8th inch, and helps the user to distinguish it from the 3D form.

Figure 7. Image slot.

Figure 8. Image slot.

Shape

The overall shape of the puzzle pieces is a rectangle with rounded corners. This shape provided the greatest surface area for accommodating the size of the image and text, and ensured that no sharp corners would be a safety hazard. The image window mimics the shape of the individual puzzle piece.

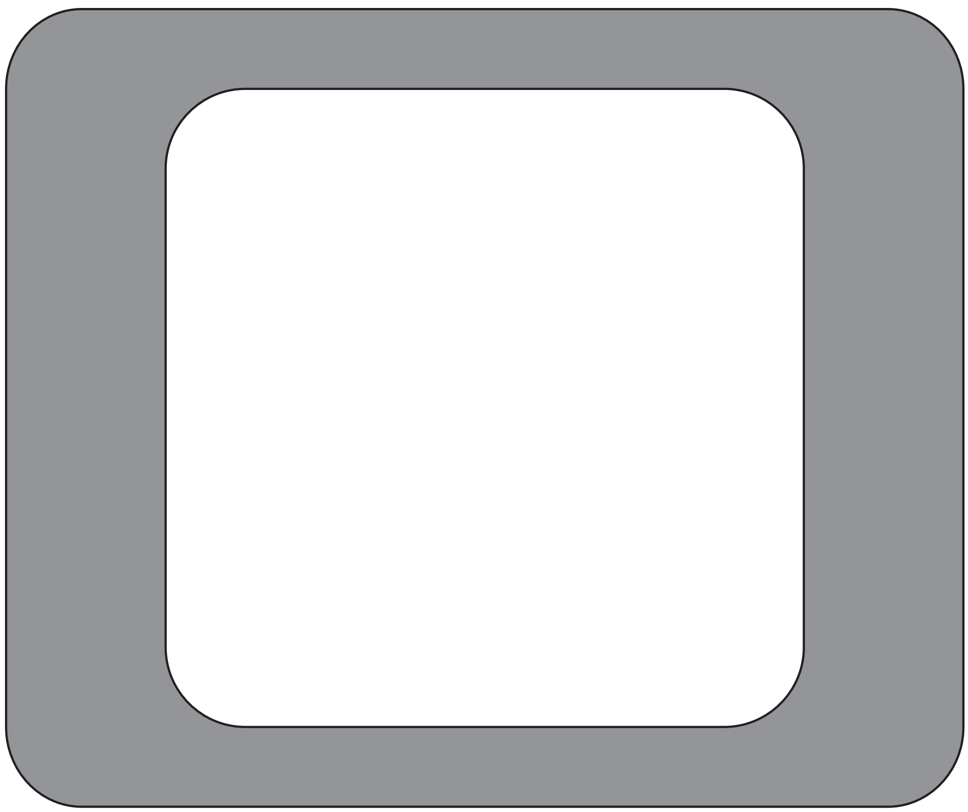


Figure 9. Overall shape of individual piece shown without shape connections.

Shape *continued*

The connecting mechanisms utilize familiar shapes (circle, square, triangle, and pentagon) to reinforce shape recognition. The positive shape matches up to the corresponding negative shape and slides into place.

Figure 10. Final shapes.

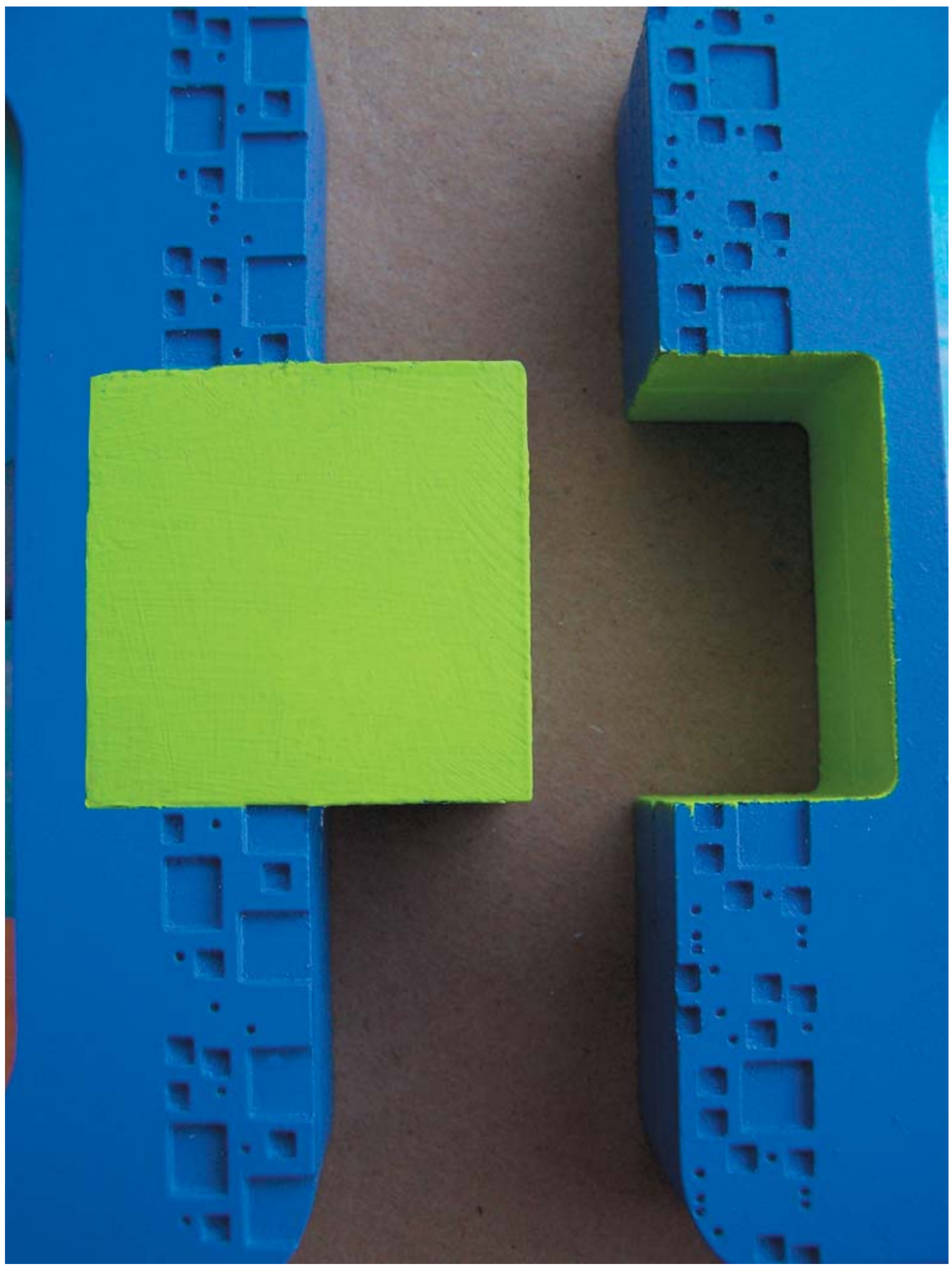


Figure 11. Shape connection, square.

Shape *continued*

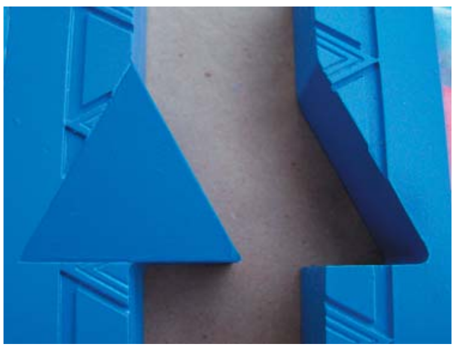


Figure 12. Shape connection, triangle.

Figure 13. Shape connection, pentagon.

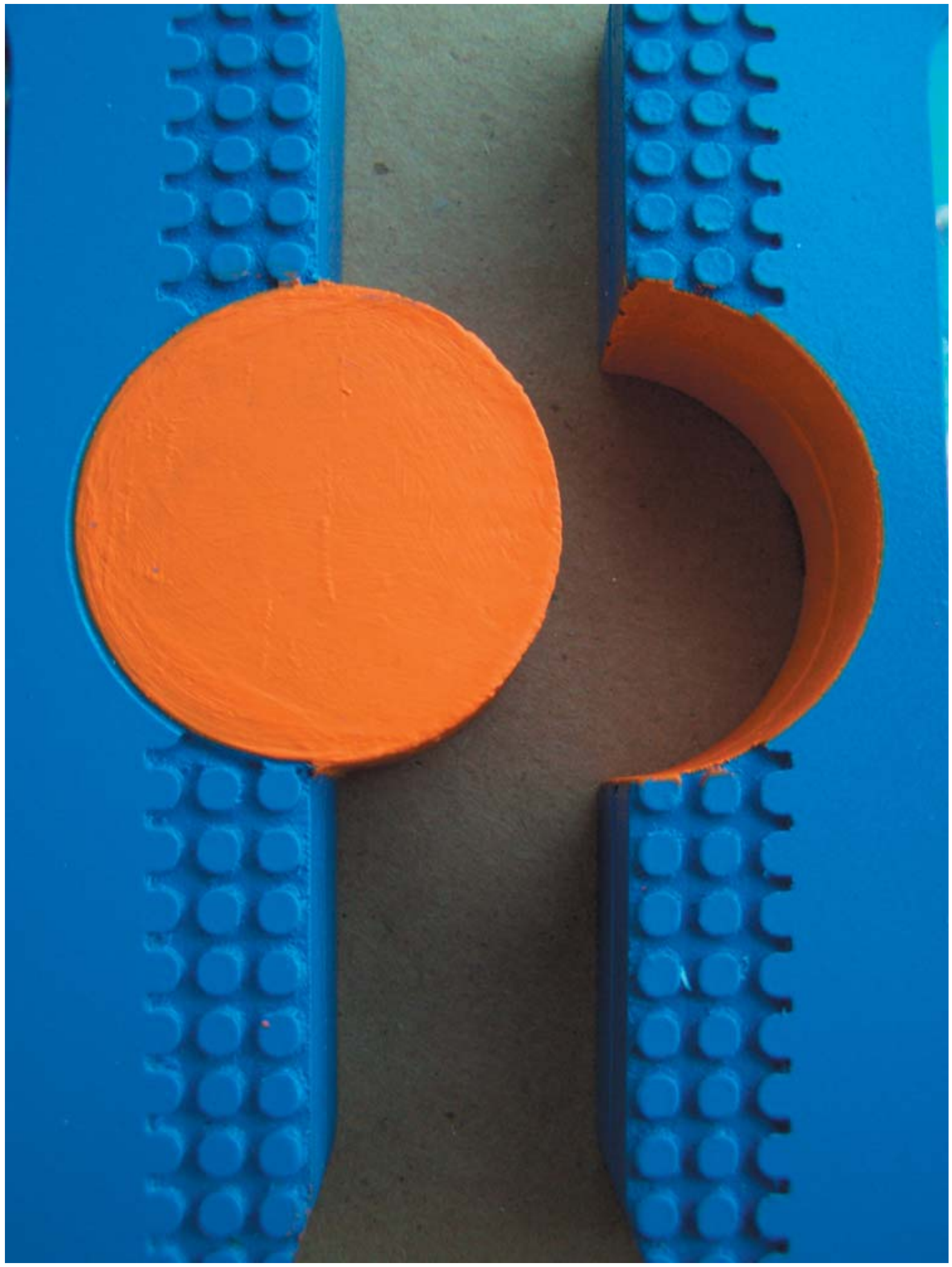


Figure 14. Shape connection, circle.

Shape *continued*

These shapes were also chosen because they allow the pieces of the puzzle to slide into place, rather than having to lift and snap them. This minimizes physical effort required and reduces the chance for error.

Figure 15. Puzzle pieces sliding into place.

Pattern and Texture

Patterns were created using the repetition of the final shapes. Patterns are differentiated according to the shape repeated, size, quantity, and regularity. Patterns are located along the edges of two connecting sides and repeat the shape of the respective shape connection.

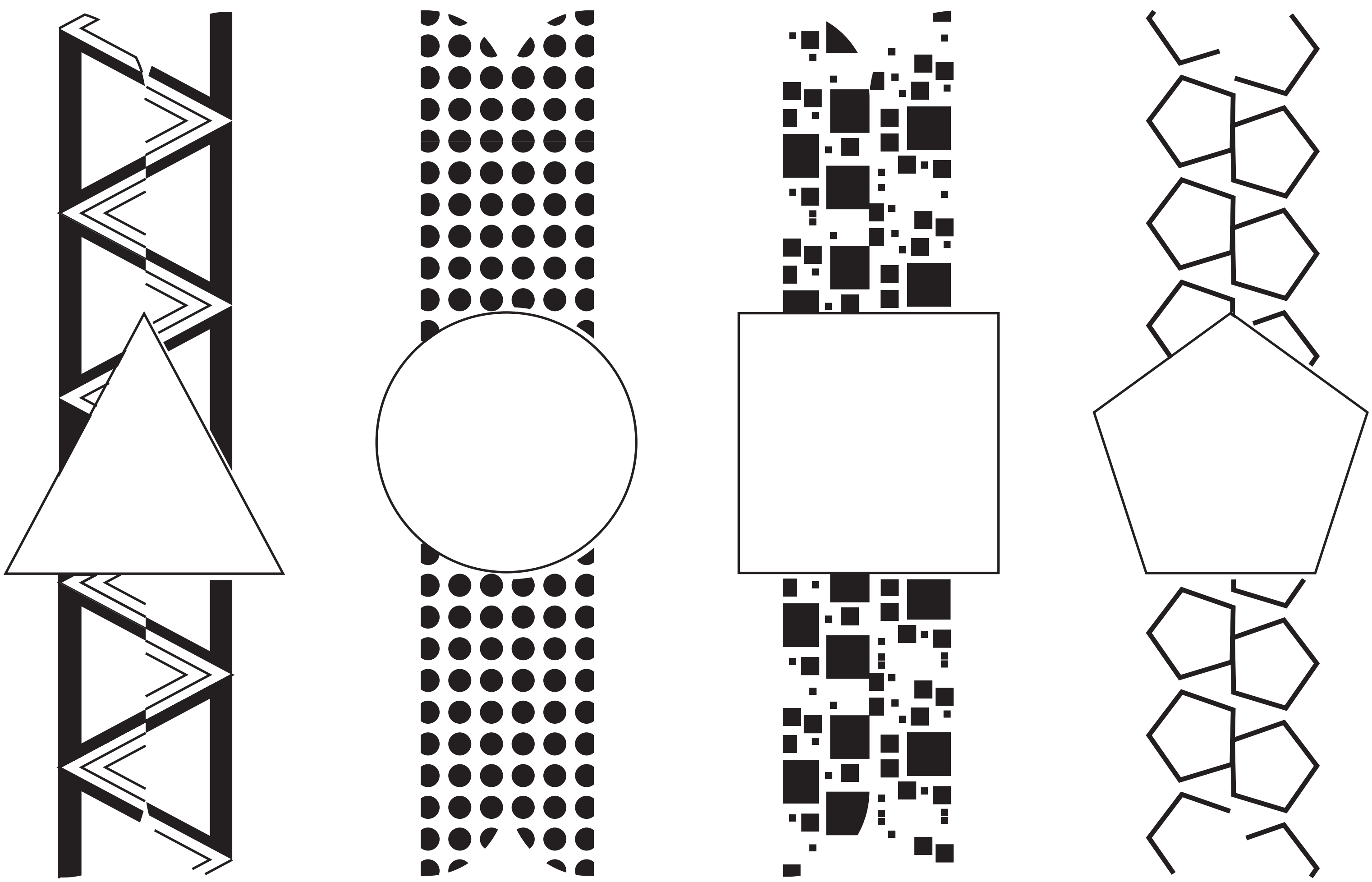


Figure 16. Final patterns for textures.

Pattern and Texture *continued*

Both visual and tactile textures were created. Patterns were milled into the surface of the 3D form, giving it a tactile quality. Pieces sharing a common edge share the same tactile pattern, another prompt for successful matching. The tactile surface helps to reinforce learning and retaining the information presented by the puzzle.

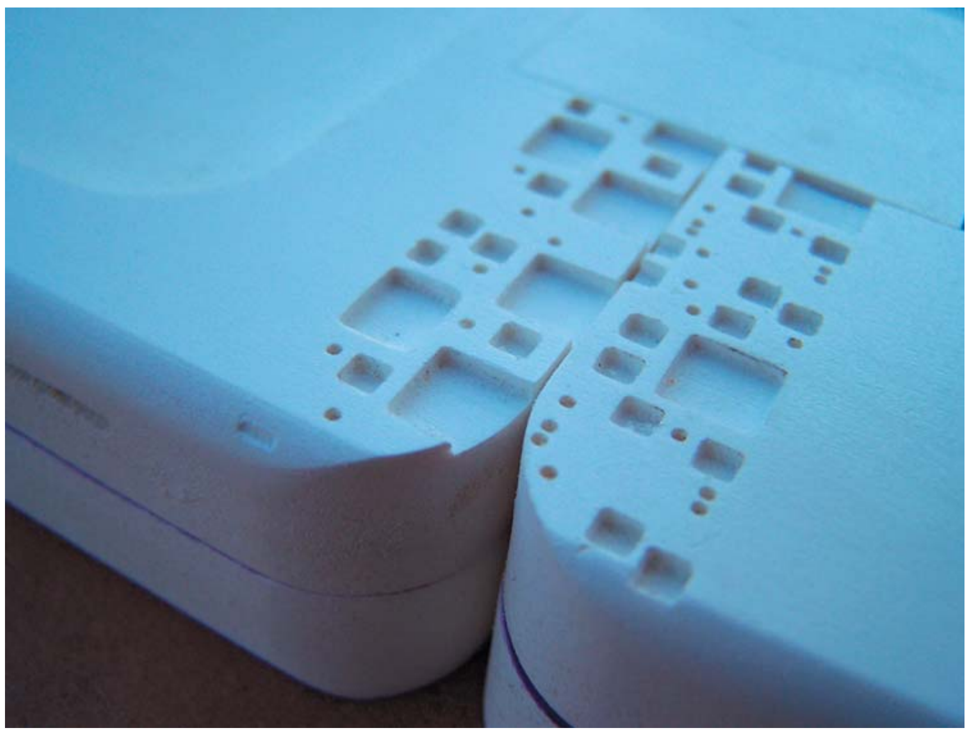


Figure 17. Final patterns milled into prototype.

Pattern and Texture *continued*

Figure 18. Final patterns milled into prototype.

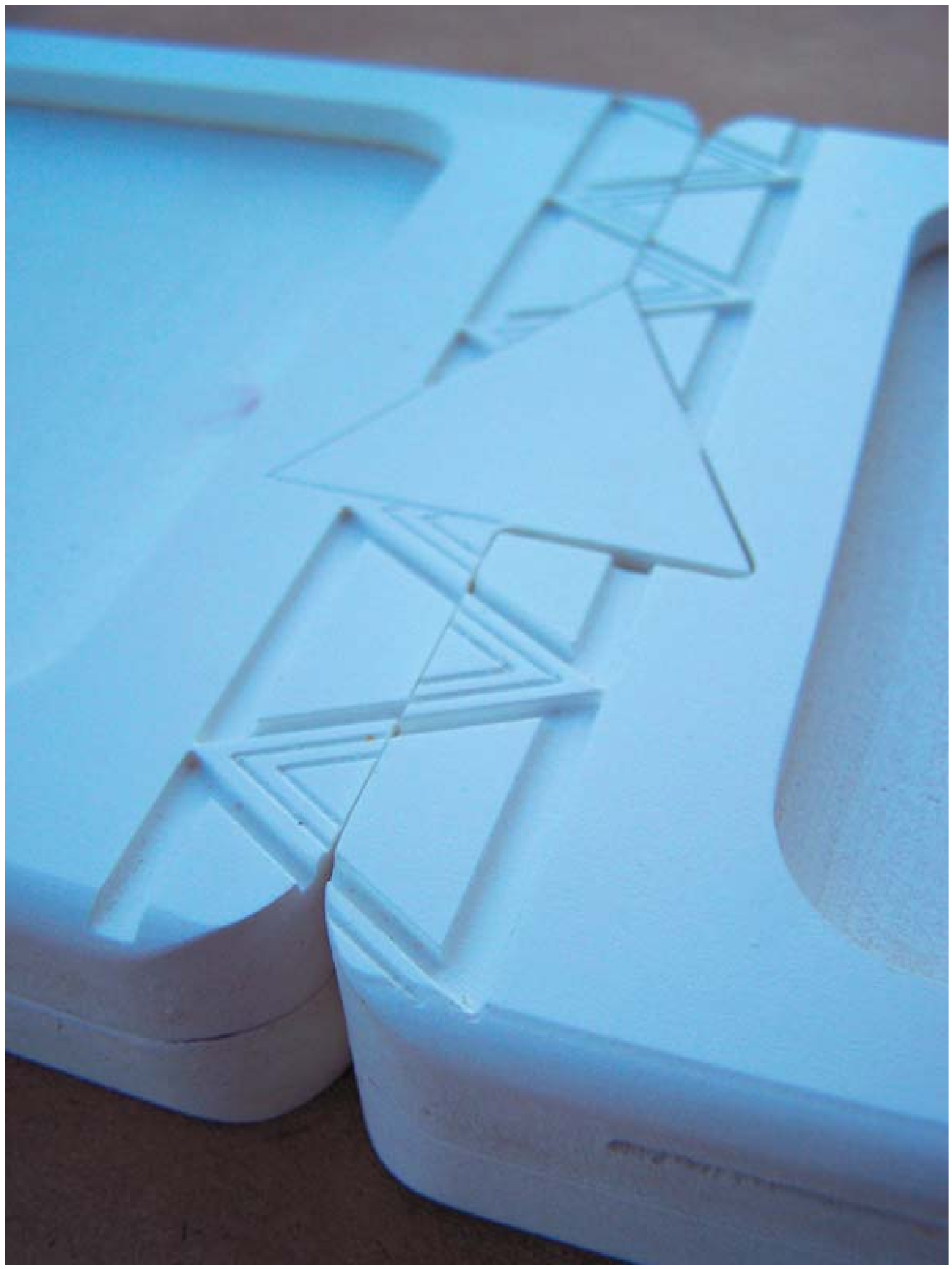


Figure 19. Final patterns milled into prototype.

Pattern and Texture *continued*

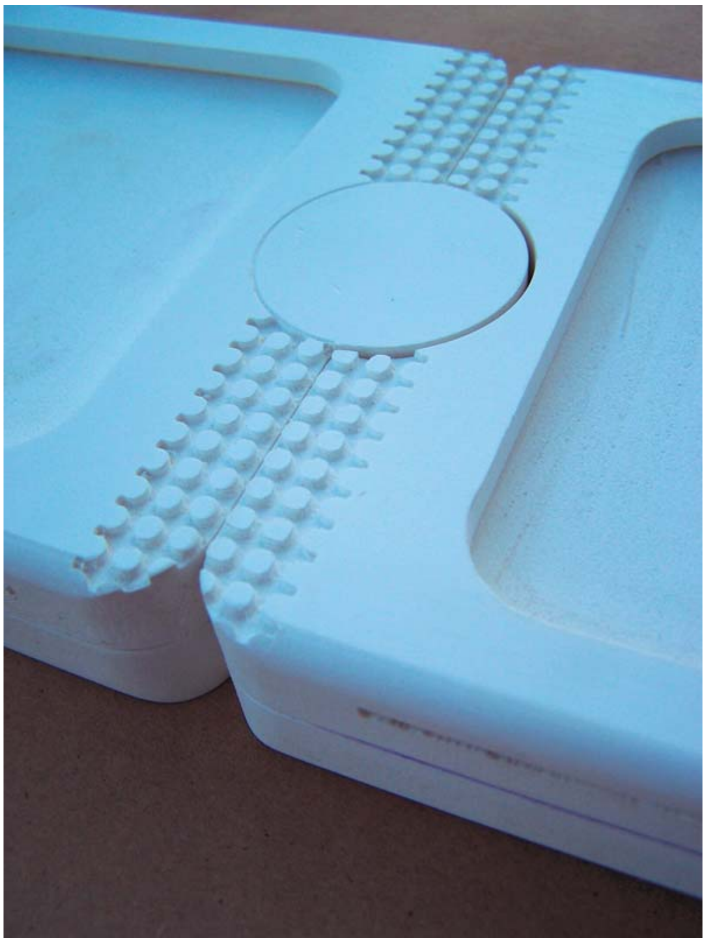


Figure 20. Final patterns milled into prototype.

Figure 21. Final patterns milled into prototype.

Pattern and Texture *continued*
The back surface of the puzzle contains a positive reinforcement message that is milled into the surface. This provides an element of surprise to the user.

Figure 22. Back view of prototype with inspirational message milled into the surface.

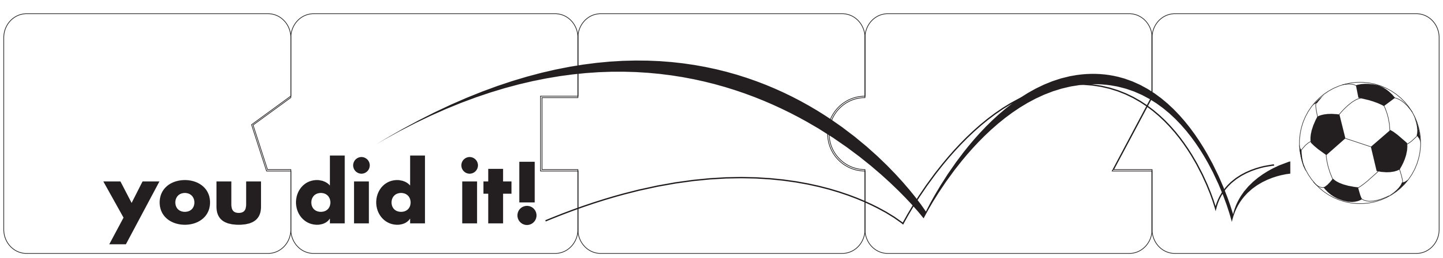


Figure 23. Back view of puzzle.

Color

The 3D form is monochromatic, with the exception of the shape connections. Each shape connection is color-coded. The surface and inner edge of the positive shape (the male connector) is the same color as its corresponding negative shape (female connector). The color-coding provides a subtle cue indicating the correct connection. The color palette is discussed in greater detail in the Graphics section.

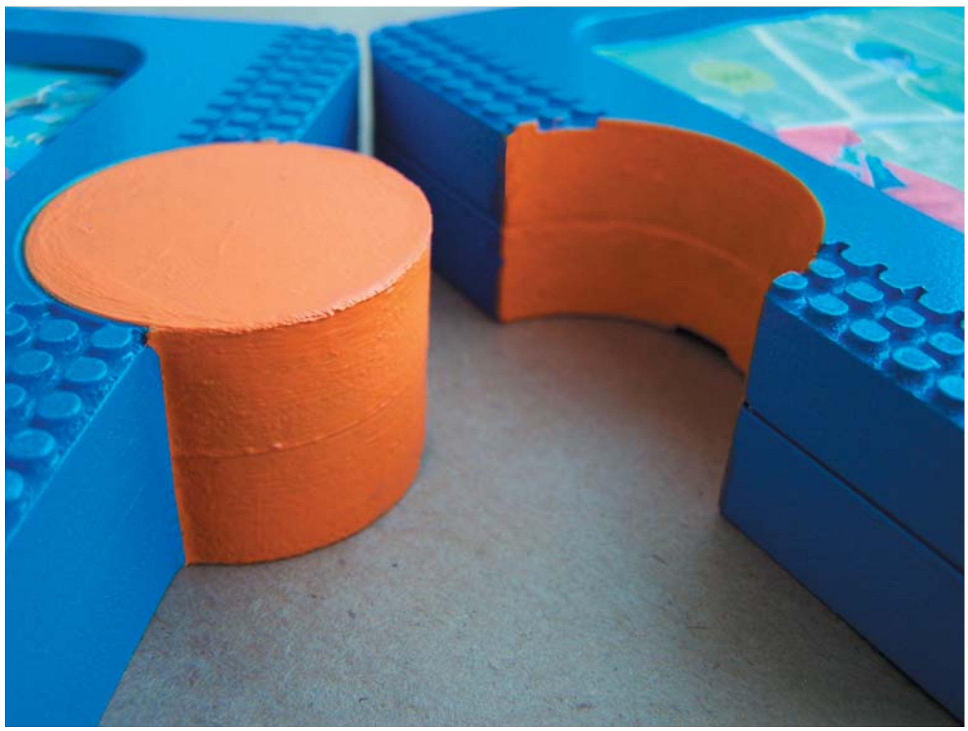


Figure 25. Color-coding of positive and negative shape.

Figure 24. Color-coding of positive and negative shape.

Figure 26. Color-coding of positive and negative shape.

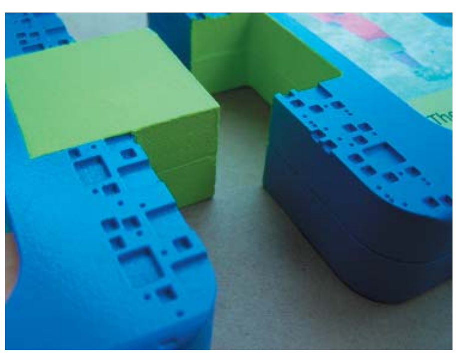


Figure 27. Color-coding of positive and negative shape.

Material

Two prototypes were created for this project. One is modeled in Sintra, a PVC plastic based material; the other was created with Renboard, a common prototyping material. Sintra is durable and could sustain rough handling from a child, although is not meant to be the final material choice. More options should be explored to ensure that the material chosen is appropriate for child safety and sustainability. Safe and sustainable methods for color application should also be investigated.

Figure 28. Samples of Sintra.

Grid

The overall base shape of the individual puzzle piece was used to create a design grid. The design grid aided in the size, shape, and placement of shape connections as well as the image window. The grid also guided design decisions for the graphic layout of the image card and placement of the patterns. The grid was constructed by scaling and repeating the base shape to create grid lines 1/4" apart.

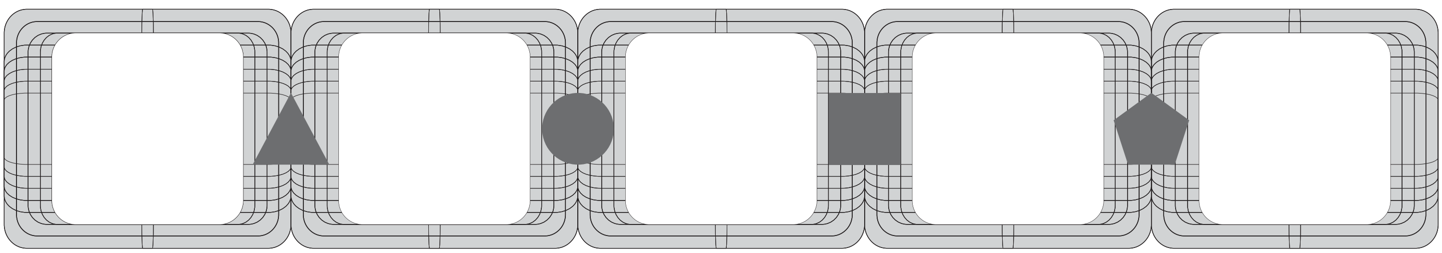


Figure 29. Design grid, assembled view.

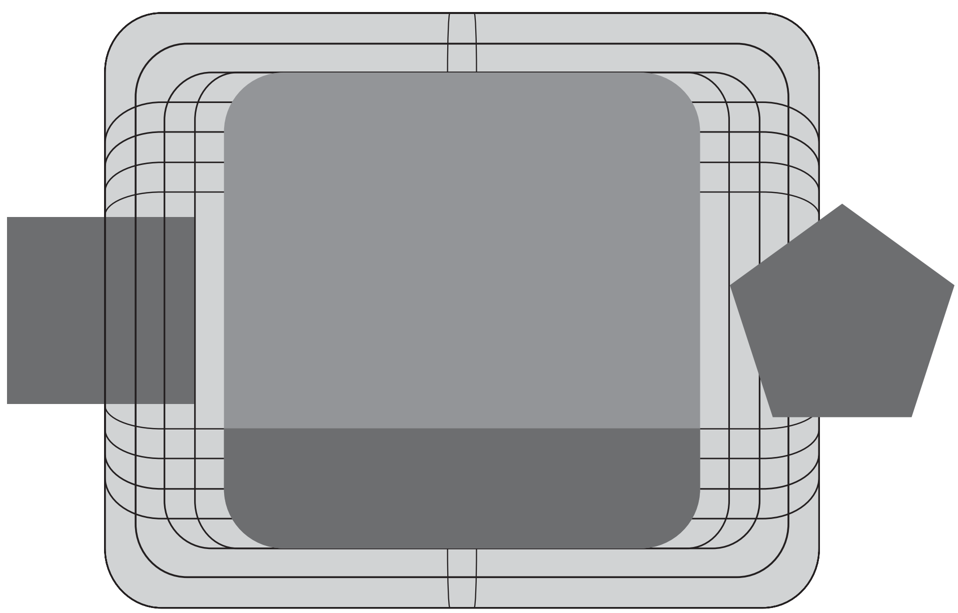


Figure 30. Design grid.

Color

The color palette consists of primary and secondary colors: red, blue, green, yellow, orange, and purple. Because color recognition typically occurs at age three, primary and secondary colors will be most familiar to the child and will reinforce this learning. Bright colors are used to appeal to the child and are aesthetically pleasing. Color is also used to aid in communication.

One color from the palette is designated for the 3D form. The five remaining colors make up the background for image card text blocks. The background color of the text block matches the preceding shape connector, further establishing the connection. In other words, the positive shape will be the same color as the image card that will follow in the sequence. The negative shape (the female connector) also matches the text block of its respective puzzle piece. The application of color is used to reinforce the successful sequencing of each piece.

The color palette allows for multiple puzzle sets to be created assigning a different background color to each set. This will broaden the appeal and allow users to choose the color that appeals most to them. The prototype for this thesis uses a desaturated purple as its background. The image cards alternate warm and cool colors (red, blue, orange, green, and yellow).

The bright colors against the monochromatic form help the image cards and shapes to “pop.” Assigning the colors in this manner contributes to the established hierarchy, and maintains the image cards as the highest priority.

Figure 31. Color palette

Figure 32. Top view of color assignment.

Photography

Simple, straightforward photography is used for the image cards. Two types of shots are used; these include a wide shot, in which the subjects are shown from head to toe, and a medium wide shot, where subjects are cut off at their legs or just below the knees. This latter shot provides the user with detail of the background, yet is close enough to give sufficient detail of the subjects. This type of shot is important to the sequence because the facilitator should emphasize the eye gaze and hand gesture of the main character.

Photographs are shot in full color with the background toned back to 50% opacity. This increases the user's ability to discriminate figure from ground. The background at this opacity keeps the focus on the characters in the story, establishes the hierarchy of information, and eliminates distracting elements. Because the background is still visible, the user is provided with the context and is able to understand the environment where the activity is taking place. Contrast, brightness, and saturation were adjusted to make the images pop from their background and relate to the established color palette.

Figure 33. Final photographic style, wide shot.

Figure 34. Final photographic style, medium wide shot.

Text

Futura Book was chosen as the typeface because a simple harmonious sans serif was desired. Decorative or serif typefaces may provide unnecessary distraction. The low contrast letter forms contribute to readability— an important distinction for beginning readers. For this reason, the lowercase letter a was an important factor in choosing a typeface.

Conceptually, Futura's geometric roots relate to the simple geometry of the shape connections and patterns. Type is set at the largest comfortable size for the provided space with ample leading and set in either black or reversed out white for maximum legibility. Text appearing in conversation bubbles is also set in Futura Book. Because the squiggly Futura question mark would likely cause legibility issues for children in this study, it was set in Avenir.

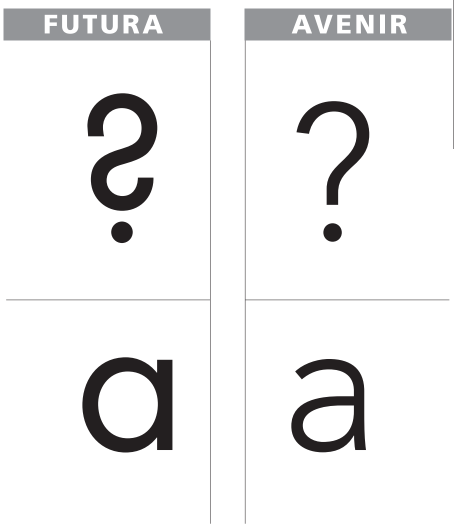


Figure 35. Comparison of Futura and Avenir characters.

Figure 36. Type size exploration.

Figure 37. Futura.

Conversation Bubbles

Conversation bubbles support the accompanying text. This graphic provides an immediate visual cue to the user indicating who is talking and what they are saying. As a result, the story line can be understood from the images alone, supporting the objective to maintain the visual as the most important element. The shape of this graphic is derived from the exact shape of the circle and triangle connectors fused together. This graphic element contains black text on a colored background. The background color matches the color of the positive shape connection on the respective piece. The text is set in Futura.

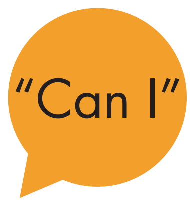


Figure 38. Conversation bubble.

Figure 39. Conversation bubble shown on image card.

Figure 40. Conversation bubble shown matching color of following positive connection shape.

Image cards

The front side of the image cards contain the image and text on a color background. Elements from the final patterns are incorporated on the back and matches in color to the base shape. The background color changes on each piece and reflects the color on the front of the card.

Figure 41. Image card, front view.

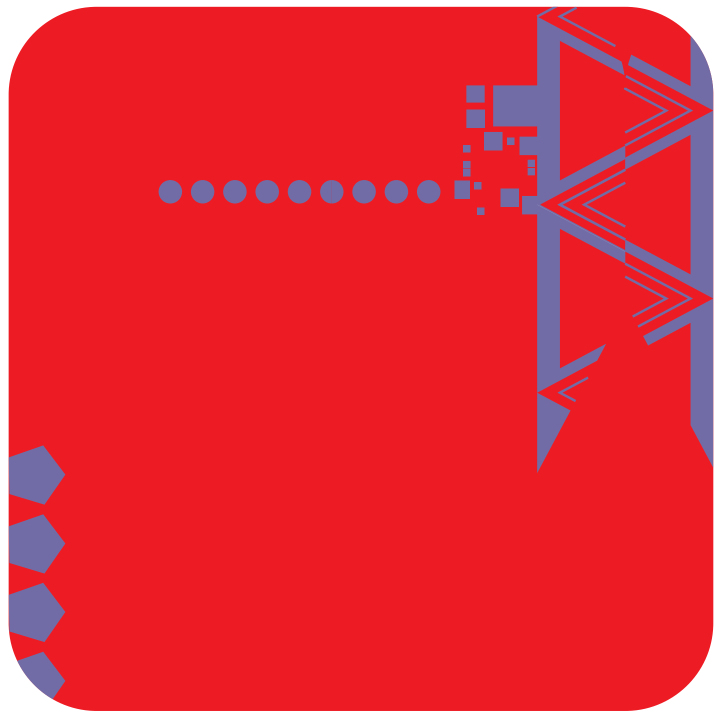


Figure 42. Image card, back view.

Image cards *continued*

Figure 43. Image card, front view.

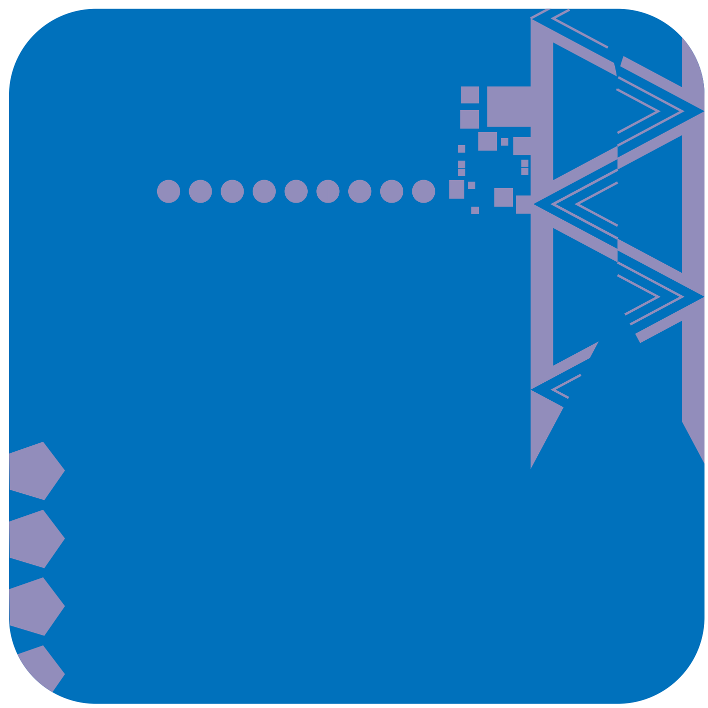


Figure 44. Image card, back view.

Image cards *continued*

Figure 45. Image card, front view.

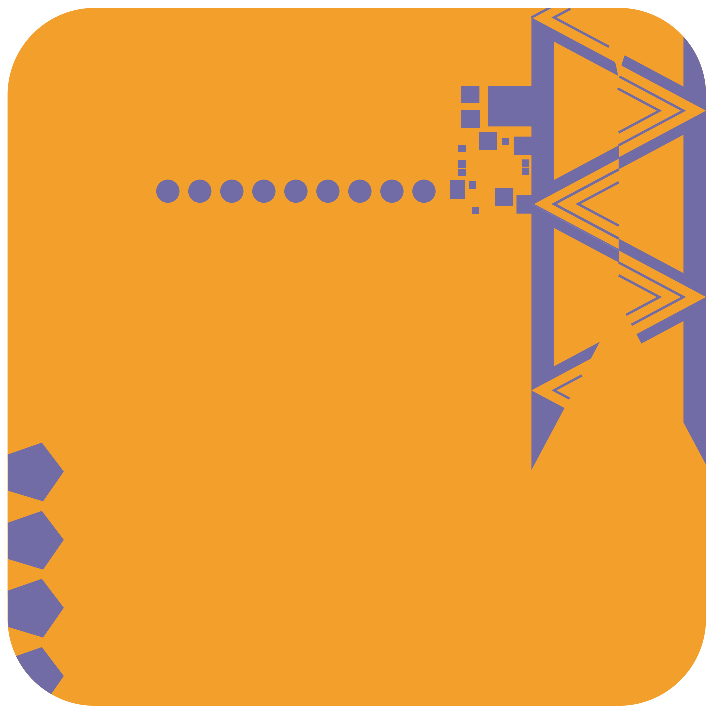


Figure 46. Image card, back view.

Image cards *continued*

Figure 47. Image card, front view.

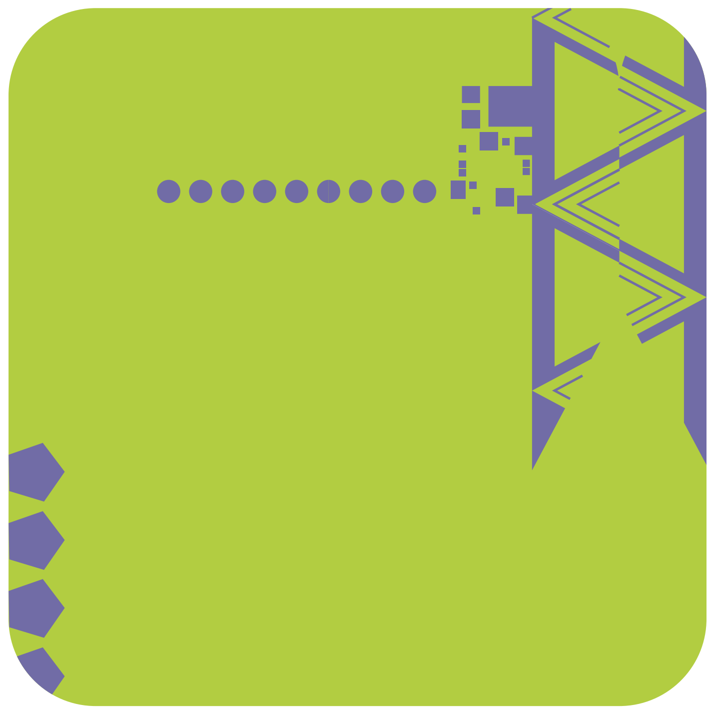


Figure 48. Image card, back view.

Image cards *continued*

Figure 49. Image card, front view.

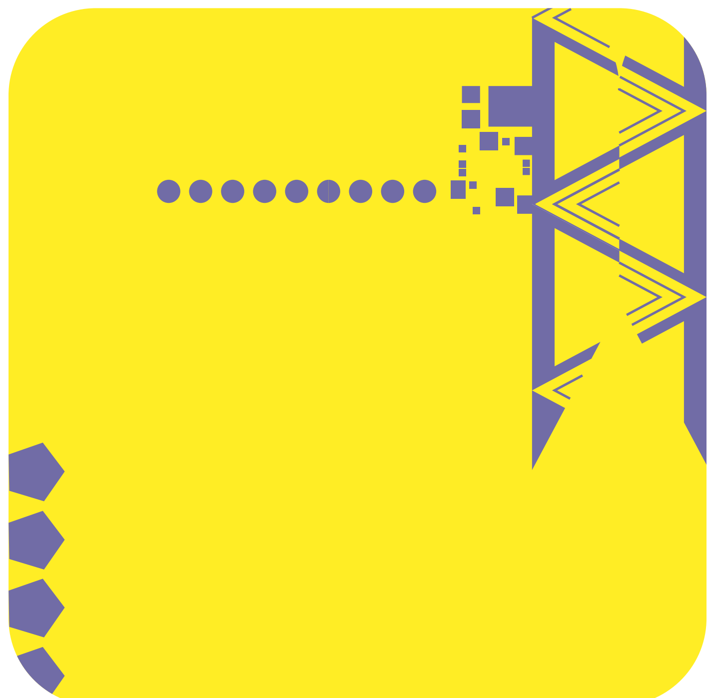


Figure 50. Image card, back view.

Image cards *continued*

Image cards insert into the image slot and can be removed and exchanged. If the user wishes to customize the story, the image cards may serve as a template for imagery and script. The image cards are laminated for protection against spills, tearing, and general rough handling.

Figure 51. Image card inserting into image slot.

Justification

There are two modalities modeled in the image cards: verbal and gesture. The gestural modality augments verbal communication, thus increasing the probability that the child with limited verbal skills will be understood.

The steps of asking to play are modeled through a sequence of still images supported by accompanying text. The following Task Analysis (TA) provides a breakdown of the process of asking to play.

Task Analysis

1. Desire to play.	2. Approaches group.	3. Asks to play.	4. Response from group.	5. Engages in play.

Figure 52. Task analysis.

Children with DS who have limited verbal skills require more modeling of step 3 in this process. To compensate for this, the following TA combines steps 1 and 2, as well as steps 4 and 5. Step 3 of the previous TA is sub-divided into 3 tasks.

Task Analysis

1. Desire to play/ Approaches group.	2. Asks to play.	3. Asks to play.	4. Asks to play.	Response from group/Engages in play.

Figure 53. Revised task analysis.

Figure 54 shows the description of the visual as it corresponds to the TA.

Task Analysis with Description of Corresponding Visual

TA	1. Desire to play/ Approaches group.	2. Asks to play.	3. Asks to play.	4. Asks to play.	Response from group/Engages in play.
VISUAL	The boy observes the children playing.	The boy has approached the children. The boy gestures "Can I" by pointing to himself. The boy maintains eye contact with the children.	The boy gestures "play" by pointing at the ball. The boy shifts his eye gaze to the ball.	The boy gestures "with you?" by pointing to the children. The boy shifts his eye gaze back to the children.	The boy is seen engaging in play with the kids.

Figure 54. Revised task analysis with description of visual.

Here the accompanying text is added.

Task Analysis with Script Added

TA	1. Desire to play/ Approaches group.	2. Asks to play.	3. Asks to play.	4. Asks to play.	Response from group/Engages in play.
VISUAL	The boy observes the children playing.	The boy has approached the children. The boy gestures "Can I" by pointing to himself. The boy maintains eye contact with the children.	The boy gestures "play" by pointing at the ball. The boy shifts his eye gaze to the ball.	The boy gestures "with you?" by pointing to the children. The boy shifts his eye gaze back to the children.	The boy is seen engaging in play with the kids.
SCRIPT	The boy wants to play with the kids.	The boy points to himself, and says "Can I"	The boy points to the ball and says "play"	The point points to the kids and says "with you?"	The boy and the kids play ball together.

Figure 55. Task analysis with accompanying text.

Figure 56. Final storyboard.

The practice component is an important aspect to the concept and it is necessary for achieving intended learning outcomes. The practice component refers to the activities that should follow completion of the puzzle. The puzzle is designed to present the steps of asking to play in a visual format. As the puzzle is being put together, or once assembled, it is suggested that a discussion take place between the child and the facilitator.

The discussion would likely be an elaboration of the steps modeled. Next, the facilitator would have the child practice these steps. The end-user would be provided with suggested activities, although they may prefer to develop their own. Role-playing is an example of a suggested activity. This would allow the child to practice the steps in a safe secure environment, where the risk of rejection or not being understood is removed. As the child gains confidence, the facilitator would remove his or herself from the situation gradually. Ultimately, it is desired for the child to execute these steps without help.

The facilitator is generally assumed to be a parent or teacher/professional. However, there is also an opportunity for a sibling or peer to serve as a facilitator for the child or be involved in another way. Peer or sibling involvement, in some capacity, is especially encouraged. As research has indicated, siblings play a unique role in social development for children with disabilities. Siblings offer a unique perspective and can model social behavior that the child in turn can exhibit among peers. Involvement of peers will help foster awareness and compassion that may transcend to social situations.

This section documents the design process of the 3D form. Early sketches helped to establish a direction for the puzzle's form. Both 2D and 3D options were explored.

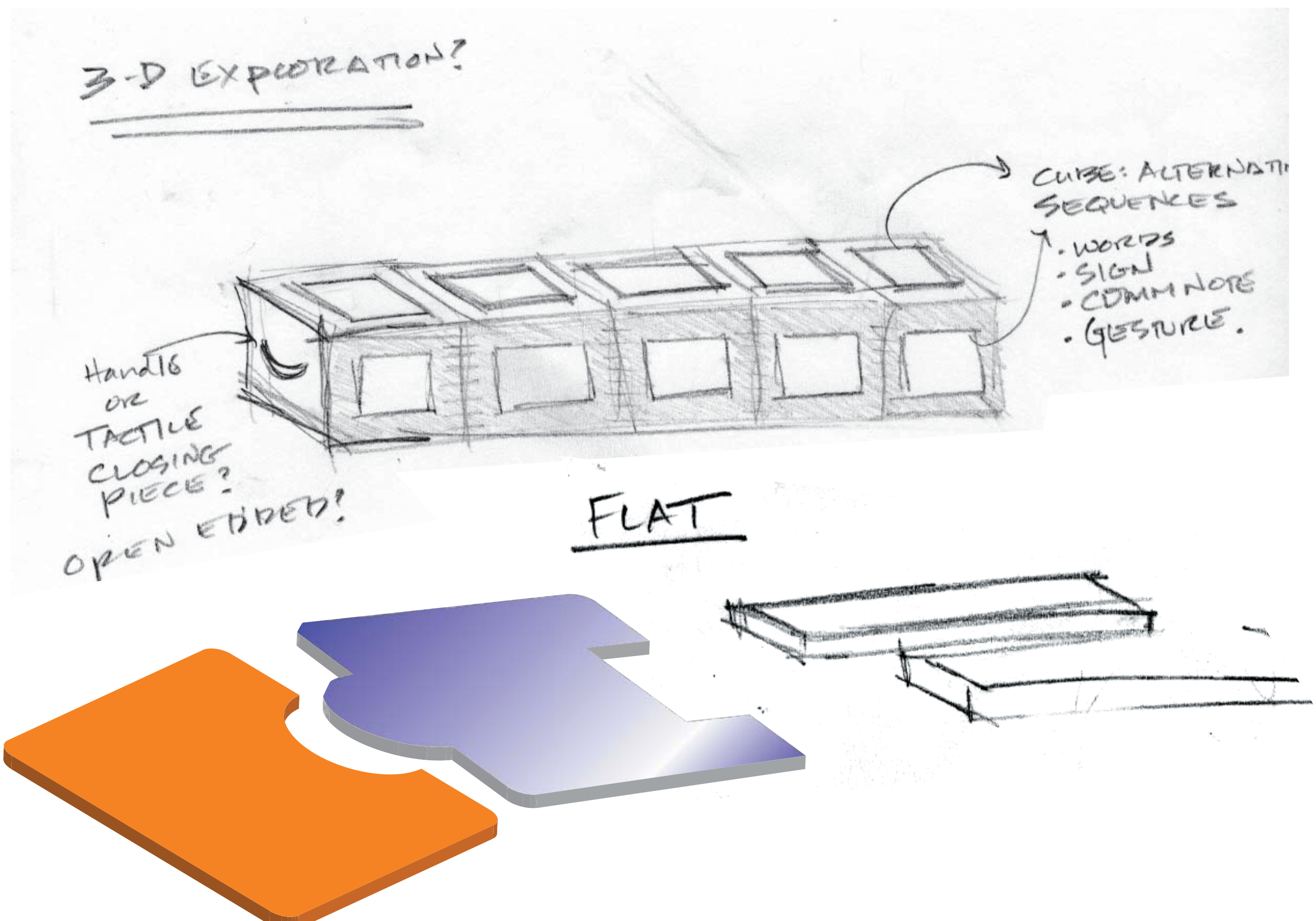


Figure 57. Early sketches.

Connection Mechanism

Research was conducted, followed by sketches exploring surface treatment and different methods for connecting the puzzle pieces.

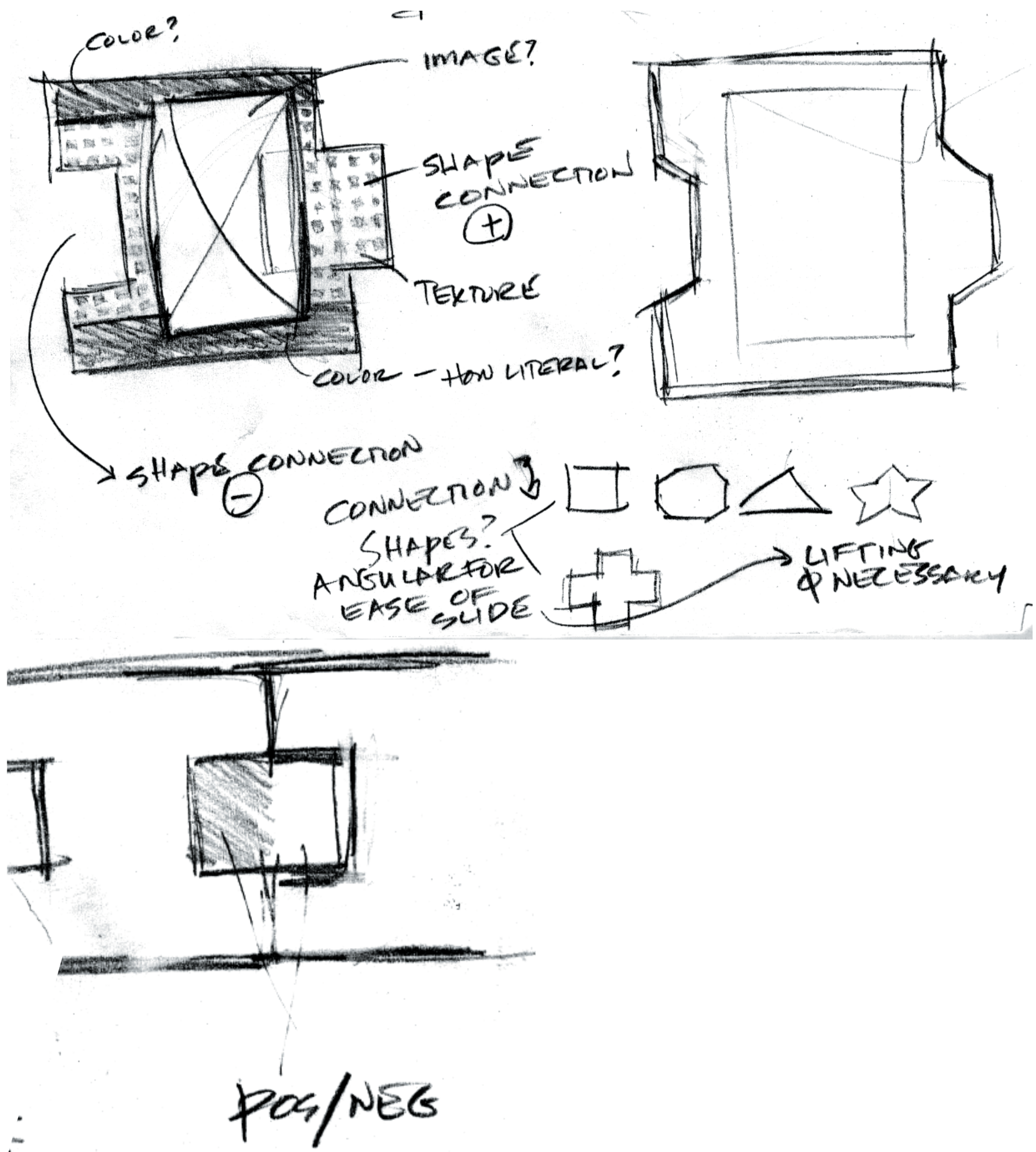
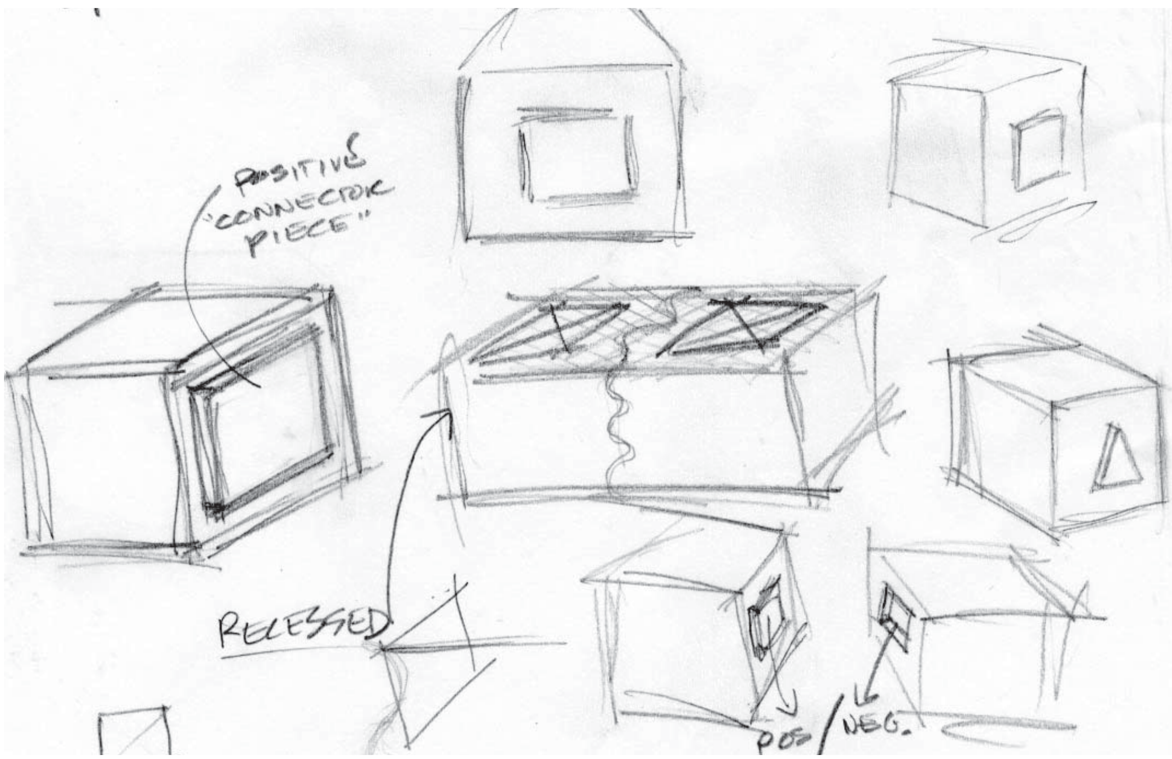


Figure 58. Early sketches.

Connection Mechanism / Sequencing

Further studies were created exploring the sequencing and progression of the puzzle. Some studies investigated the idea of moving from simple to complex and quantity increase.



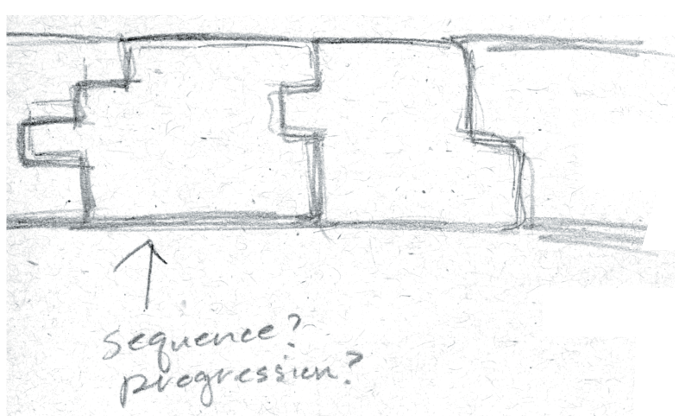


Figure 59. Early sketches.

Shape

Due to the target age range and typical motor function characteristics of children with DS, complex connection mechanisms were ruled out. A direction was established utilizing familiar shapes. This provided a secondary learning opportunity because shape recognition would be developing with this age group.

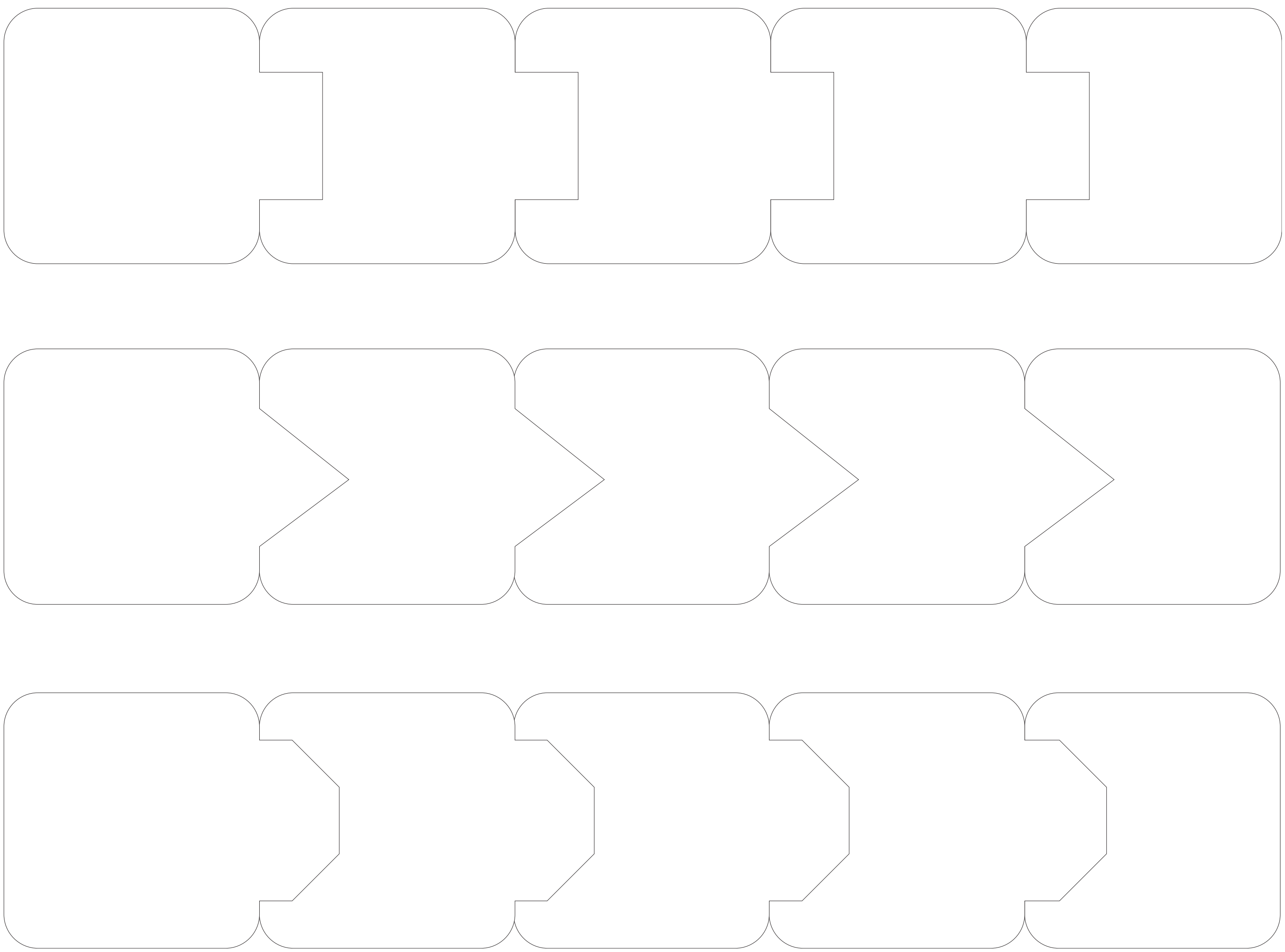


Figure 60. Shape studies.

Shape *continued*

Shapes were eliminated if they proved to be too complex, shared too many commonalities with another shape for successful discrimination, or could not easily slide into the connecting piece. For example, the diamond shape was eliminated because of its close resemblance to the triangle, and the star was ruled out because it would require the child to lift the piece and snap into place.

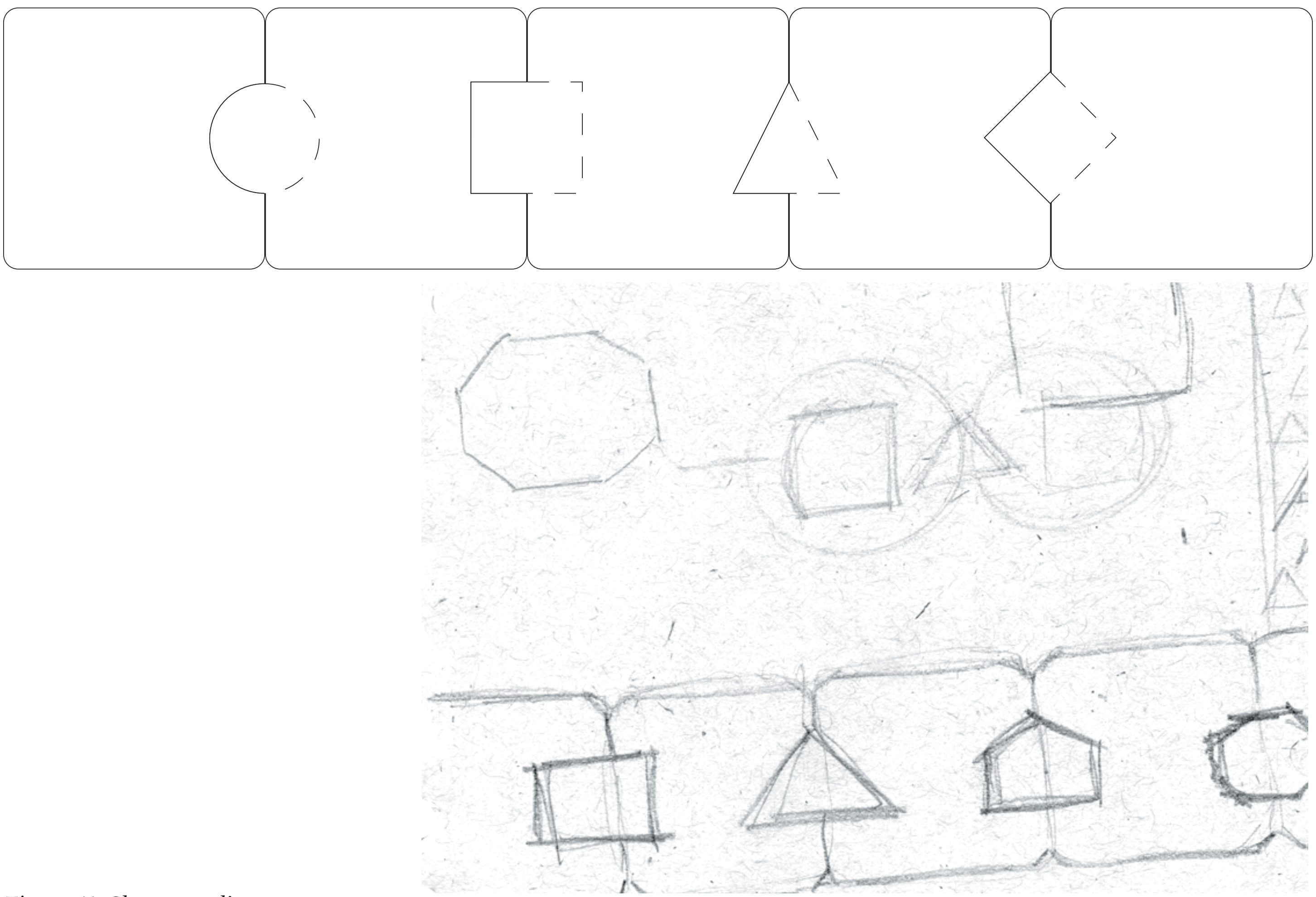


Figure 61. Shape studies.

Shape *continued*

The overall shape of the pieces was also considered. Going along with the shape theme, various shapes were looked at to serve as the main structure. Some shapes proved to be too distracting, or not conducive to an appropriate amount of space for the visual and text. Ultimately, a simple square shape with rounded corners became the focus. After being tested, however, the square shape was found to reduce visual space and felt “forced.” A rounded rectangle proved to be most effective.

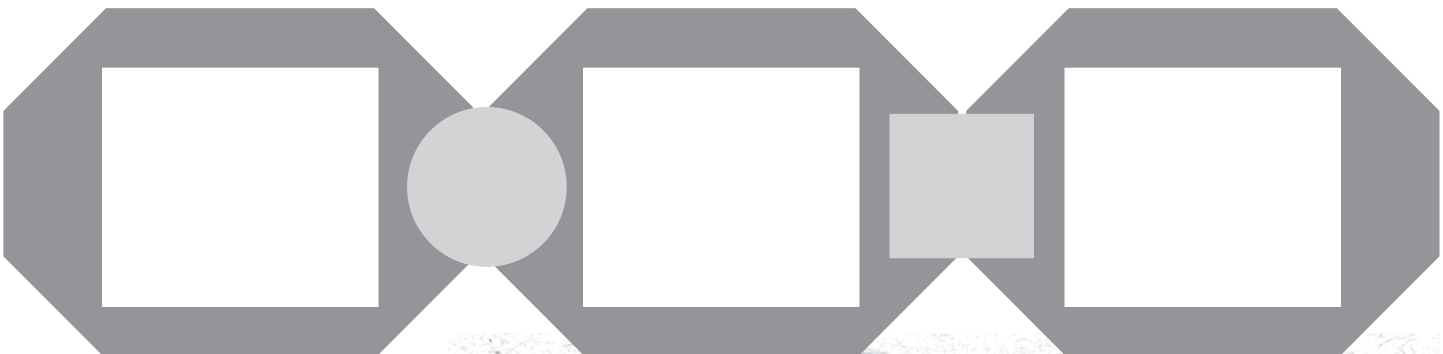


Figure 62. Shape studies.

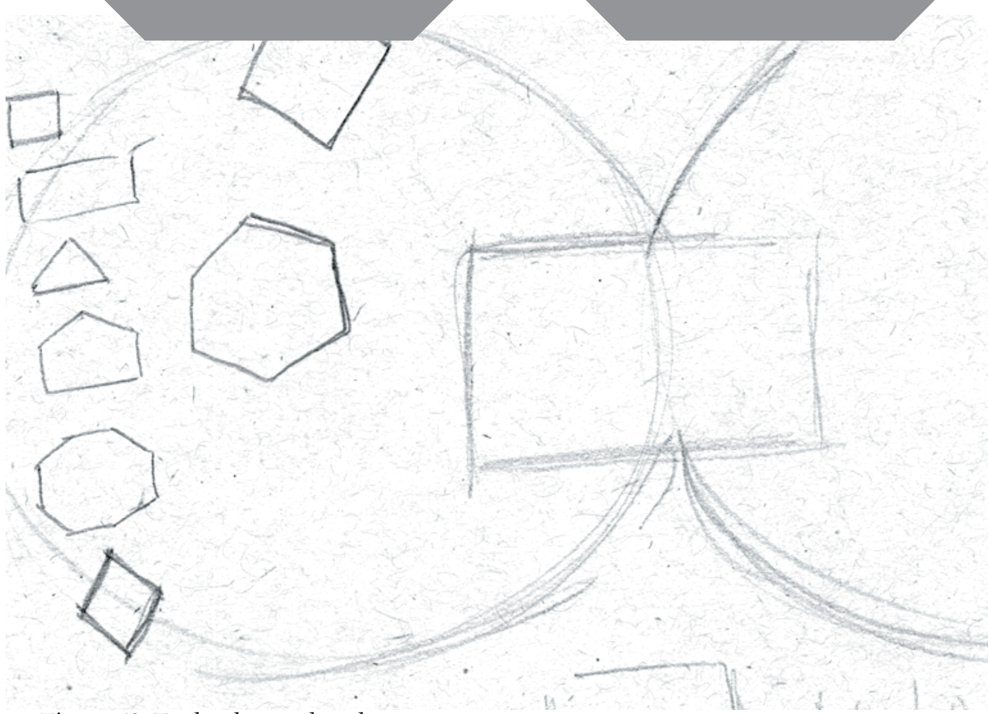


Figure 63. Early shape sketches.

Size

Models were created from Polystyrene (pink and blue foam) in order to test the overall size and thickness desired for the puzzle pieces. Models were cut using a hot wire and a corrugated guide. A range of sizes were tested with extremes of small and large. Tests were done using models with a square surface area of 3", 4", 4.5", 5", 5.5", and 6". These surface area dimensions were then cut in the following thicknesses: .5", .75", 1", 1.5", and 2". Also, some of the foam models used for testing had beveled edges, while the rest were square.

Figure 64. Foam models showing thickness.

Figure 65. Foam models.

Figure 66. Foam models.

Size *continued*

Foam models were tested with children ranging from ages 6-10. The desired outcome of the testing was to determine the appropriate size and thickness for the child's hand, ease of use, and the ability to grasp and manipulate the pieces. Children used in this testing phase were typically developing. The size of their hands were then compared to that of an eight-year-old boy with DS. The measurement from the base of his palm to the top of his middle finger was 5.5". His palm measured 3.25" wide. In comparison, the smallest hand size was that of a typically developing six year-old girl. Figure 67 shows the measurements taken from the 8 year-old child with DS. This graphic, at full size, was compared to the various sizes of the foam models.

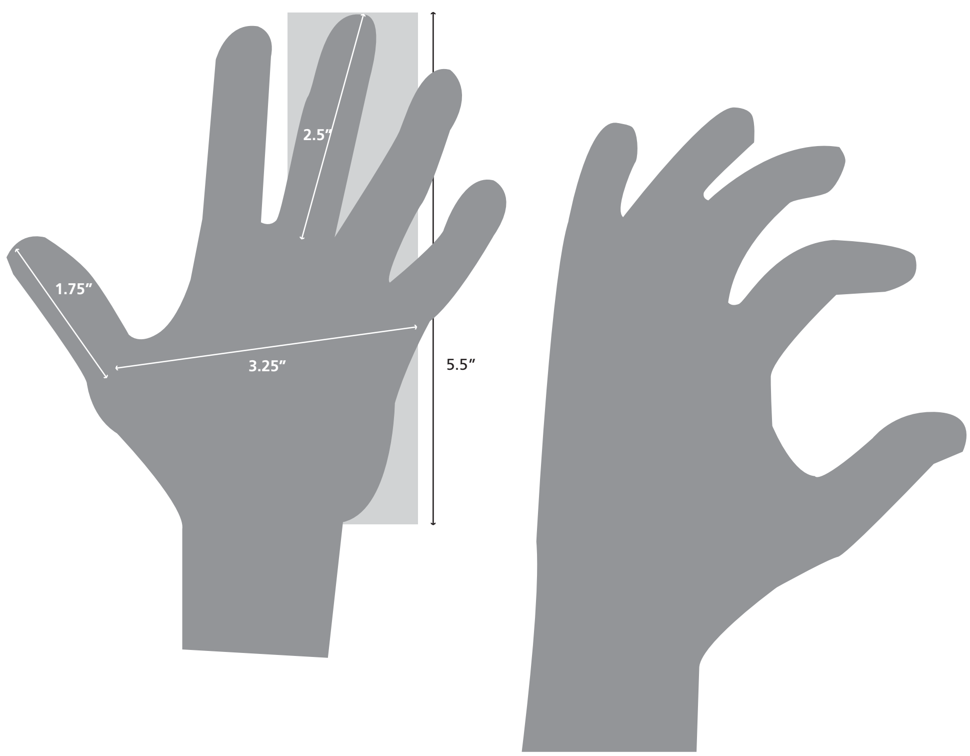


Figure 67. Hand dimensions of male child with Down syndrome, 8-years-old.

Size *continued*

Children were observed manipulating the pieces and asked questions that related to the ease of use. Care was taken not to influence the children's responses. It was also necessary to make it clear that color was not an issue, so that a child's penchant for a certain color (pink or blue in this case) would not influence their responses. In the future, these issues could be eliminated by making sure all of the pieces are the same color and texture.

The children were first observed manipulating the pieces. Observations were made as to how each child held the piece, moved them around, lifted them, etc. After initial observations were made, the children were observed doing specific tasks. These tasks included lifting or sliding the pieces in a certain way.

After this phase of testing, it was concluded that pieces greater that 5" in height were too big to position comfortably in the child's hand. Children consistently gravitated towards pieces with a thickness of 1". Additionally, it was observed that they preferred pieces with beveled edges. When asked to identify their favorite piece, the majority chose the model equalling 5" in height, 1" thickness, and beveled edges.
A limitation of this exercise is the possibility that peer influence may have played a role, although this behavior was not observed.

Pattern and Texture

Figure 68 shows early pattern sketches considering placement, quantity, and scale. Figure 69 highlight two options for determining how the patterns and texture would interact with the grid, along the shared edges of two puzzle pieces. In the first example, the patterns seemed to dominate the space and would ultimately compete for importance with the visual. This would be exacerbated when the pieces were joined. The second option is less distracting, and still provided enough space for the child to appreciate the tactile quality and use this to aid in correct sequencing of the puzzle.

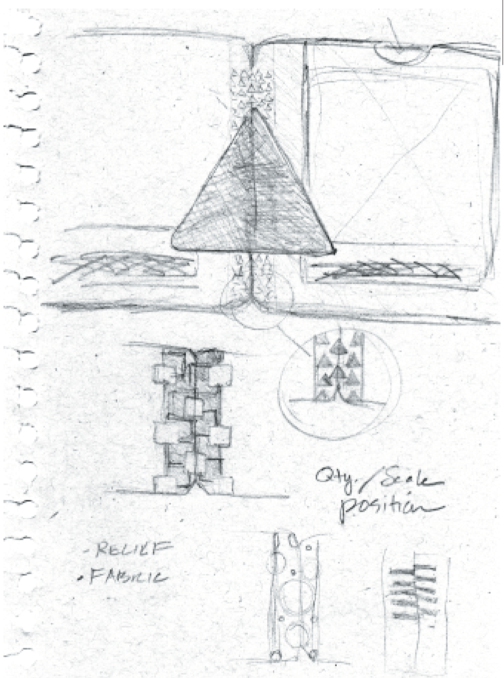


Figure 68. Pattern sketches.

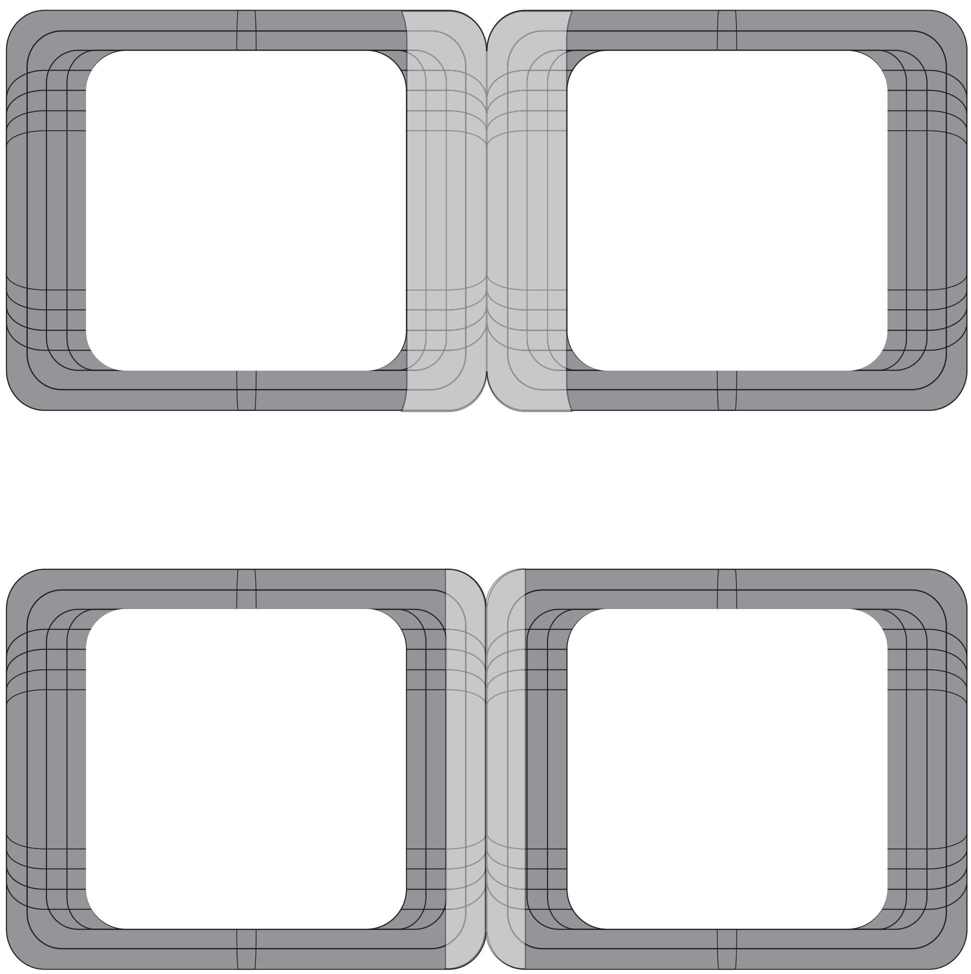


Figure 69. Relationship of pattern to grid.

Pattern and Texture *continued*

Different patterns were explored using the final shapes: triangle, circle, square, and pentagon, as they relate to the connecting mechanism. Quantity, size, repetition, density, and regularity/predictability of elements were considered. Here, explorations are shown in black and white. Also concave and convex tactile treatments were explored

Figure 70. Final pattern, triangle.

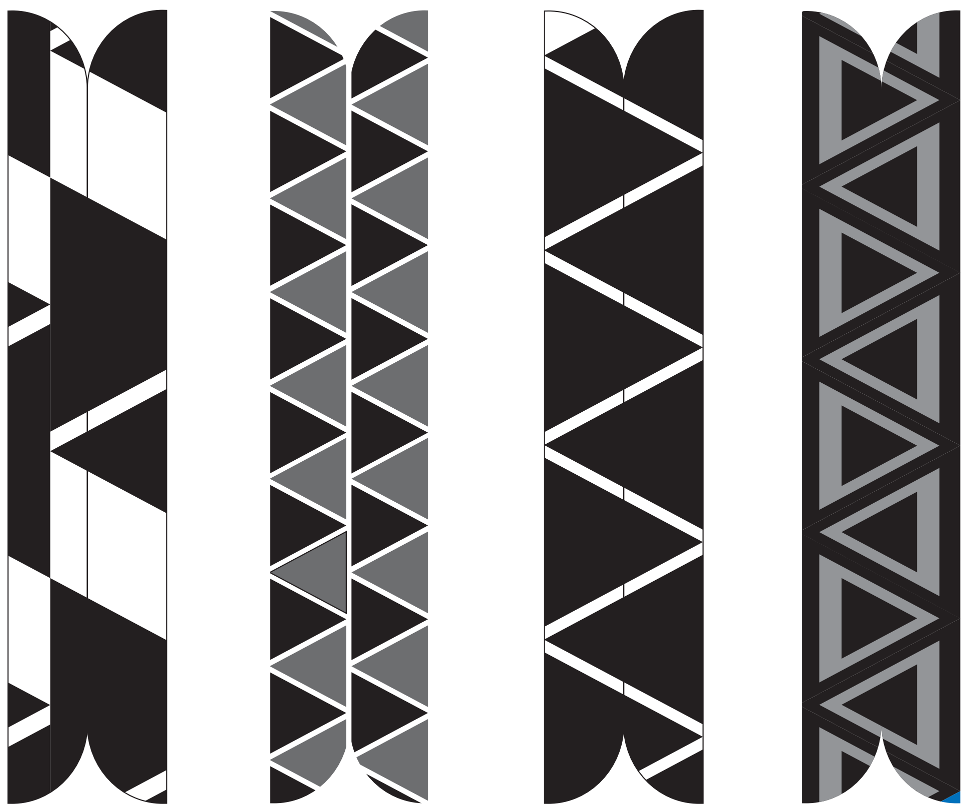


Figure 71. Pattern variations, triangle.

Pattern and Texture *continued*

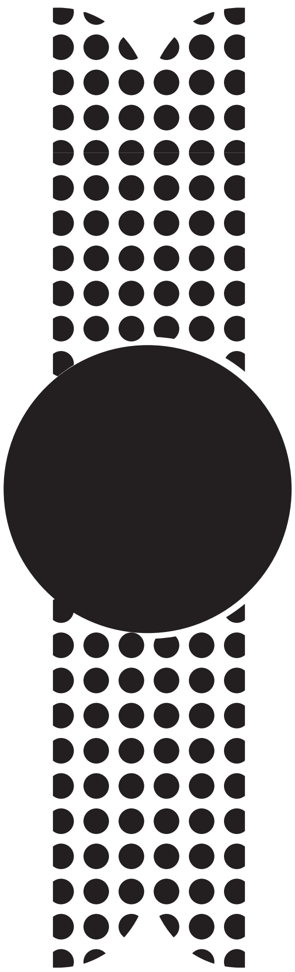


Figure 72. Final pattern, circle.

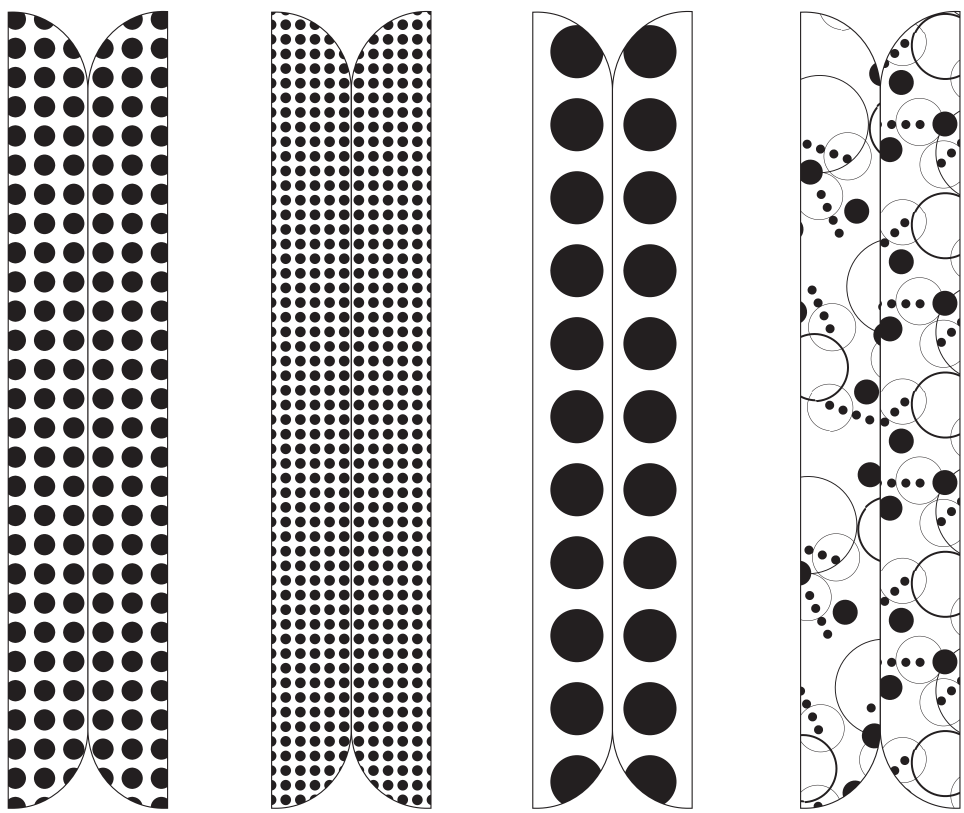


Figure 73. Pattern variations, circle.

Pattern and Texture *continued*

Figure 74. Final pattern, square.

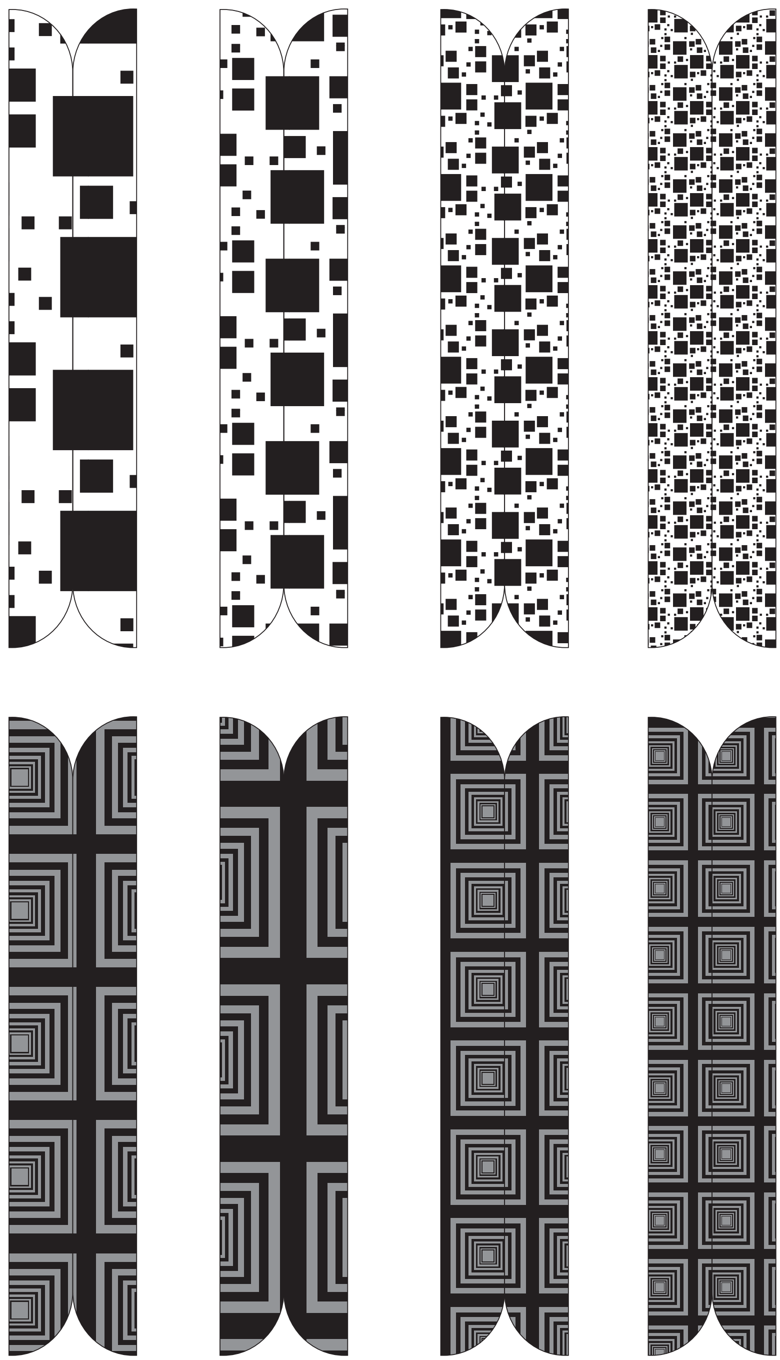


Figure 75. Pattern variations, square.

Pattern and Texture *continued*

Figure 76. Final pattern, pentagon.

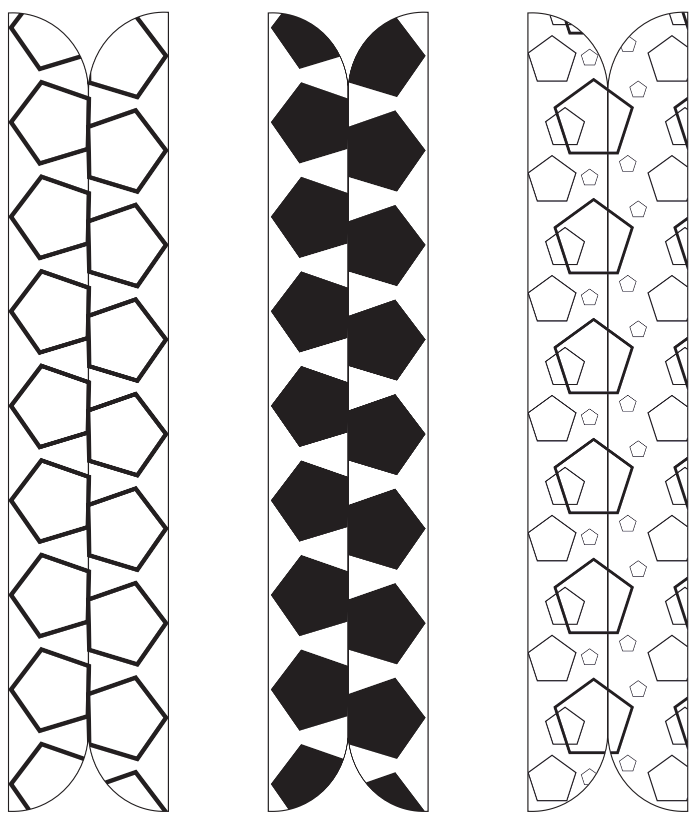


Figure 77. Pattern variations, pentagon.

Pattern and Texture *continued*

The application of color was also explored. Each pattern in the final solution maintains consistent color with the 3D form. Additional color was ruled out because it was determined to be distracting. A tone of the 3D form color was investigated but also ruled out. It was concluded that the patterns would be distinguished through their tactile quality, shape distinction, and overall nature, and still maintain the hierarchy of communication.

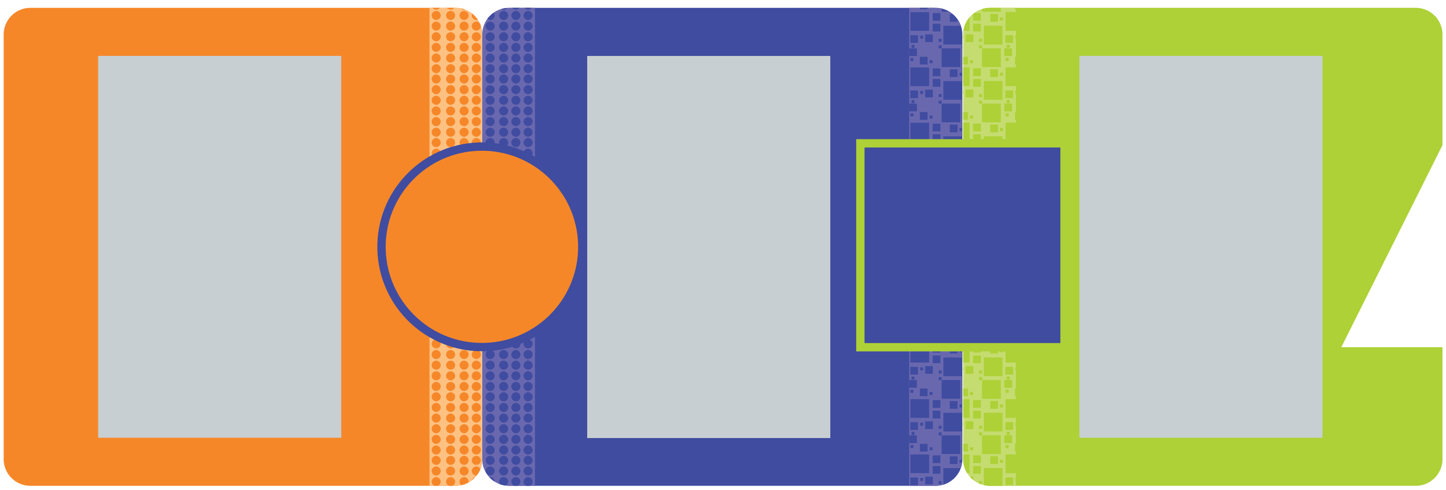


Figure 78. Color exploration of patterns.

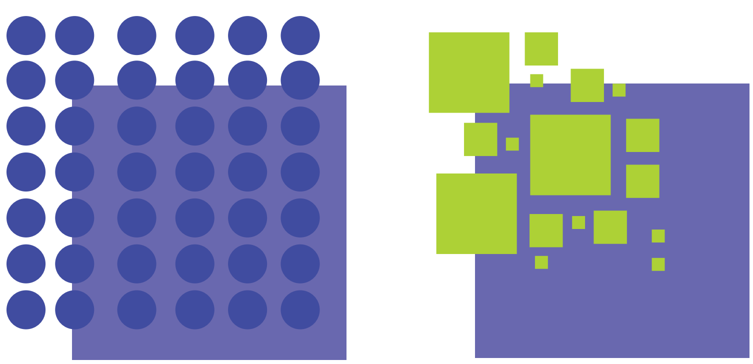


Figure 79. Color exploration of patterns.

Material

Initial concepts for material included wood and plastic. Wood was excluded because it would not be suitable for withstanding spills, possible chewing, or other rough handling.

Two plastics companies were consulted in choosing the desired material for the prototype. Some samples were deemed less favorable due to the weight of the material, durability, availability, or ability to be machined. One prototype was created in Sintra, a PVC plastic. This material is durable for rough handling, accepts paint, and cuts similar to wood. A second prototype was created with Renboard.

Figure 80. Representation of wood.

Figure 81. Representation of hard plastic.

Both protoypes were milled from a 3D modeling file (courtesy of Scott Lincoln and the Rapid Prototyping Center in DAAP) and then glued together. Pipe cement, specifically meant for PVC material, was used on the Sintra prototype.

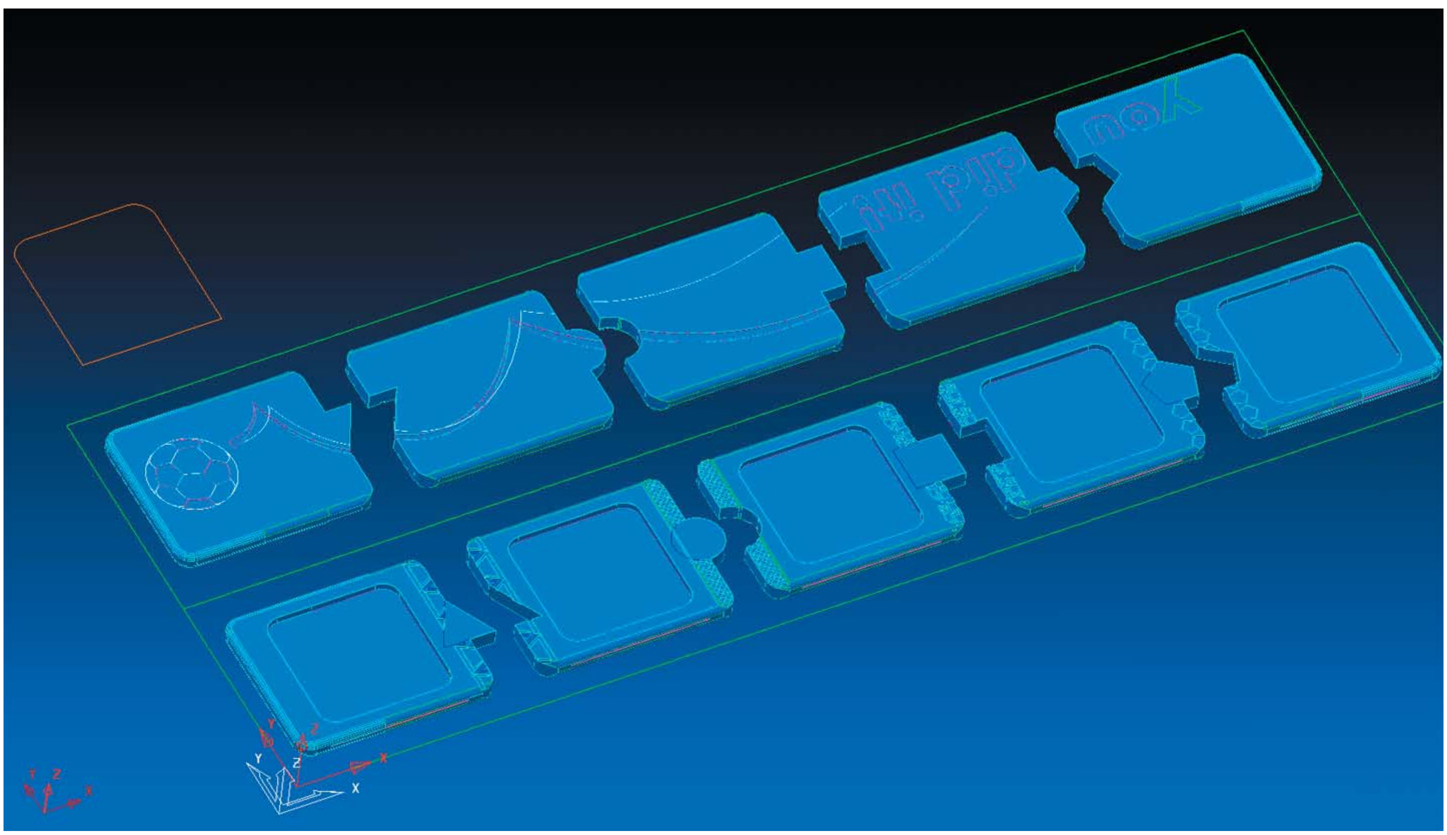


Figure 82. 3D modeling file, *Courtesy of Scott Lincoln, Rapid Prototyping Center, DAAP.*

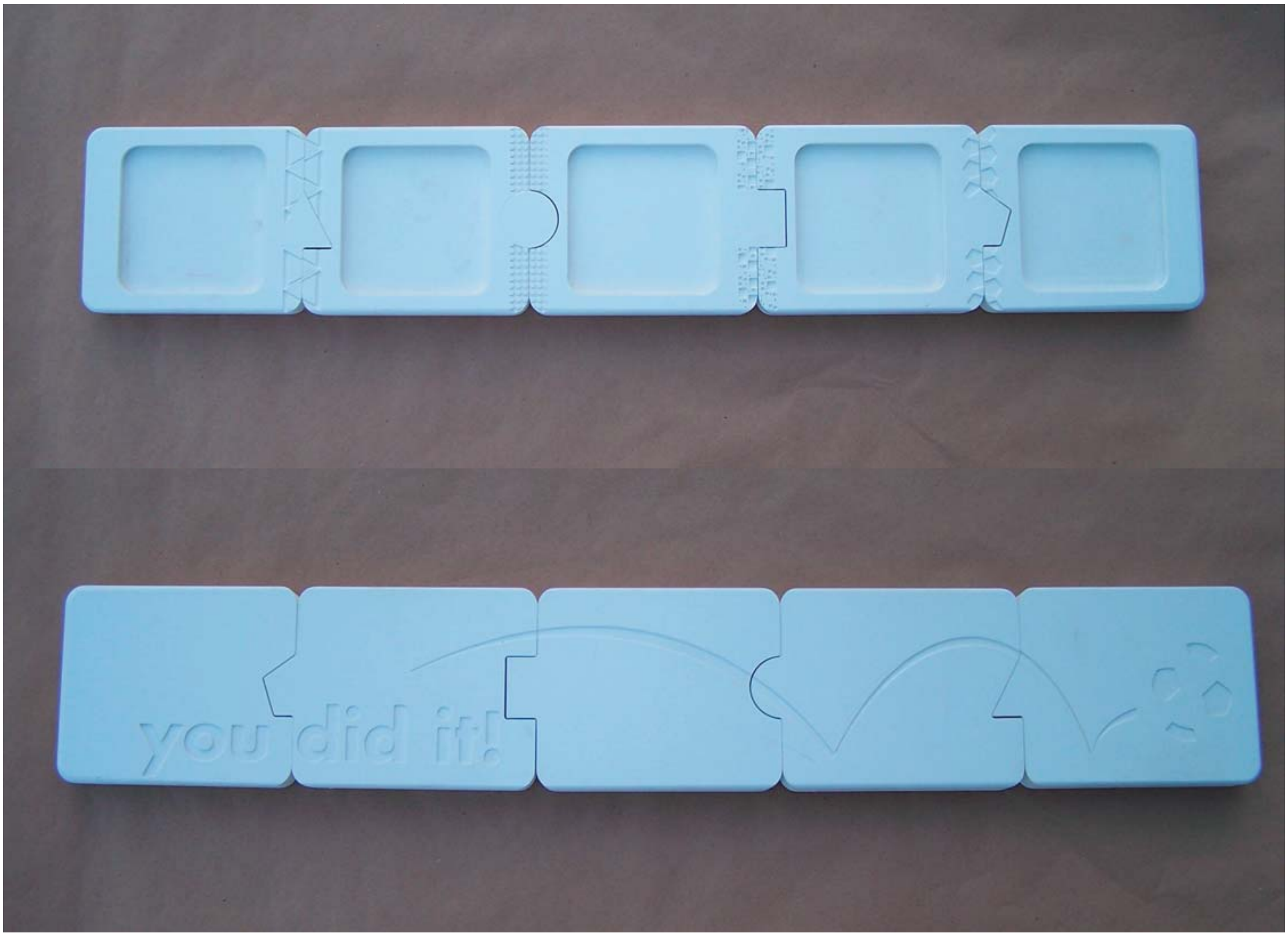


Figure 83. Assembled prototype, front and back view.

Figure 84.

Figure 86.

Figure 85.

Figure 84-87. Prototype, unpainted.

Figure 88. Prototype, back view, unpainted.

After being glued together, each piece was sanded and spray painted for.

Figure 89.

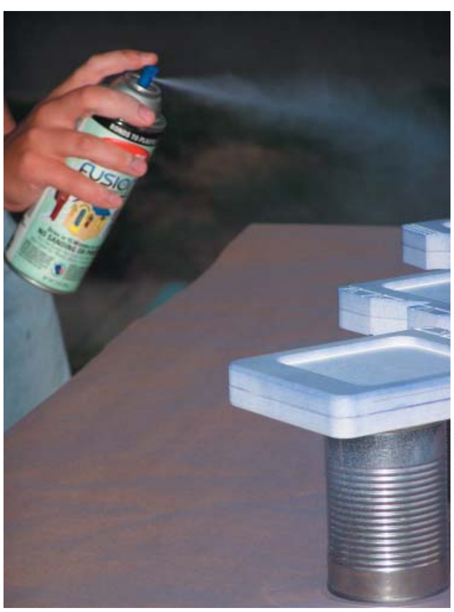


Figure 90.

Figure 89-91. Prototype construction.

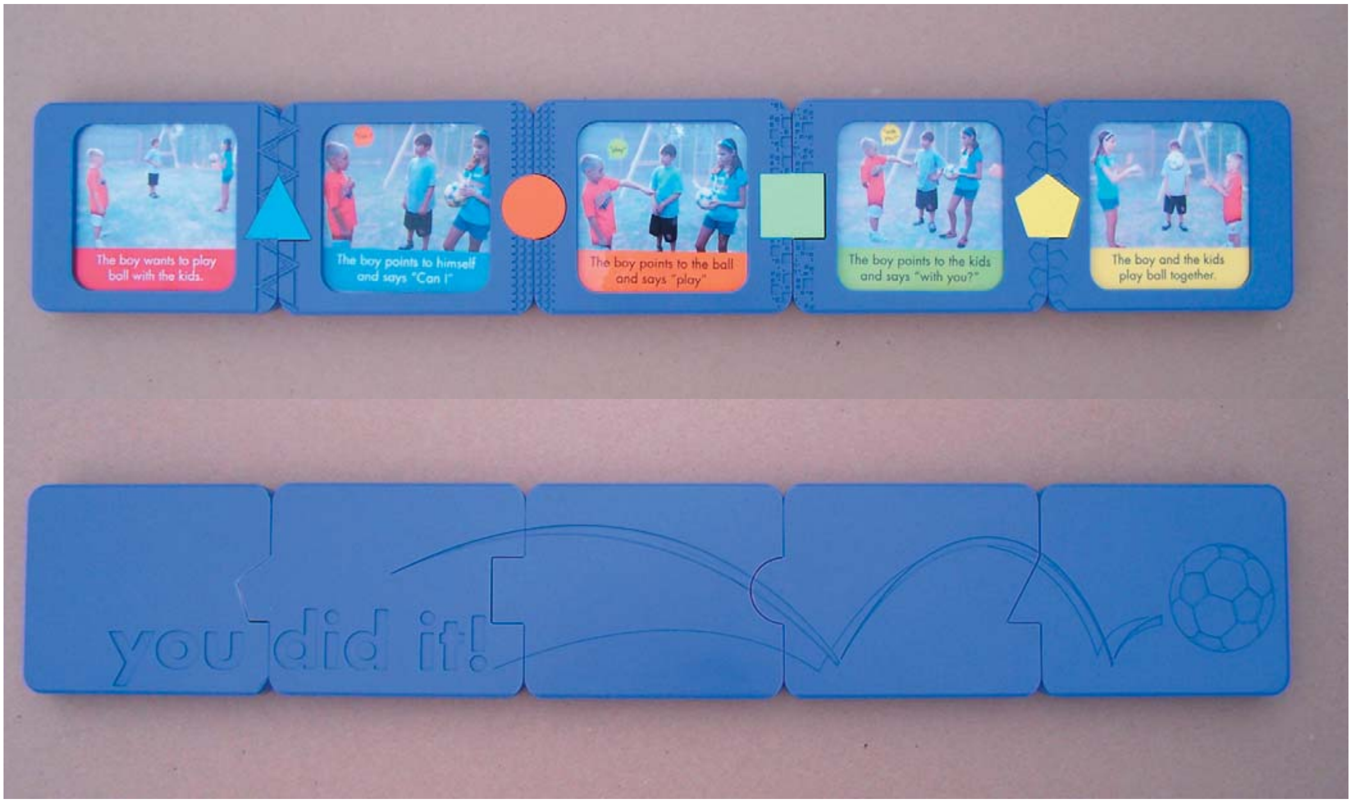


Figure 92. Prototype, painted.

Color

Different methods for color application were investigated.

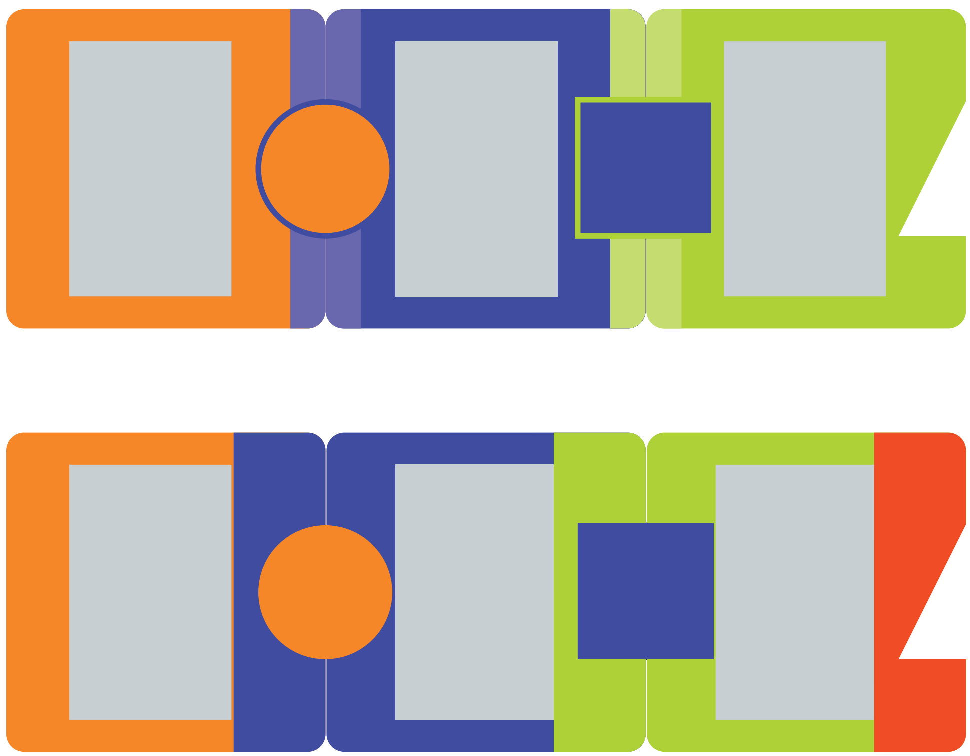


Figure 93. Color exploration.

Color *continued*

Various color palettes and applications were studied.

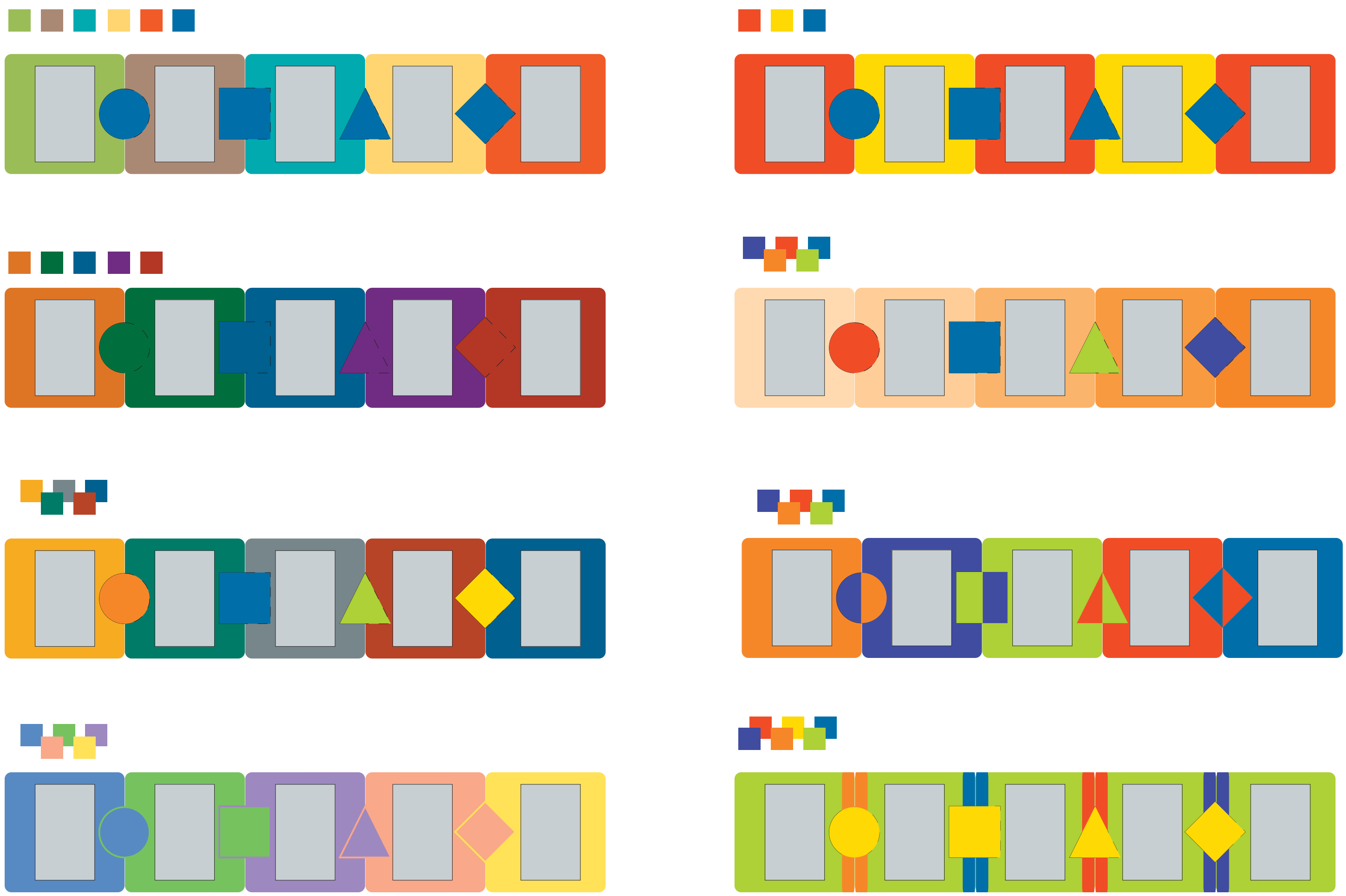


Figure 94. Color exploration (color palette and application).

Color *continued*

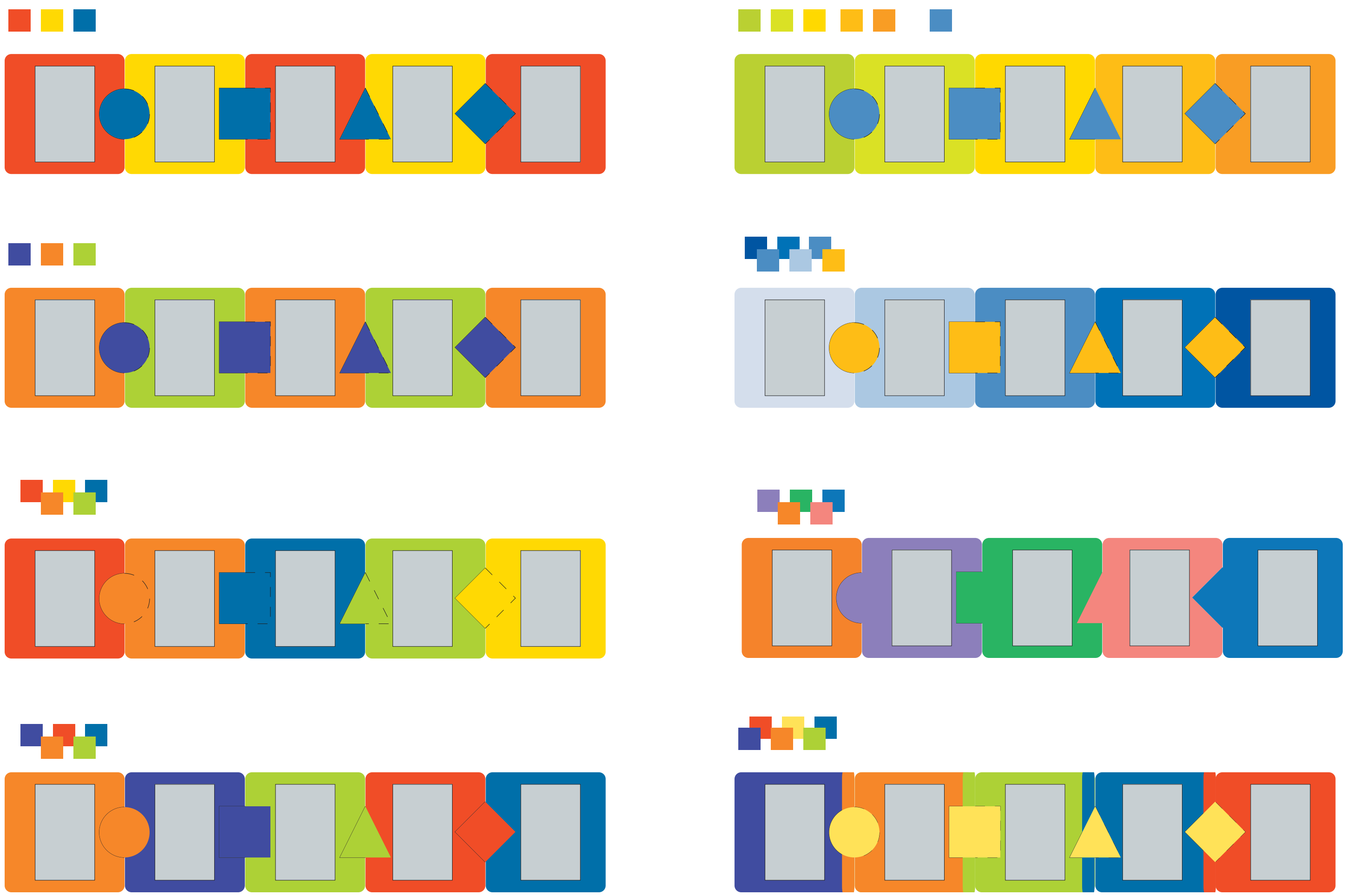


Figure 95. Color exploration (color palette and application).

Color *continued*

Figure 96 shows studies exploring temperature, tints and shades, saturation and value gradations. These studies looked at how temperature, value, and saturation could be used to communicate the sequence of steps in the puzzle.

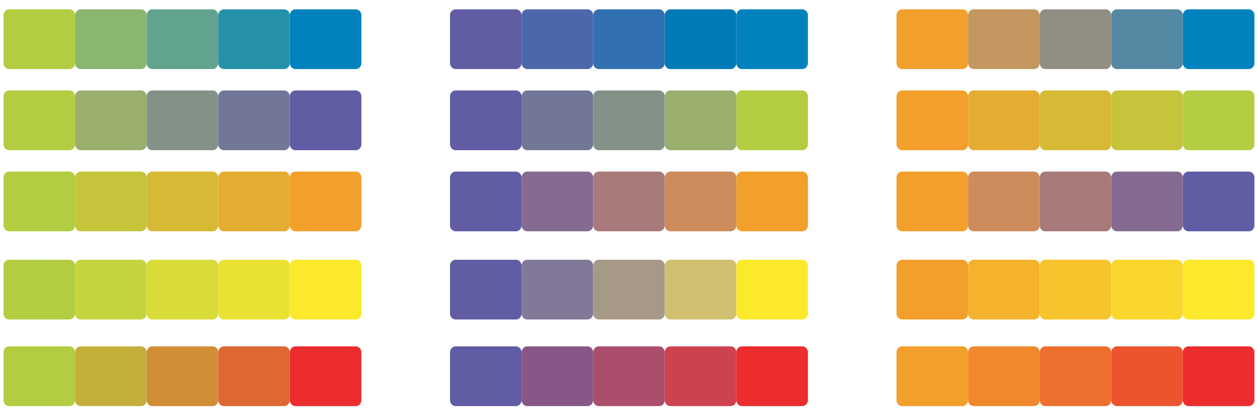


Figure 96. Temperature studies.

Color *continued*

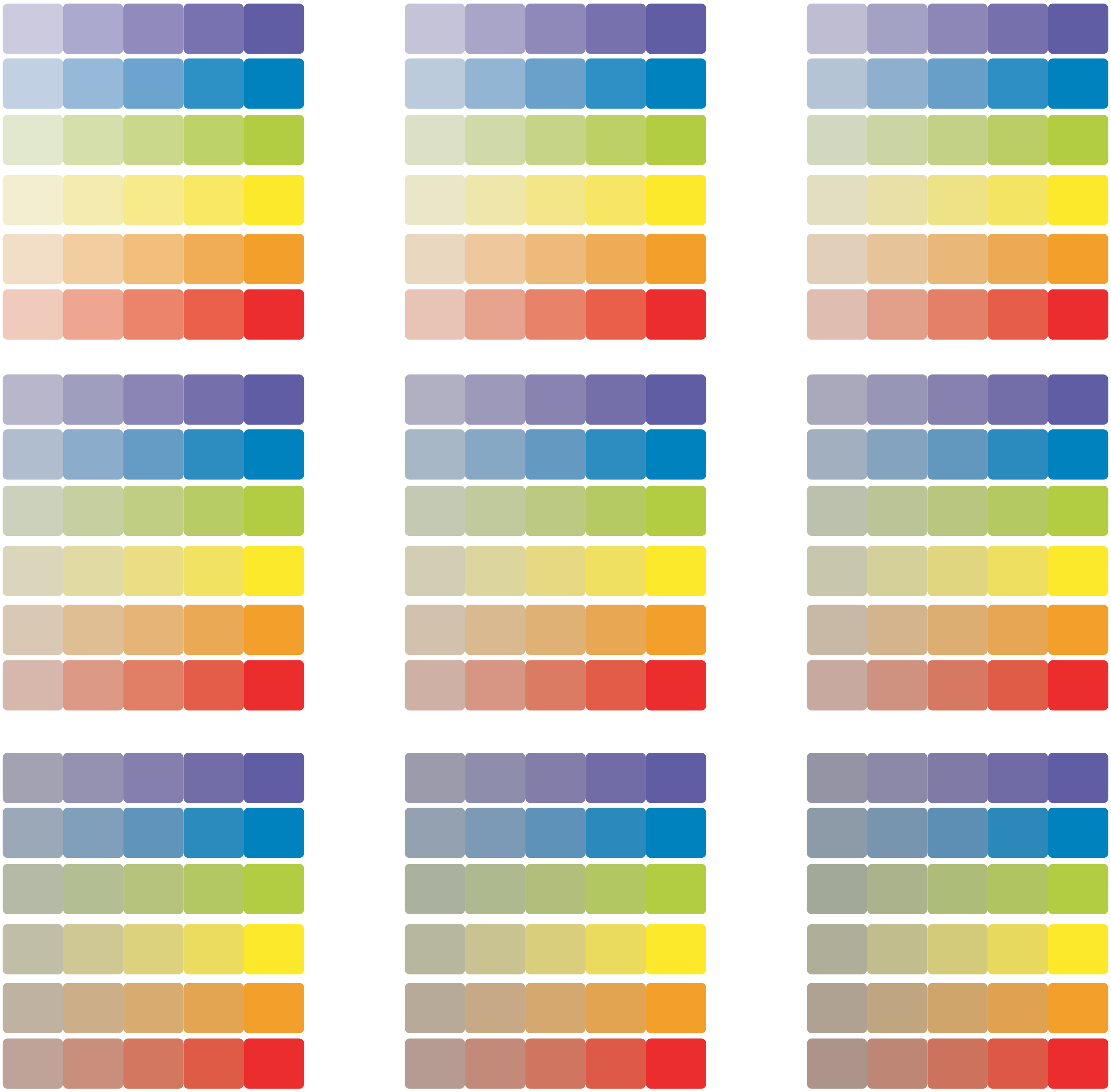


Figure 97. Saturation studies.

Color *continued*

Figure 98 shows studies in value. This investigation has led to an interest in exploring whether one reads from dark to light, or light to dark.

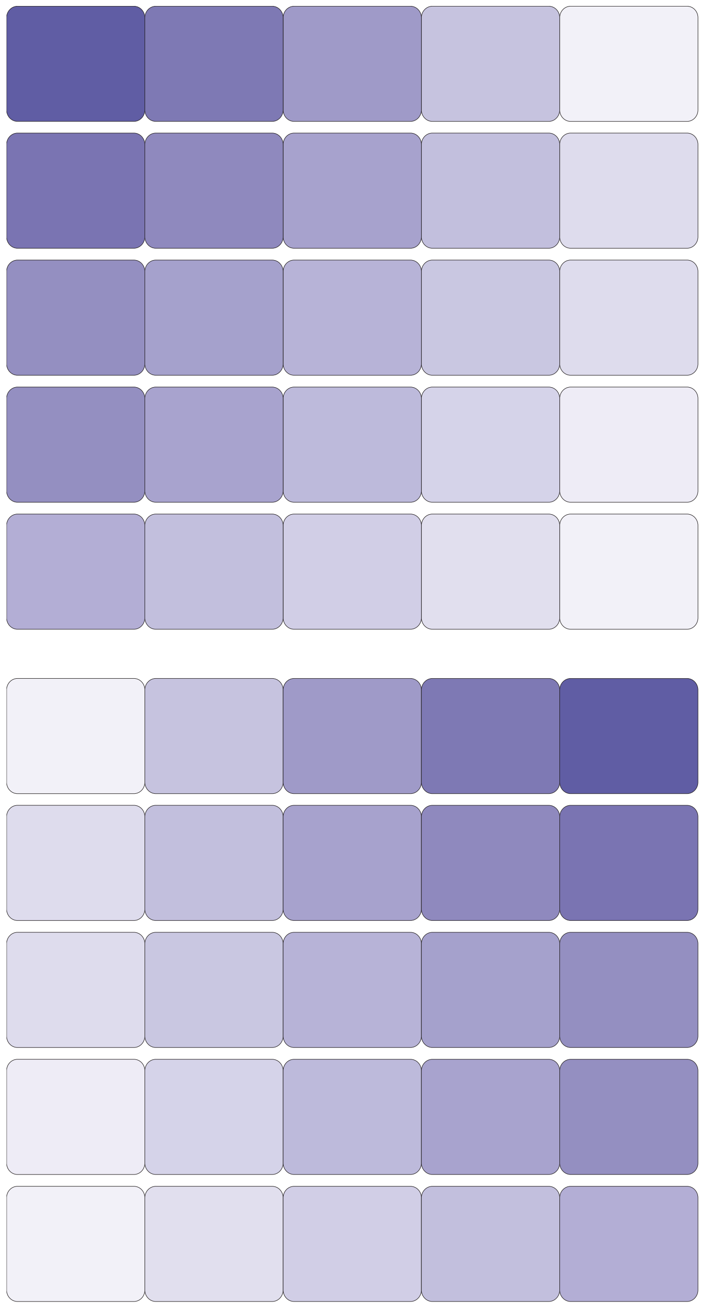


Figure 98. Value studies.

Color *continued*

Swatches were taken from saturation studies and further broken down by value. Below, each color represents the steps in the puzzle, with six different options for puzzle color. As each step of the sequence is pieced together, value increases. Although the final prototype was executed as a single value, further testing should be done to see if this color application would be effective. Testing should be done to see if value change would aid in successful completion, or hinder the user.

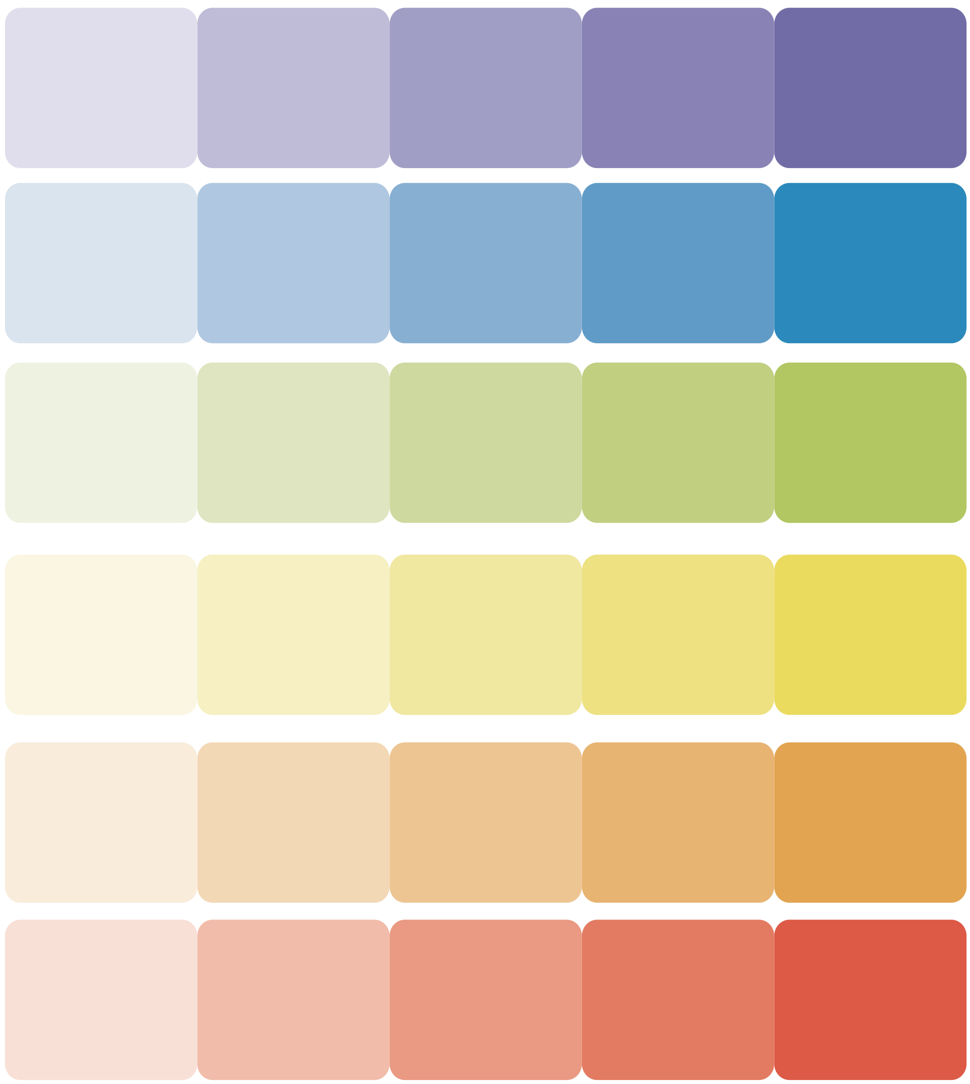


Figure 99. Value studies.

Photography *continued*

Different treatments to photography were investigated. Image treatments shown in Figure 100 explored isolation of the main activity or subject. These directions were concluded to be too distracting.

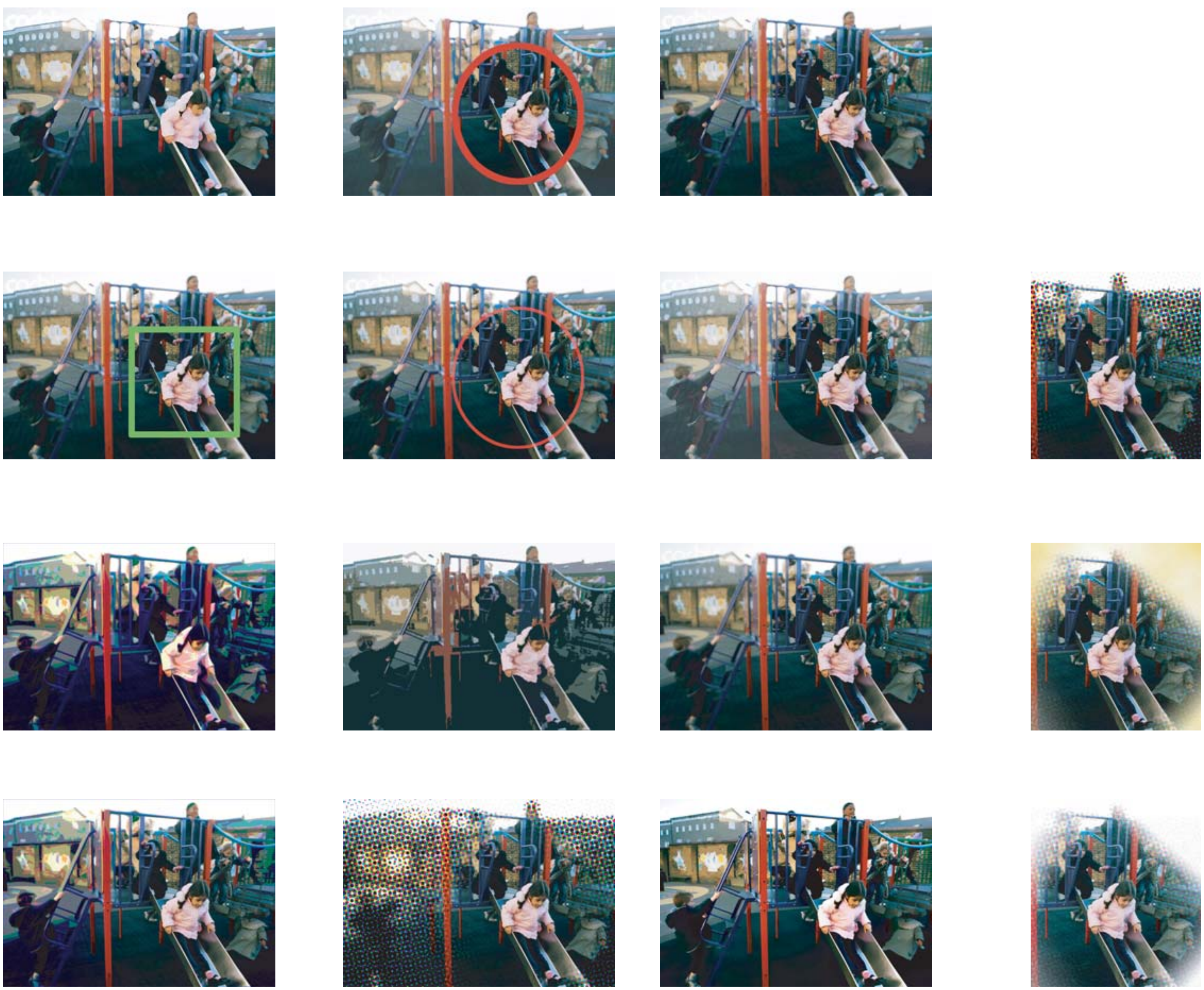


Figure 100. Photo treatment variations.

Photography *continued*

Studies also looked at illustrative effects. Currently, this direction was eliminated due to the irregular shapes that resulted. These shapes— highlights on the boy's face— were potentially distracting. This however, may provide an opportunity for future research. It would be worthwhile to explore and compare the effectiveness of realistic photograph, illustration, and a hybrid of the two.

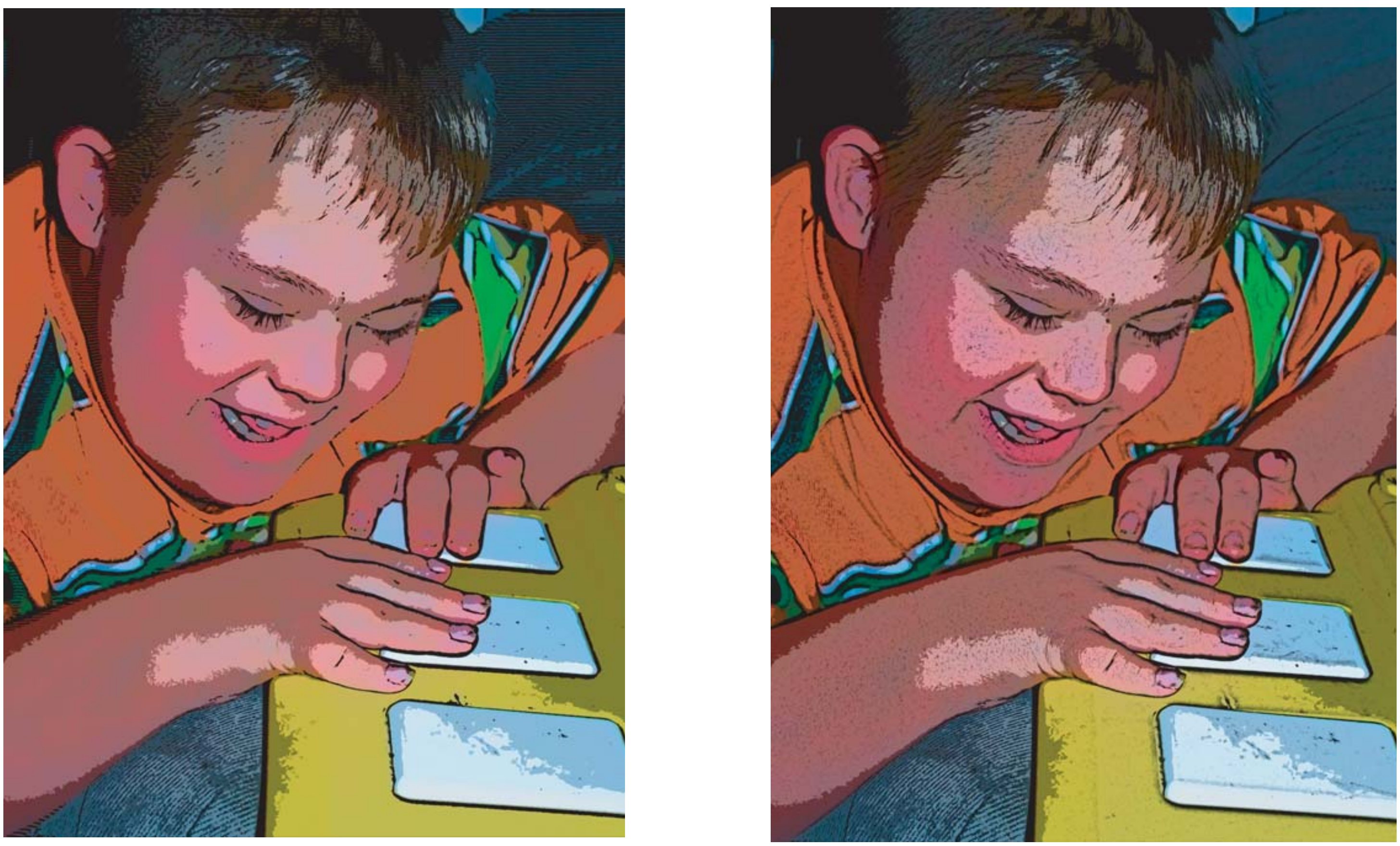


Figure 101. Illustrative effects.

Photography *continued*

Studies were done to reduce the amount of background discrimination required by the user.

Figure 102. Raw image.

Figure 103. Background with translucent color.

Figure 104. Color background.

Figure 105. Characters on faded background.

Text

Initially, two type sizes were chosen— the larger of the sizes were used to call out important words in the script, less important words were set in the smaller size. Words were classified as important if they referred to a verbal or gestural action. This was intended to allow the user to scan the text easily. Conversely, it proved to be a source of distraction during testing. The smaller size also inhibited readability.

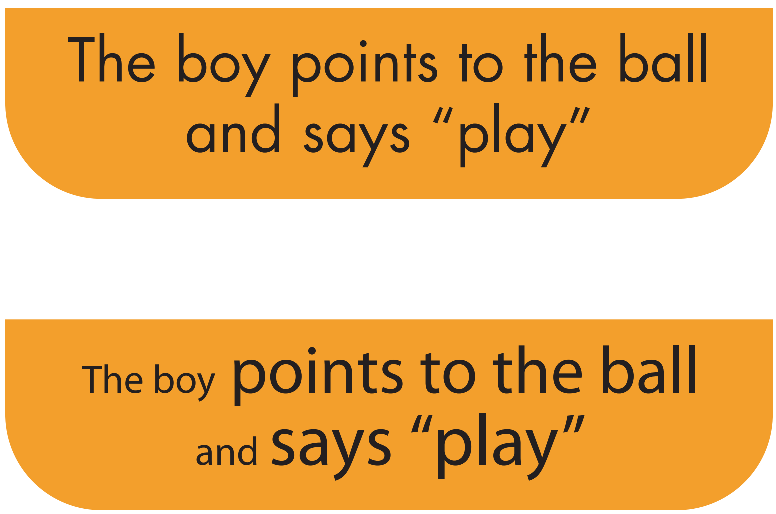


Figure 106. Type exploration.

Image Cards

Several variations were done on the image card layout.

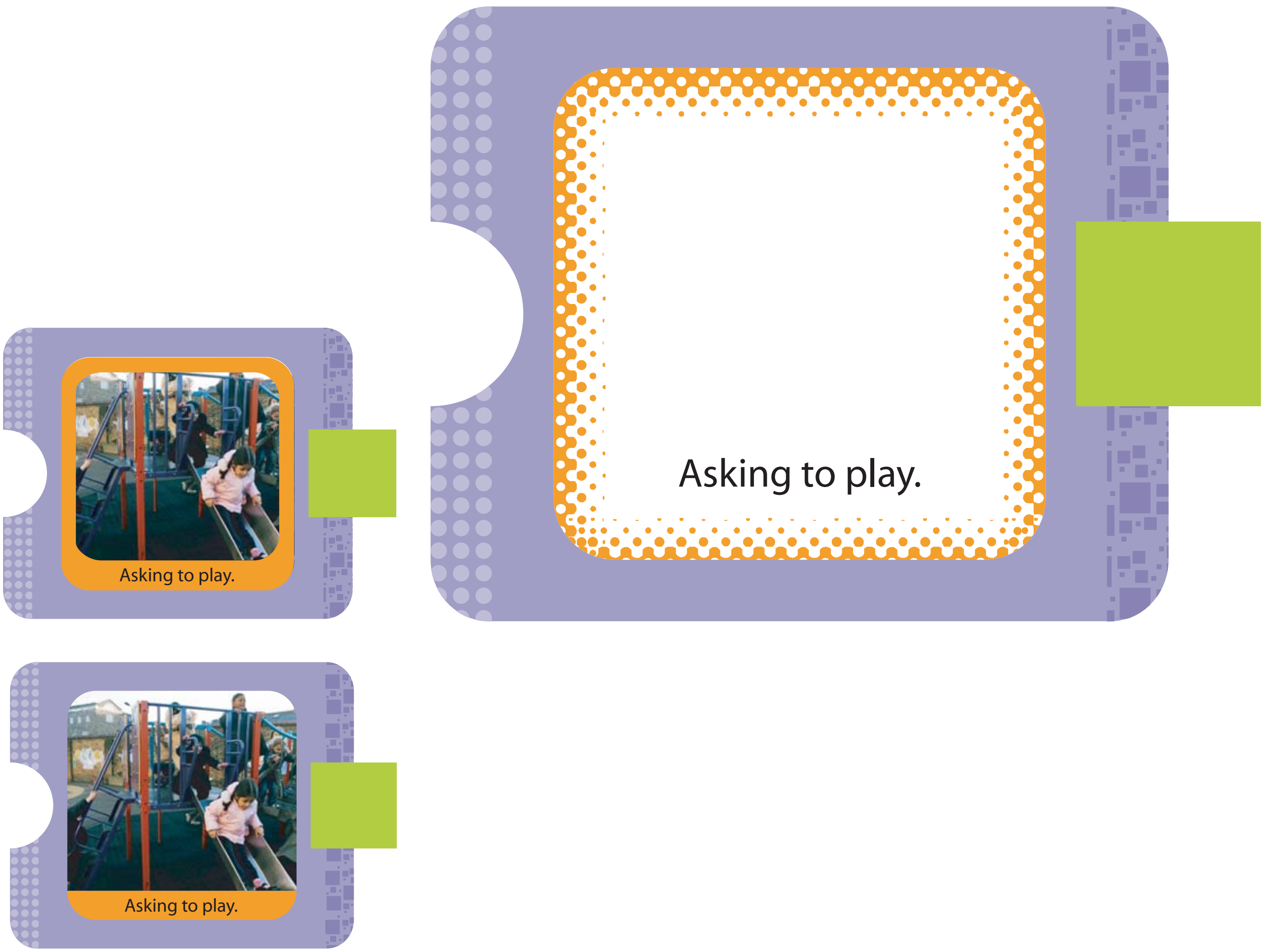


Figure 107. Image card layout exploration.

Image Cards *continued*

Figure 108. Image card layout exploration.

Image Cards *continued*

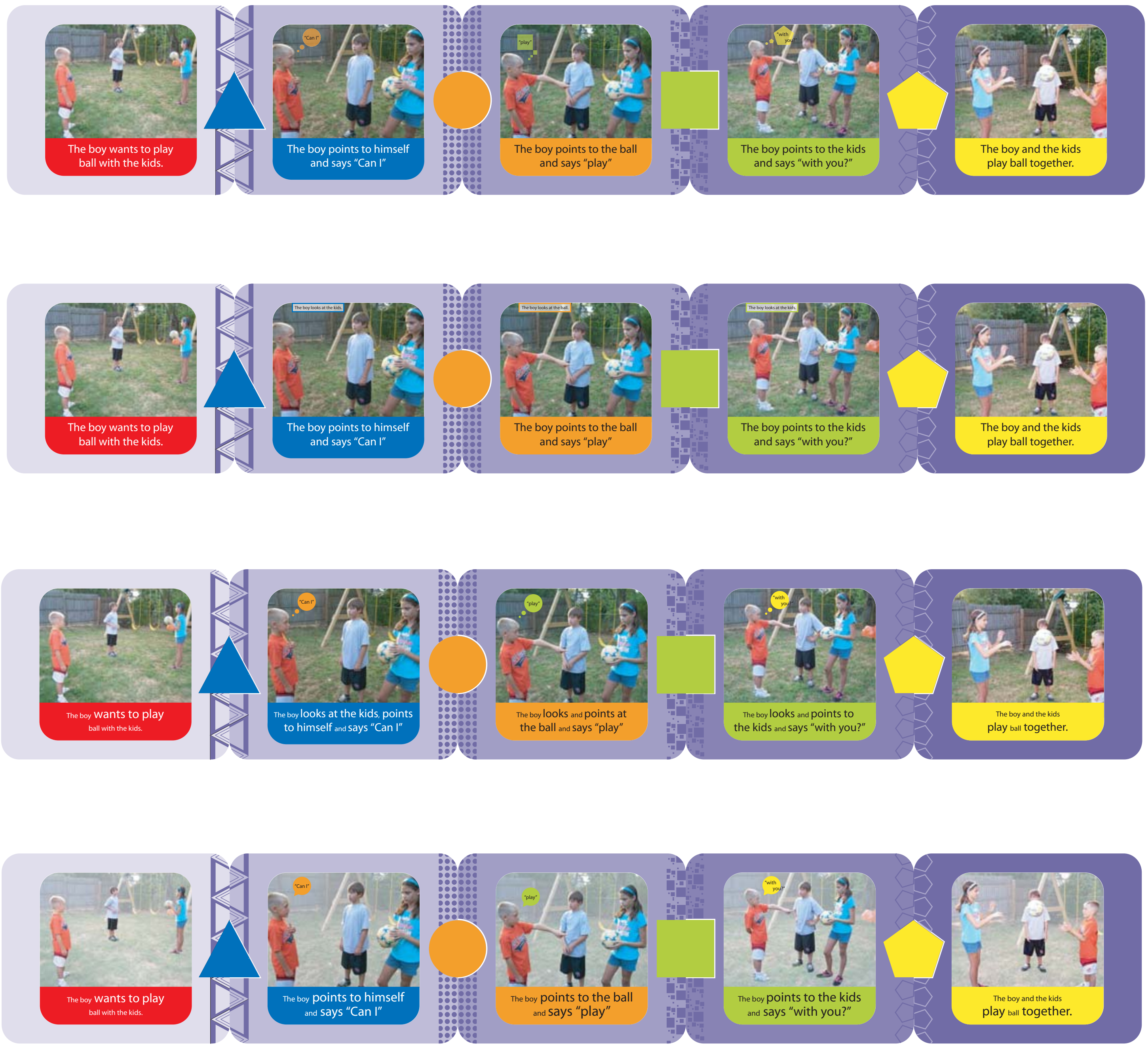


Figure 109. Image card layout exploration.

A Task Analysis was done early on to help identify the specific steps that one goes through when asking to play. Because of the combination of verbal and gestural modalities, the language supporting the imagery must also describe the non-verbal action. Two options are shown below. The first option references eye contact. In this option, the text became too lengthy and risked losing the attention of the user.

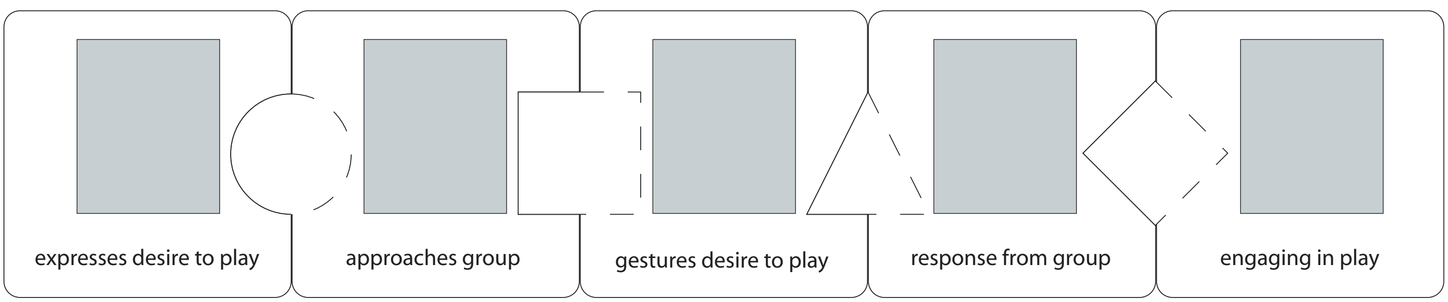


Figure 110. Storyboard.

The boy looks and points to the kids and says "with you?"

The boy points to the kids and says "with you?"

Figure 111. Story variation.

Testing was done on the puzzle at the Miami Valley Down Syndrome Association's (MVDSA) annual Buddy Walk. These events are held all over the country and help to raise funds, promote awareness and education, and advocate inclusion for individuals with DS.

MVDSA provided a table labeled with my name for the puzzle to be displayed. Through a brief interview, I was able to inform attendees about the project, its purpose, and encourage them to visit the table, interact with the puzzle, and offer feedback.

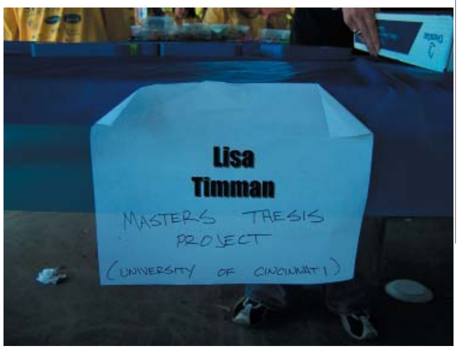


Figure 112. Table identification.

Figure 113. MVDSA logos.

Figure 114. Presenting puzzle at annual MVDSA Buddy Walk.

Figure 115. Annual MVDSA Buddy Walk, 2007.

Figure 116. Annual MVDSA Buddy Walk, 2007.

Figure 117. Annual MVDSA Buddy Walk, 2007.

Figure 118. Annual MVDSA Buddy Walk, 2007.

Figure 119. Annual MVDSA Buddy Walk, 2007.

Figure 120. Annual MVDSA Buddy Walk, 2007.

Getting feedback was incorporated into a scavenger hunt, organized by MVDSA. My station was designated as one of the stops, where children could collect an object from a list of required items. Children participating in the scavenger hunt were required to stop at my table and participate by assembling the puzzle, answering questions, and giving feedback. These children were then given a cardboard puzzle piece in return, helping to complete their list. The scavenger hunt helped to draw children over to the table.

Figure 121. Participants in scavenger hunt.

Figure 122. Scavenger hunt participants providing feedback.

In addition to children participating in the scavenger hunt, parents, teachers, and professionals inquired about project details and evaluated the puzzle.

Figure 123. Parent inquiring about puzzle.

Figure 124. Parent inquiring about puzzle.

Both children with DS, as well as typically developing children were observed manipulating the puzzle.

Figure 125. Buddy Walk observations.

Figure 126. Buddy Walk observations.

Figure 127. Buddy Walk observations.

Figure 128. Buddy Walk observations.

Figure 129. Buddy Walk observations.

Figure 130. Buddy Walk observations.

Figure 131. Buddy Walk observations.

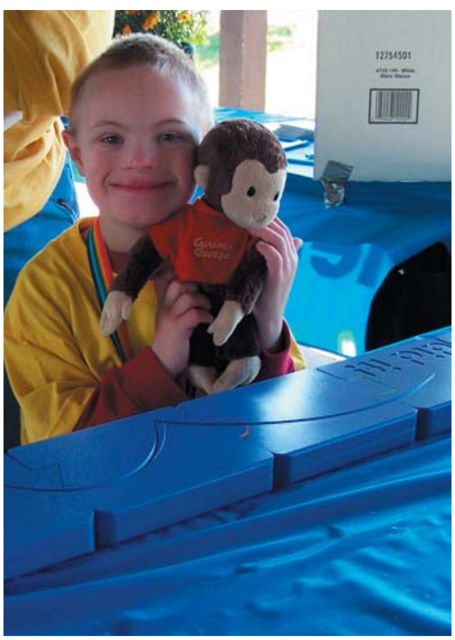


Figure 132. Buddy Walk observations.

Figure 133. Buddy Walk observations.

Feedback was attained in several ways. An audio recording documented reactions from children, parents, and professionals. The tape was then reviewed at a later time and compared against written notes for accuracy and completeness.

With assistance, notes were taken during discussions with parents, children, and professionals. A form was completed either by myself or the person assisting me, identifying the person giving feedback, their reactions, and our observations. It was first identified if the participant was a child, parent/family member, teacher, or professional. The form for each child was marked as DS, if the child had Down syndrome, or TD if the child was typically developing. The age of each child was also recorded.

Figure 134. Buddy Walk observations.

The form provided a list of topics to consider during observations, as well as a section to make miscellaneous notes. The form served as a guide for asking questions and identifying areas to observe. Some questions that needed to be answered through observation included: Is the design simple and intuitive? Does the design accommodate a wide range of abilities? Does the design minimize unintended actions?

Children were observed manipulating the puzzle, how they held or moved the pieces, as well as different techniques they used to assemble and successfully sequence the pieces. Notes were also made about the child's ability to understand the visuals, read accompanying text, and their general comprehension of the story. The child's level of interest was recorded and their reactions from initial contact through puzzle completion were noted. The overall user experience was observed (Did the child find the activity enjoying?).

Figure 135. Buddy Walk observations.

In addition to observations, questions were posed to both children and parents/professionals. Children were sometimes asked how they knew certain pieces went together. Children were also asked to talk about the story. Parents and teachers were asked how they might use this puzzle, and in what environment. They were asked to identify aspects that they anticipated being a source of frustration or confusion for their child. The following section details these findings.

Key Findings

Both parents and teachers endorsed the puzzle and expressed that it would be beneficial for their child or students. One parent related to the social challenge depicted and expressed that her child does not initiate play and does not verbalize. In a case where a child was viewed as having strong social skills, the child was also assessed as having strong verbal skills. This may suggest a link between verbal and social skills.

Parents who felt that initiating play was not an issue for their child, did agree that the puzzle could be used to teach other social skills or be used for other learning purposes. One parent suggested that it would be good for teaching a child to read, because of the emphasis on sequence. This showed that these parents recognized the usefulness of the image slot and ability to remove and exchange pictures.

A teacher viewing the puzzle stated that parents or teachers could use *Go Talk* software to adapt or personalize the images. There are similar softwares, such as *Boardmaker*, that allow parents, teachers, and professionals to create personalized images and text with a sufficient amount of control. These programs are likely to be familiar and available to the parent/teacher, allowing them to adapt the puzzle with little effort or cost. The opportunity to replace and customize images broadens the usability and effectiveness of the puzzle.

A teacher, along with another, who both work with children with Autism, were very enthusiastic about the project. They felt that the puzzle would work great for the kids that they teach, who generally have multiple learning problems. One teacher said, “I would *love* to have this in my classroom.” A teacher from Dayton Public Schools stated that she would like to use this puzzle to help with transitioning a child from one activity to another, especially transitioning between classes, or to lay out the day’s activities. She believed that using the puzzle for these purposes would decrease tantrums in her classroom.

One teacher also stated that the colors were very appealing and he thought children would genuinely enjoy working with this. He agreed that the functionality was simple and intuitive and that the color-coding, shapes, and tactile patterns contributed to this.

Key Findings *continued*

Positive feedback was also given regarding the use of a puzzle to tell the story. A typically developing teen-ager commented that the puzzle was a good idea for young children because it would be familiar to the child. A parent commented that it was a good idea because her child “likes to put stuff together.” She also stated that it uses “something they understand and like to play with.”

The puzzle attracted children from a distance and held their attention after approaching the table. This suggested to me that the colors appealed to the audience, and that they found the puzzle engaging. Some children stated explicitly that they liked the colors. One child was observed putting the puzzle together several times and following the story along with his finger.

The puzzle appeared to be simple and intuitive for children, while still providing enough of a challenge to be engaging. Some children expressed that the puzzle was “too easy,” however; these children were typically developing and older than the target age range.

One child spotted the orange circle right away, and located the other orange piece for a successful match. Another child discovered the use of color and stated, “I see what you are doing,” and subsequently identified all of the matching parts. It was also observed that parents were aware of color coding and would ask the child, for example, “What color is this? Do you see the other blue piece?” After this prompt, one child then relied more heavily on color to match the remaining pieces. Children seemed, though, to generally rely on the shape to help them match pieces together. When asked how they knew a certain piece went with another, one child responded that it was the shape.

Figure 136. Buddy Walk observations.

Key Findings *continued*

Figure 137. Buddy Walk observations.

It was interesting to note that there was a tendency for typically developing children to not be as aware of the tactile element as the children with DS, until it was pointed out to them. One child with DS continuously felt the surface, and would slide his hands over the textures repeatedly. A young gril with DS used her entire hand to explore the tactile surface. This reinforces the design objective to make the puzzle multi-sensory and include a tactile component. Several children would touch the images as they read and outlined the image window slot with their finger. It was also common for children of reading age to use their finger to follow each word as they read. This may provide an area for more design investigation, where the tactility of the text is considered.

Figure 138. Buddy Walk observations.

Key Findings *continued*

The size of each piece proved to be effective. The visuals and text were legible, while allowing children to comfortably handle the pieces. The overall width of the puzzle also seemed to be a good fit. One child would put his hand at each end of the assembled puzzle, revealing that it fit comfortably within his arm-span. This also demonstrated that the assembled puzzle could work in multiple environments, including the table-top or the floor. The majority of the children were observed sliding the pieces together, though some lifted them and set them in the correct position. Both methods seemed to be achieved with ease and little physical effort required, allowing equal access and accomodating a wide range of abilities.

Frustration was not observed during testing; however, after several failed attempts in matching the pentagon, one child began to lose interest. It was noted that other children required several attempts at matching the pentagon. This was concluded to be a possible source of confusion. The types of shapes, and their color application should be investigated further, as a result. Most children were able to successfully assemble the puzzle with a minimal amount of scaffolds.

Figure 139. Inspirational message.

Several children exclaimed, “I did it!” after successfully completing the puzzle. The expression and smile on their face showed that they were proud of this accomplishment. This is important to note because the puzzle should create a pleasant and positive environment for learning. It should also aid in building the child’s confidence. The inspirational message on the back was intended to recognize and affirm the child’s accomplishment with a positive feedback message. On several occasions, the back of the puzzle served as a nice surprise for the user. Children became delighted when they read the words “You did it!” etched into the surface. The child completed the puzzle and was rewarded with positive feedback.

Key Findings *continued*

An unexpected use of the puzzle came from a seven year old boy with DS. After assembling the puzzle several times and reading through the story, the boy began to stack the puzzle pieces like blocks. This was a surprising, but welcome use of the puzzle. The size, thickness, and material contributes to the puzzle pieces feeling toy-like. It should be considered whether this treatment of the puzzle can be reinforced as a secondary use. Block playing has tremendous benefits, including the development of mathematical skills. Although it is assumed that the puzzle will generally lay flat on the table, it was intended to be capable of standing up vertically. The action was also observed.

Figure 141. Puzzle standing vertically.

Figure 142. Puzzle standing vertically.

Figure 140. Puzzle pieces stacked.

Key Findings *continued*

After piecing together the puzzle, children immediately recognized and seemed interested in the story. Their responses showed that they understood the content and communication was clear. It was sometimes offered up by the child that they liked the images, a particular image, or subject within the image. For example, one child with DS mentioned that his favorite part of the entire puzzle was the 'girl in the picture'. His reaction to the pictures, along with others, suggest that the photography treatment may have aided in successful discrimination between figure from ground.

It was interesting that several children (both with DS and typically developing) pointed out that they "liked the story." When asked why, the common answer was that they liked that the children were all playing together, or they liked that the other children "let the boy play." I found this interesting because it suggests to me that children naturally want to include and be included. Inclusion, as it turns out, may be a concern we can all relate to.

Figure 143. Buddy Walk observations.

Figure 144 shows the resolution to each Universal Design Principle.

Universal Design Principle	*Explanation of Principle*	*Explanation of Resolution*
Equitable Use	Design allows users equal access, avoids segregating or stigmatizing anyone.	Does not require lifting (lmt); easy to slide in place; utilizes visual and tactile to engage a diverse group
Flexibility in Use	Accommodates a wide range of individual preferences and abilities	Connection mechanism accommodates physical and sensorimotor preferences; visual, tactile and text appeal to multiple intelligences, varied pace, multiple options for sequencing: color, shape, texture/ pattern, content. Can be used with parents/teachers; can be used as instructional or for assessment.
Simple and Intuitive	The design is easy to understand.	Color, shape, and texture/pattern reinforce connections and sequencing; images pop from background requiring less image/ ground discrimination.
Perceptible Information	The design communicates information effectively through different modes— pictorial, tactile, and verbal, and regardless of sensory abilities.	Primary visual component; text; texture/pattern; follow-up practical application involving verbal instruction and role-playng.
Tolerance for Error	Design minimizes hazards and adverse consequences of accidental and unintentional actions	Connections are loose fitting to slide easily in place; shapes are distinguishable; color and texture reinforce shape connections.
Low Physical Effort	Design can be used efficiently and comfortably and with a minimum of fatigue.	No lifting required— pieces slide into place; type selection, size, and photo treatment aid in legibility of text and images.
Size and Space for Approach and Use	Size and space is appropriate for approach, reach, manipulation and use, regardless of user's body size, posture, or mobility.	individual pieces are sized for comfortable use in target hand-size and manipulation; Puzzle span upon completion allows user to use on a table-top or on the floor.

Figure 144. Design resolution to Universal Design Principles.

A limitation of this project is the limited sample from which initial feedback was attained. Of the members initially contacted from DSAGC and MVDSA, approximately 15 families from MVDSA participated. More in depth questions and discussions took place with four of those families. Because of this, more feedback from a diverse demographic would be ideal.

Testing of the puzzle provided tremendous insight into the design, usability, and applicability, although the circumstances did not reflect the intended environment. The intended use of the puzzle is in a comfortable setting— likely in the child's home or classroom, and on the table or floor. There would also be a facilitator that would engage in a discussion of the steps and the act of asking to play. This activity would likely take place without the pressure of observers.

An important aspect to the content of the image cards is the emphasis on dual modality. Demonstrating the child gesturing while he speaks uses an alternative mode of communication to augment verbal communication. Further research in the area of augmentative communication and combining modalities is necessary to illustrate an authentic sequence of images. In addition, photography should be carefully selected or shot in order for the communication of the gesturing or actions of the character to be clear.

While this project focused on the characteristics and needs of children with Down syndrome, the results could be beneficial to a variety of disabilities. Research should be done in this area to extend the application to individuals with diverse abilities and multiple intelligences.

In addition to asking to play, this educational toy could be expanded to incorporate various social skills, to address desired or undesired behavior, or to teach a concept that is sequential, such as learning to read.

Because the follow-up practice component is essential to the solution, more follow up applications and activities should be designed to provide the user with many options and suggestions for use.

The material chosen for the product should be durable, safe for the child, and sustainable to the environment. Further research should be done in this area to address these issues.

The solution for this project is considered to be low technology. The benefits of low technology include portability, durability, low cost, and intuitiveness. The incorporation of high technology, however, may provide an opportunity to reinforce learning. For example, integrating a voice recording option could allow parents, teachers, or children to record a short 3-5 second phrase on each piece where the child could receive audio output. This would appeal to a broader group of individuals.

When I first entered into the program, there were some topics of interest to me that had the potential to become my focus in thesis research. From early on, I was interested in how design could benefit individuals with disabilities. I was also interested in design's role in education.

I was having difficulty narrowing my topics— so many things interested me. My ideas were too broad and I needed to focus. The advice I received from Robert Probst was to make my thesis meaningful to me— to find a way to relate it back to what is important to me.

To put things into context, when I began this project I was a new mom preoccupied by this tiny person, a human sponge. I was fascinated with watching her play— and *learning through play*, developing, and changing everyday. It would have been near impossible to not let this influence my direction. I began looking at my topic from a new perspective. I began to focus on inclusion during play.

The research stage was a great learning experience for me. I rediscovered how important it is for a designer to listen. I brainstormed ideas for research that focused around play, but it wasn't until I listened to what the parents had to say that I really understood what the challenges were. Scholarly research and first-hand feedback from parents seemed to feed off of each other. Findings from the research presented me with a unique challenge. Design is about problem solving. Although at times, this stage was frustrating— the process was very exciting to me.

There were several instances during the course of study where I left my comfort zone. This first occurred when I reached out to the medical community. It is easy to get used to working alongside designers and creatives who seem to share a common language, so working with other disciplines can initially seem intimidating. But in order for my design solution to be authentic and functional, I needed feedback from professionals specializing in the area of Down syndrome and speech pathology. Working with individuals outside the realm of design provided a unique perspective, incredible insight, and a well-rounded solution. I feel very strongly that the authenticity of my project is the result of interdisciplinary collaboration. It was rewarding to connect to the larger community, while working towards a common goal.

Finding safety in what is familiar also proved to be true within DAAP's college walls. As a graphic designer I traditionally work two-dimensionally. So naturally when my proposed solution began to take on a three-dimensional form, I became uncomfortable. I found graphic design merging with industrial design. Working through that, extending myself, and reaching out to people with diverse experiences, allowed me to grow and develop into a better designer. This widened the possibilities and the creative solution was enhanced because of it.

One of the highlights of this experience was being able to test my design at the annual Buddy Walk— observing children engaging the puzzle that I designed. The observations and feedback from parents, children, and professionals was a culminating experience that rounded off earlier stages of research and design.

As a mother, I watch my children on a daily basis take risks and leave their comfort zone. I realize that this is necessary for them to grow, to learn, and to master one task so that they can move on to the next. I quote the Greek philosopher, Plutarch, in my acknowledgements, "The mind is not a vessel to be filled but a fire to be kindled." My graduate studies have sparked new ideas, new possibilities. I look forward to what challenges and opportunities lay ahead.

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