VISUAL REPRESENTATIONS IN AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC):

AN EYE TRACKING STUDY TO EXPLORE INFLUENCES OF ABSTRACTION, REALISM, AND FAMILIARITY ON THE GAZE PATTERNS OF A PERSON WITH ANGELMAN SYNDROME WHO USES AAC TECHNOLOGIES AND IMPLICATIONS FOR RESEARCH AND THE ART CLASSROOM

by

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People who are non-verbal and have intellectual disabilities often use augmentative and alternative communication (AAC) technologies to have a voice, but are often left out of decisions about how their language is represented visually and how its lexical symbols are organized. The gap between designing effective images as part of a visual language expands as many images designated for use on AAC technologies are based upon assumptions of what is appropriate and effective. This eye tracking study explores the effects of images with varying levels of familiarity, abstraction, and realism, and how these factors affect the gaze patterns of someone with Angelman syndrome and is also an emerging communicator. Results revealed evidence to support Kress and van Leewen's theories describing how salience and vectors, when employed in images, influence ways of looking and the reading of images. Further exploration into how visual elements can direct the gaze and potentially create more effective visual

language representations could inform educational and research practices to allow people without a voice to become more active agents in their lives, communities, and discourses.

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CHAPTER ONE

Introduction

The ability to speak one's thoughts, opinions, desires, and needs is an essential part of connecting and interacting with people, however some populations of people lack a voice of their own. For some people, their only accessible methods of communication is reduced to unarticulated gestures and vocal noises. People who are non-verbal and have complex disabilities and communication needs, the access to communication tools is vital to their personhood, because having voice means one has agency, or the ability to consciously act within one's environments. Augmentative and alternative communication (AAC) AAC tools and devices are meant to enable one to express their identity; broaden and deepen connections with people, their community, and society; realize and participate in societal and community roles; and most importantly to help the person overcome communication barriers (Blackstone, Williams, & Wilkins, 2007, p. 199). Non-verbal refers to people who are unable to speak, sometimes linked with particular disabilities or injuries. Complex communication needs is a much broader term that describes someone who uses AAC and have diverse communication needs; however, the field of AAC research claims this "umbrella term" does nothing to describe the level of need or interventions (Alant, Bornman, & Lloyd, 2006, p. 144).

The images purposed for use on AAC devices must provide individuals tools to expand their language skills and claim their voice. As seen in Figure 1, AAC device span from high-tech to low-tech, which will be further discussed in chapter 3, and these devices use images to help emerging communicators make meaning and develop communication skills. Emerging communicators are children or adults who are new to AAC technologies and are beginning to develop language and communication skills. One might assume that the images used for AAC devices would be easy to use, however, these images are highly problematic. Representational and compositional choices of images specifically designed for AAC may be failing the purpose of the image: to act as referential pictures, symbols, and signs to function as a part of a visual language.

Figure 1. **Right: *Touch input* (Rehabmart.com, 2016), Left: *Touchscreen (*Autism Speaks, 2016).**

Although we use images, symbols, and signs to communicate, we do not necessarily consider how such visuals are perceived, ‘read,’ and understood, especially when the viewer is someone with a profound intellectual and developmental disability. The English language is visually represented by letters, which are also symbols, but are referenced as text and not necessarily part of visual discourse and visual literacy. To learn to use the alphanumeric symbols that create English text, one must be taught to be literate. However, when one’s mode of communicate is aided by visual images, the user must build associations with the images available to make meaning and use the images to communicate. Therefore, people who use AAC devices must become literate in the visual discourse and visual language representations used on a particular AAC device. Augmentative and alternative communication technologies use many different communication tools such as: printed cards with images, physical buttons/triggers with images on them, and more high technology devices like tablets. High-tech AAC devices are an example of a communication platform that uses visual representations, which often function as buttons, that when touched will speak the text that is programmed with the image on the device. The programming is first completed by the company, so that devices are ready-to-use, and then customized by speech therapists, parents, service workers, etc. The person *who uses* the device often has little agency, ability, or influence over how their own language is communicated, represented, and organized.

I learned about AAC when I worked with a young woman diagnosed with Angelman Syndrome who helped me discover some ways art instructors can work with a complex learners so that these individuals can have more access to language and vital learning opportunities. For two years, I worked with Liz (whose name has been changed for confidentiality purposes) as her habitation technician or service worker, to facilitate developments her independence, communication, psychomotor skills, and roles in the community. Liz is diagnosed with Angelman syndrome, which is a rare and complex syndrome that, for Liz, manifested in having non-verbal communication, seizure disorder, balance and coordination issues, intellectual and developmental delay, high tone or extremely tight and consistently contracted muscles, excessive laughter, and short attention span. Although these issues create significant barriers for her, she is extremely determined, active, expressive, and full of personality. People in the community often perceived her as a happy but empty person, but often because of their own impatience and misinterpretations. Liz's lack of oral voice and need for processing time, to overcome the many ways her body and brain impede her, were often interpreted as having a lack of awareness, of personhood, of humanity.

Liz uses several alternative means to communicate, such as her eyes, gestures/movements, vocalizations, facial expressions, and behaviors. These and other types of communication are part of augmentative and alternative communication methods, but AAC also offers other ways to communicate (ASHA, 2016). Liz uses an AAC speech-output device that display images and text on a touchscreen tablet-like device to speak programmed words or phrases when she touches an image. In addition to helping Liz become more literate/communicative using the device, she also has many goals centered on fine and gross motor skills.

From 2011 to present, Liz has been attending individual art classes with a faculty member, whose goal has been to increase Liz's communication, problem-solving, and psychomotor skills, and expressiveness through visual media. In the beginning of these sessions, Liz would not engage in any activity except throwing materials on the ground while watching and laughing at people scrambling to pick them up again. The faculty member heading these sessions suggests that these behaviors were a way for Liz to have control. Over time, Liz became more and more engaged in activities and now can fill a large sheet of paper with marks, engage in musical activities for an hour or more, and has learned to control and manipulate tools.

Regardless of Liz's visual attention during art, we discovered interventions that vastly improved engagement and duration of arts activities, communication skills, generalization of concepts to other environments, and her ability to demonstrate her learning. Above all, learning about Liz informed our design choices to create meaningful learning opportunities. Kleinert, Browder, and Towles-Reeves (2009) state that educators must provide opportunities for students with profound disabilities "to learn skills that are applicable across contexts and learning settings," because the generalization of critical skills improves cognition (p. 310). For any experience we designed, we had to carefully consider what Liz needed to learn to participate in an activity; for example to begin learning to draw and develop her range of motion, we had to teach and support her to extend her arms, counter to her impulse to keep her elbows close to her body. Liz has difficulty controlling motor patterns, so I learned to support her develop motor memory, which enabled her to perform motor movements needed for various activities. Brown (1996) provides a summarized continuum defining levels of engagement that can be used to assess the quality of engagement during activities: physically present during an activity, awareness of the activity, response, engagement (directed attention), participation (possibly with supports or engaging in part of the activity), involvement (active participation or initiating participation), and attainment (as cited in Byers, 1999, 185-186). In working with Liz, I noted a trend in the process she goes through when acquiring new skills. First, she expresses aversion to the activity (partially or wholly) and/or materials in the activity, then progresses through varying levels of engagement, participation, and willingness to allow assistance in guiding motor movements to teach the new skill. Once she is accustomed to the new stimuli, her engagement and participation develop into independent initiation during the activity and/or explicit requests on her AAC device for the activity.

Designing assessment methods which identify behaviors during activities can begin to reflect growth in skill and knowledge acquisition. Also, the cycle of rejection, acceptance, and initiation further emphasize the need to follow through with well-designed learning opportunities that critically consider the learner's needs and abilities. Kleinert, Browder, and Towles-Reeves (2009) also suggest that learning activities or assessments should be "designed so that limitations… do not result in the student *not* being able to demonstrate skills that are a part of that student's learned repertoire" (p. 309). Given the complexity of representing knowledge acquisition for these students, more research is required before more comprehensive recommendations can be made for arts educators.

My primary goal when I began taking Liz to these art sessions was to understand what engages her and why, then learning what we could do to improve upon that to connect communication and psychomotor skills. When I began looking for research about teaching students in the art with profound disabilities, I found that there was very little scholarly research being done in the art to develop these skills. While addressing psychomotor skills continued to be a goal, I kept going back to Liz's AAC device and examining the symbols. I could not understand why in 2013, when Liz received her current device, there were heavily pixilated images being designed and used when the screen resolution is 1024 x 768. As I continued to program images on the device, I found that the device often failed at providing an appropriate visual from which one could make-meaning of, regardless of one's abilities or disabilities.

Figure 2*. *Devices **(Tobii Dynavox, 2016).**

Through in-depth experience working with an individual diagnosed with a profound disability who uses AAC technologies, I questioned why the images available on these devices were designed and represented in strange ways considering the capabilities we have in developing digital images. AAC images which are designated to function for communication use pre-determined visual representations paired with text (Figure 2). This use of images indicates that images are part of a visual language system. The design, input/selection methods, and symbol-sets differ across devices and the companies that design these technologies, further complicating learning the visual language when a device must be replaced with a new visual vocabulary.

AAC devices and technologies which utilize images, symbols, and signs to represent meanings are often accompanied by text; however, the text becomes secondary when such a device is used by an emerging and textually illiterate communicator. In essence, the necessity to make meaning with images when learning to communicate develops visual literacy and AAC devices use a visual language. There are “2 faces of literacy—literacy that is used to control and literacy that is used to democratize and make free" (Cunningham, 1989; as cited in Everly, 2002 p. 20). Without access to literacy, one is denied control over one’s life. So AAC technologies should be an effective communication tool which enables users to become more visually and communicatively literate as well as give these individuals more control over their own communication and language.

When I began working with Liz, she had a voice-output communication device called the “tango!” which was developed and designed by Tobii, currently Tobii Dynavox[1], a prominent developer of AAC technologies. As I learned how the device worked and could be programmed, my role was to help her increase acquisition of language skills through contextual repetition of use of the symbols and speech. Although she is capable of using the device, the images are small and designed specifically for the tango!; meaning that images on the device are not used on any other AAC device. The device also limited the number of choices or selections available at one time, displaying only six images. The tango! is preprogrammed with images that are predominantly cartoon-like and intended to appeal to young adults (Figure 4). The device is touch-input and each display box is framed to assist users who are developing fine motor skills.

[1] Tobii and DynaVox were separate companies until they merged to become Tobii Dynavox in 2014.

To navigate between “pages” or sets of six images/choices/selections, required a different input method: buttons with triangles that were best activated when pressing with the thumb. In addition, the device was no longer being manufactured, which would have meant that if Liz continued to use the device, one day it would not be able to be repaired or replaced. In 2013, her mother decided to look for another device that might improve her daughter’s independent communication and decided on the DynaVox Maestro, prior to DynaVox becoming Tobii Dynavox. Because the tango! utilized a unique symbol-set, the Maestro required Liz to learn a *new* visual language and memorize a *newly* organized lexicon not of her choosing. One might imagine the difficulty if the associations and locations of one’s language and meaning suddenly changed to something one had no agency in organizing nor of how the language is represented visually and what each representation represents. The meanings/speech output of AAC devices is interpolated by those that program the device if the person’s disability prevents them from participate in its programming; which underscores the need for AAC images to function well as representations of things and ideas in the world.

Images play many roles and serve many functions, but when images are designated and designed for use in AAC, the designer must understand the ways in which images can function. Arnheim (2004), a renowned scholar and theorist of art, images, and meaning-making practices, defines three functions that images and art can serve as to make meaning: pictures, symbols, and signs, which can function independently or overlap with other functions. For example, images act as pictures to the extent to which they represent things at lower levels of abstraction or are more genuine in their portrayal of something; some examples being pictures, stylized paintings, or even line drawings (Arnheim, 2004, p. 138-139).

The ways that images function in accordance to Arnheim's theory should inform the design of AAC images. If symbols must represent something in the world, the choices made during the abstraction process should reflect features that are most salient. Salience, according to Kress and van Leeuwen (2006) are the features within an image that draw attention to itself, which can occur in a multitude of ways through line, contrast, color, level of rendering, etc. (p. 210). Kress and van Leeuwen, distinguished theorists and researchers of visual culture and linguistics, provide a theoretical framework to understand how images can have a hierarchy of importance and/or features that draw more visual attention, which should inform representational choices of AAC images (p. 201). For example, artistic choices of representing happy or sad could employ color, representations of a person or facial expressions, and use linear marks that may more or less effectively reflect a sense of such feelings depending upon how quickly the image can be interpreted as reflecting a feeling of happiness or sadness. Perhaps an enlarged eye more clearly shows tears or bursts of bright colors surrounding a happy face would then act as salient features. However, the images must be tested with the people who will be using them.

Although some believe that images and art inherently contain or are imbued with meaning that an informed viewer will sense and understand, however the meaning of any representation is neither universal nor inherent. Roland Barthes theorizes that images contain connotative meanings, or associations which vary over time, place, and space (context), and these meanings are informed by the cultural, political, social, and historical context of the viewer and of the image (Sturken & Cartwright, 2009, p. 20). The interaction of the viewer's culture and context with the image's context and use, aids the viewer in making meaning of an image and its association to them. Words and concepts can become "anchored" by a visual image that becomes an "ideal" representation for that word, which is based upon exposure over time and is culturally specific (K. St. Amant, guest lecture, February 24, 2014). St. Amant (2014) explains that the visual anchors create an equation of visual association between an image and the association:

image + viewer's culture + context of use = association

Regardless of an artist's or designer's intentions, the viewer ultimately determines the meanings and associations an image has for themselves. Any intended meanings and culturally embedded associations images may have, the intended meanings do not necessarily equate to all people making the same meaning of the same image. Therefore, neither meaning nor associations are inherent, but rather decided by the viewers on their terms as they are influenced by their sociocultural values, experiences, associations, knowledges, and ways of making meaning. Yet, what we do not know is how people who are non-verbal and have an intellectual disability meaning because we cannot know the contexts through which they are able to make meaning.

Although current research does not fully examine the effects of stylistic representation on AAC devices, I hope to add to the conversation so adult and child emerging communicators who use AAC are enabled with more meaningful and effective images. Gillespie-Smith and Fletcher-Watson (2014), prominent researchers and educators in the field of AAC, identify that research is needed to understand how users of AAC technology understand concepts related to symbols. While many researchers have utilized eye-tracking technology to explore visual attention, identification of symbols to objects, comparative studies between neurotypical and differently abled populations, there is a distinct lack of research in the effect of varying stylistic representations of abstraction and realism and their relationships with familiarity of symbols in comprehension and utilization (Gillespie-Smith & Fletcher-Watson, 2014). To explore some of the identified issues of visuals used in AAC technologies, I conducted a case study investigating the relationship of familiarity to representations, the impact of varying stylistic representations of symbols, and how familiarity and style affect recognition and utilization of pictorial symbols.

To reliably report on how visual representations affect visual attention, I used an eye-tracker to examine the ways Liz looks while viewing images. I chose Liz as my research participant because she has history with three different AAC devices, exhibits the ability to differentiate and use images for communication, and is a good representative of someone with complex communication needs. Though Liz may sometimes exhibits low-attention, she hones in on images and videos she finds engaging by reaching toward them, leaning close to the display, and paying rapt visual attention to what she is looking at. Of all of the pages Liz uses on her device, the one she most often struggled with was having a way to express how she felt. Though she liked using the “I’m excited” picture, the device had little to offer in terms of representing a range of emotions. As Liz demonstrated over time and Wilkinson and Light (2011) identify in their research, the human figure attracts visual attention more quickly and for longer durations when compared with images excluding people. To understand what types of representations Liz prefers, I exposed her to images representing emotions and all of which included facial features while wearing an eye-tracker to capture her gaze patterns and duration of visual attention on areas of interest.

CHAPTER TWO

Literature Review

One of the most fundamental problems of AAC design is how images are designed as a visual language. The goal of augmentative and alternative communication is to use images that allow quick and effective means of representing and containing associative meaning to be used by people who require these technologies to have voice and connect with people. Blackstone, Williams, & Wilkin (2007) emphasize the importance of AAC research and practice being parallel to goals related to expanding the individual's communication abilities and social networks, self-determination, and education. To expand one's domains, AAC research should inform instructional strategies, and AAC technologies and strategies (p. 192). Images in AAC use many methods of representation meant to enable communication, but some representation choices may further disable people who use AAC. Choosing a style of visual representation remains a fundamental problem in AAC design (Light & McNaughton, 2012, p. 37). To develop best design practices for AAC images and language development, an understanding of how design elements and choices impact perception becomes necessary. My research responds to issues noted in research and design of AAC images by investigating the implications of design choices for AAC images in terms of realism, abstraction, and familiarity of these types of images by conducting an eye tracking study to examine their effect on visual attention for a person with Angelman syndrome.

Current Research

To build upon bodies of knowledge about human visual processing, perception, and how images can be best utilized as a visual language, researchers employ eye tracking technologies to record how people look at images. The field of AAC research supports the use of eye tracking technology to further expand these bodies knowledge of visual processing and how people look at, search for, perceive, and use images (Gillespie-Smith & Fletcher-Watson, 2014; Light & Drager, 2002; Light & McNaughton, 2012; Shane et al., 2012; Thistle & Wilkinson, 2009; Vales & Smith, 2015; Wilkinson & Light, 2014; Wilkenson, O'Neill, & McIlvane, 2014; Wilkinson, Light & Drager, 2012;). Eye tracking equipment enables researchers to record the chronological gaze patterns of where people look and durations of fixations where the eye rests for more than 100 milliseconds. Monocular eye tracking equipment is calibrated to the wearer's eye, uses a mounted camera to record the 'scene' or direction and space the wearer is looking, and a beam of light reflects into the wearer's cornea to sync with the wearer's eye movements. This technology enables researchers to examine visual attention, gaze patterns, visual scanning strategies, and perhaps brief glimpses into cognition and social processes (Karatekin, 2007; as cited in Gillespie-Smith & Fletcher-Watson, 2014, p. 161).

To examine factors that contribute to creating images that attract the gaze, many researchers have investigated visual factors that influence the viewer's eye gaze, such as: color, shape, form, contrast, iconicity, realism, as well as other elements (Blackstone, Williams, & Wilkins, 2007; Drager, Light, Speltz, Fallon, & Jefferies, 2003; Light & Drager, 2008; Light & Drager, 2002; Light & McNaughton, 2012; Lund, Millar, Herman, Hinds, & Light, 1998; Shane et al., 2012; Thistle & Wilkinson; 2009; Vales & Smith, 2015; Wilkinson & Light, 2011; Wilkinson & Light, 2014; Wilkinson, Light, & Drager, 2012; Wilkinson, O'Neill, & McIlvane, 2014). The available research has unveiled factors that influence a viewer's eye gaze. Thistle and Light (2009) and Wilkinson, O'Neill, and McIlvane (2014) found that visual cognitive research supports color as being one of the most powerful components for attracting the gaze and assisting during visual search tasks. When choosing images for my study, I looked for uses of color that I thought might draw Liz's gaze to particular features.

Studies have also compared the symbol systems currently used on AAC devices to determine which may be more effective in communication; however, much of this research uses people who are neurotypical instead of the people who actually use AAC (Light & Drager, 2002; Thistle & Light, 2009; Wilkinson & Jagaroo, 2004). Knowing the importance of including AAC users in research and having in–depth knowledges about Liz's characteristics and behaviors, I chose to have Liz as a single participant. Her experience with AAC devices made her an ideal candidate, because it allowed me to compare images from her current device, the DynaVox Maestro, to other abstract representations she is unfamiliar with. Although many researchers investigating AAC design and images use neurotypical people to reduce the number of variables, but using such individuals does not exemplify people who use AAC and this exclusion of populations who use AAC can lead to assumptions that are not applicable AAC users (Alant, Bornman, & Lloyd, 2006; Blackstone, Williams, & Wilkin, 2007; Gillespie-Smith & Fletcher-Watson, 2014; Wickenden, 2011; Wilkinson, O'Neill, & McIlvane, 2014). However, the need for a base of knowledge about visual processing, perception, and patterns is needed to inform research design, methodologies, and bodies of knowledge.

Blackstone, Williams, and Wilkins (2007) state that best practices for AAC research need to be built upon a foundation of sound theoretical constructs with relevant empirical evidence that inform AAC practices and research, with the input from people who use AAC technologies. The most critical and least researched component of the design of AAC is the effect of the visual representation style on the gaze. The only study to date that explores gaze behaviors when looking at abstract versus real images only included participants with autism, who tend to show atypical gaze patterns when viewing faces and/or people (Riby & Hancock, 2009; as cited in Gillespie-Smith & Fletcher-Watson, 2014, p. 166). Researchers in the field of AAC are reaching into other disciples to understand visual perception and processing so that the design of AAC images are informed with these knowledges to further enable people who are non-verbal to have a voice. My research explored the implications of representational choices in the design of images used in AAC by comparing the effects of familiarity, abstraction, and realism to find quantitative data that displayed a preference toward a representational style and to examine what qualitative features the participant fixated on to examine which components are most salient or eye-catching and possibly aiding in making-meaning. In their review, Glillespie-Smith and Fletcher-Watson (2014) reference salience, aspects of images that draw more visual attention, when discussing AAC representations. However, I will discuss salience in the discussion using Kress and van Leeuwen's framework of salience, which analyzes how visual elements can influence the gaze through connections, disconnections, and vectors to move the viewer's eye more intentionally and with purpose to represent.

Functions of AAC Images

Images used in AAC function to varying degrees as pictures, symbols, and/or signs to represent meaning, but the design or representational choices may be hindering the ability for the person who uses AAC to associate meanings to the image. The meaning(s) we typically attach to images are not necessarily similar to associations made by someone who has cognitive disabilities due to wide discrepancies in the quality and quantity of experiences and social interactions (Alant, Bornman, & Lloyd, 2006, p. 148; Blackstone, Williams, & Wilkin, 2007; McNaughton & Bryen, 2007; Stans, Dalemans, Witte, & Beurskens, 2013 Wilkinson, O'Neill, & McIlvane, 2014). Unfortunately, people with more profound disabilities often have extremely limited social access beyond family and service workers (Blackstone, Williams, & Wilkins, 2007; McNaughton & Bryen, 2007; Stans, Dalemans, & Beurskins, 2013). The limited social connections then limits access to and knowledges of social and cultural codes, although this reduction makes room for the individual to create their own meanings more freedom of interpretation of iconic cultural symbols. People who use AAC may create associations with images that deviate from socially constructed meanings of images. Few researchers have addressed how the design or the methods of representation effect how people with cognitive disabilities make meaning of images due to the difficulties in measuring comprehension (Alant, Bornman, & Lloyd, 2006; Gillespie-Smith & Fletcher-Watson, 2014; van Balkom & Verhoeven, 2010). To begin uncovering how someone with Angelman syndrome perceives facial representations of emotions, my research exposed her to images to see if a particular representation styles or degrees of familiarity attract more of her visual attention, because if the image attracts the gaze, the symbol may be easier to interpret, comprehend, and use for communication.

Making Meaning of Images

How we make meaning of images is informed by our experiences, social interactions, cultural and social conventions and codes, aesthetic conventions, and contexts (*time, place,* and *space* of cultural, political, social, and historical contexts) and these contexts all influence how we create, use, and make meaning of images (Kress & Van Leeuwen, 2006; Sturken & Cartwright, 2009). AAC researchers have noted that our social constructs and conventions influence the design, interpretation, and practice of AAC research and design (Blackstone, Williams, and Wilkin, 2007). When viewing art or images each individual bring their own identities, preferences, experiences, beliefs, and associations, creating a dynamic interaction between the viewer and the image. Those that design AAC systems may intend certain meanings of images they design based upon their own cultural constructs and perceptions of how they think AAC users will make meaning of the images, but ultimately, the viewer and the context in which the image is viewed/used will decide the meaning of an image, because images are created in the contexts of culture, history, society, and ideology (Arnheim, 2004; Sturken & Cartwright, 2009).

Understanding how we make meaning of images provides insight into why we construct images in a particular way, in addition to how we develop associations and make determinations of value of art and images. The art discipline typically uses the critique as a method to analyze and interpret the meaning and value of images: identifying and understanding the visual elements in play through the composition, interpreting the combination of what is seen and what might be implied, and using various criteria to decide if the work is successful or effective, which varies depending upon what is valued to determine "successfulness" as defined by the values of a person or larger agency. However, the traditional critique often leaves out the context of the image and contexts of viewers. The visual art discipline predominantly uses concepts rooted in design and aesthetic preferences that have changed and evolved over time in many cultural contexts (Kim, 2006). As aesthetics developed over time, so did the conventions used to create images. As these visual conventions changed over time, so did the educational practices to disseminate these conventions. In the US, these conventions are the elements of art and the principles of design, which will be discussed further on. Discipline Based Art Education (DBAE) was a primary vehicle in art education to teach and use the elements and principles of design, as well as how we make meaning of images and art. DBAE was part of a larger institutional initiative in the US to reform art education intro a disciplinary structure similar to science and depart from what was perceived as excessive self-expression during the 1960s (Efland, 1990). The elements and principles of design remain a well-integrated aspect of current visual art education.

The elements of design are comprised of line, shape, color, form, value, texture, and space (physical or perceptual). The elements are components used to create images: we use line to create boundaries or define shapes, color to differentiate shapes, and so on in infinite ways. These elements can then be organized with the principles of design, thereby arranging and designing the elements in meaningful ways, such as using color schemes to unify a composition, proportion to give more visual weight to similar shapes of varying size or repetition of lines to create a sense of motion. The elements of design are fairly stable in that they have developed over time with understandings of human sensory processing. However the principles of design are more variable depending upon where and by whom one was educated in these constructs. The naming and number of these principles varies, but are often referred to as rhythm/repetition, harmony/unity, variety, balance, contrast, proportion, dominance, movement, proximity, economy, and others. Many theories in art support that the interplay of the elements and principles can have particular effects on how the viewer’s eye will move through a work of art. Though these principles are useful in understanding ways to make meaning through artistic representations, the principles of design are not founded upon research. However, art research could examine how the elements and principles of design function in terms of how well these constructs function in images and meaning-making practices. Eye tracking research using perceptions how the elements and principles of design interact in images could potentially enhance or verify these concepts and contribute knowledges of how people look at and perceive images.

More recent educational reforms have defined the discourses to be used in Arts Education in the US in effort to meet new criteria set by the Common Core State Standards Initiative through the National Core Arts Standards. In terms of how the National Core Arts Standards values meaning-making practices when viewing art, there is a repeated theme that students will interpret the intent and meaning based upon beliefs of the artist's intent with no mention of how students can analyze the work from their own context (National Coalition for Core Arts Standards, 2016). The National Coalition for Core Arts Standards (2016) for US K-12 education states, "The arts inform our lives with meaning every time we experience… joy…[from experiencing art]" (p. 2). This statement indicates that art informs life but leaves out that life informs art. I would not claim that understanding intentions are meaningless, but intentions do not equate to making meaning. Viewers bring their identities, experiences, practices, beliefs, and ideologies when viewing art and images, and the meanings inscribed by the viewer are controlled by *their* associations, thereby lending weight to the viewer's interpretations as influenced by their contexts and the context of the viewing the work. Putting this interaction between the individual using images as language through an AAC device and the designer choosing how to create images purposed for communication, the problematic nature of AAC images becomes more complex.

From an international research seminar for AAC researchers and professionals held in 2004, Alant, Bornman, & Lloyd (2006) report that the field is conflicting in its definitions of symbols and signs, which may be restricting expansion of the AAC field (p. 145). Some researchers define symbols and signs by their arbitrariness or iconicity, some refer to signs as visual representations of Sign Language, however the field does recognize that AAC symbols/images are purposed to function as representations of meaning: an image visually representing its referent (a person, place, thing, concept in the world) in either a direct or indirect manner to be used to make meaning and communicate (Alant, Bornman, & Lloyd, 2006, p. 145; Wilkinson, O'Neill, & McIlvane, 2014, p. 457). Analyzing what makes an image function as a representation of meaning could inform the rationale of design choices for AAC images. The study of semiotics, or study of how we make meaning, has much to offer when analyzing images and art. The field of semiotics is more closely related to linguistics, the study of language and how we make meaning through language, but offers well-respected and widely-used frameworks about image analysis, making meaning, and how an image can become synonymous with a concept or idea. If existing semiotic frameworks were to inform the design of images used in AAC, the evidence base of what contributes to effective AAC symbols could increase.

Arnheim (2004), a well-respected art theorist, offers that images can be function in three roles that can be used in one or multiple ways depending upon purpose and interpretations: pictures, symbols, and/or signs. These roles may be performed individually and in conjunction with the other(s). Arnheim's (2004) theory states that the role of an image being a *picture* is one that visually references to its referent(s); meaning that an image of a tree (anywhere on the spectrum of realism/abstraction) will visually reference the salient characteristics of a tree: a large trunk, branches, leaves, roots, etc… (p. 137-139). *Pictures* must maintain a relationship with the salient or most recognizable aspects of the thing it represents, and may be realistic or abstract, but their role is to 'stand for' something: to visually represent meaning through the display of fundamental characteristics (Arnheim, 2004, p. 139-140). For example, painting of the sun rising could be displayed in a home to function as a *picture*, or the same image of dawn could be a painted mural and function as both a *picture* dawn and as a *symbol* of hope or new beginnings; illustrating that designer's choices of representation and purpose in addition to the viewer's interpretation alters we make meaning of images.

For an image to function as a *sign*, the image does not need to visually reference the thing it represents, but rather is designed based upon purpose: what does the image need to do? (Arnheim, 2004, p. 138). Arnheim (2004) includes an additional facet to the function of signs in that they should be distinguishable from their environment (p. 138). An example is the use of color in warning signs to make them distinguishable from its environment and communicate a sense of urgency through additional cultural associations to traffic signals. The Occupational Safety and Health Administration (OSHA) standards state that caution signs should be predominantly yellow and danger signs should be predominantly red (OSHA.org, 2016). Culturally in the US, we use yellow and red in other applications, such as traffic signs and signals, that have created the cultural association of yellow meaning "caution" and red meaning "stop" or "danger." Warning signs often use angular shapes, because shapes like triangles are sharp; whereas if circles were used, circles are generally perceived a comfortable and "whole," which is not conducive to communicating danger. The success of an image fulfilling its intended function(s) is dependent upon its purpose, relevance, context of use or display, and the viewers--who each bring their contexts and experiences with them when viewing images. How we associate meanings to visual elements and images creates a very dynamic visual culture, but such dynamism is problematic when images are purposed as a visual language on AAC systems.

Barthes is a prominent philosopher who influenced the development of semiotics and the theory of the signifier, signified, and signs. A signifier is an image, word, or sound and the signified is the idea or meaning brought to mind by seeing, reading, or hearing the signifier (Barthes, n.d.; as cited in Sturken & Cartwright, 2009, p. 29). For example, when viewing a symbol of a heart, the likely immediate association is love; so the visual image of the heart becomes a sign for love, which allows us to communicate an idea of love without writing the word love. These associations of meaning with images are influenced by culture, sociohistorical contexts, and also how a particular image is used over time (Sturken & Cartwright, 2009, p. 27-29). Meanings may shift over time, but these shifts are directed mostly by culture. For example, a brown paper bag once (and potentially still) signified an acceptable amount of “brown-ness” a Black American could have to be allowed certain privileges; if one’s skin were darker than the brown paper bag, the person would be denied and discriminated based upon their “darkness” or deviation from “whiteness” (Journal of Blacks in Higher Education, 2002). To many people, a brown paper bag only signifies lunch. This example illustrates how associations change over time, space, context, and culture.

Design Choices for AAC Representations

When images purposed for AAC are created, associations may seem “embedded” or inscribed onto the image because of one’s cultural knowledge, but the people who use AAC may not have the same associations. As previously noted, representational style and design choices remains a fundamental problem in AAC design. Overall, the design of AAC images is based upon predictions: predictions of what people who use AAC want to communicate, of what is developmentally appropriate, of what is relevant both for visual representations and to the lives of people who use AAC, and of how people make meaning of images (Tenny, 2014; Sturm & Clenden, 2004; Light & McNaughton, 2012).

Studies have investigated and implicated representational choices that contribute to or hinder communication and making meaning using available symbol-sets. The predominant symbol systems will go through upgrades of images, usually by reducing the pixilation, even though current technologies can display high definition displays. The symbol-system developed by [Tobii] Dynavox/Mayer-Johnson called Picture Communication Symbols (PCS™) “follows a common approach among AAC system designers using a selection sets of thousands of symbols; which is to rely on the transparency of their pictures or icons to indicate the meaning of the intended word or phrase” (Tenny, 2014, p. 15). With companies that design AAC technologies depending upon an inherent transparency of meaning being conveyed by their images to the user, the importance of understanding what contributes to images being easily and effectively used for communication [by a highly diverse population] and what informs these practices becomes critical. When designing my research and selecting images for eye tracking sessions, I looked for varying representations of emotions to see if particular features and visual attention could reveal the salient characteristics; such as abstract faces with black dots as eyes or ones with more fully rendered eyes. The effects of images having more realistic or abstracted qualities being more or less effective for AAC and in terms of making meaning are poorly understood. AAC research is conflicted about how different levels of abstraction or realism of images are perceived, interpreted, and comprehended amongst all populations (Alant, Bornman, & Lloyd, 2006; Blackstone, Williams, & Wilkin, 2007; Gillespie-Smith & Fletcher-Watson, 2014; McNaughtoon & Bryen, 2007; Wickenden, 2011; Wilkenson, O’Neill, & McIlvane, 2014). My research examines these issues directly by using abstract images that Liz uses or has used on her device, and with others that are similar or different in design or appearance, but differ in realism and abstraction.

AAC images are not designed using empirical evidence, rather the designers create AAC images based up their assumptions and perceptions of what is developmentally appropriate and of what is relevant to the lives of people who use AAC. Higginbotham, Shane, Russell, & Caves

(2007) claim that AAC images fail to function for the needs of emerging communicators (including preliterate children and adults whose communicative abilities have been delayed). Even as I programmed Liz's AAC device, I made interpretations and judgements about what images I thought might be most rational and effective for her only informed with what information I could glean about Liz and her preferences through experience over time. Particularly in context of individuals who rely upon the images to communicate, the designers create thousands of images that are decided as relevant to a person's life only informed by their own interpretations and assumptions (Tenny, 2014; Sturm & Clenden, 2004; Light & McNaughton, 2012). In addition to AAC design not being informed by the people who use AAC nor knowledges and research that would better facilitate communication. Few AAC technologies are designed considering visual processing and how it develops from childhood to adulthood (Wilkinson, O'Neill, & McIlvane, 2014, p. 455-456). Further extending the gaps in research and design of AAC devices and images, little is known about how people who use AAC look at, perceive, and process images (Wilkinson & Light, 2011, p. 1643-1644). To facilitate communication for individuals who are non-verbal, the image designs must be informed by the people who use AAC, research builds empirical evidence of design elements and principles that help develop understandings of how people who use AAC look at images, and are informed by respected semiotic frameworks and visual theories.

Symbols closely representing its referent are claimed to be easier to learn and use for communication and some evidence from eye tracking studies supports that more realistically rendered images positively contribute to quicker recall, matching, and use (Bloomberg, Karlan, & Lloyd, 1990; as cited in Gillespie-Smith & Fletcher-Watson, 2014, p. 166). But real images cannot be used to communicate all aspects of language, so abstract representations must be employed at some point, such as facial expressions the face because the face contains socially salient features that help us interpret emotions. If all images were realistic and contextual, the visual search and identification processes could prove cumbersome. However, Arnheim (2004) cautions that abstraction can cause a paradox if the elements of the represented object distort the salient features (p. 141) or if aspects in the design distract from the salient characteristics. For example, the images in Figure 4 are of search results on Liz's AAC device for images of the ideas "fast" and "slow." The likely intended salient feature is the curvy and spiraled lines trailing the figures to indicate "fastness" and "slowness," however the eye is so dominant in color and size, this representation may cause more confusion than comprehension. The more pixilated images on the left have several layers of problematic design. The pixilation and use of color,

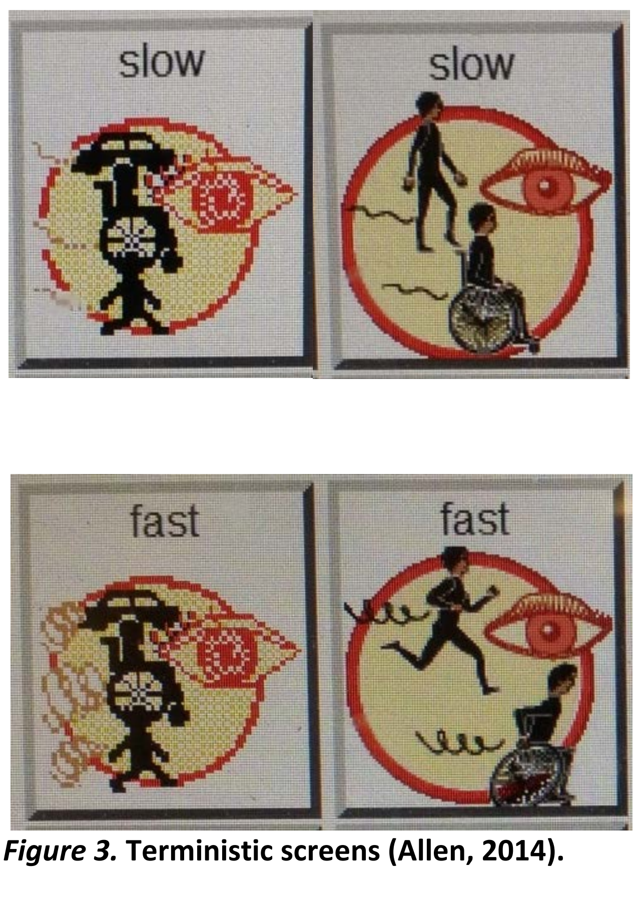


Figure 3. **Terministic screens (Allen, 2014).**

line, shape, and abstract representation cause these images to become what Burke calls a terministic screen. As a renowned theorist in Rhetoric who explores perception and symbolic actions, Kenneth Burke (1989) offers a theory to explain how the grouping of visual components become terministic screens: the representation becomes so distorted that they are no longer seen for what they are, but could become so ambiguous that the figures become one strange, unrecognizable shape – seeing but not seeing. The two images on the right are updated designs of the original symbols and do offer more information about speed through the verticalness of the slow figures and diagonal directionality of the fast figures, but the large circle and imposing eye have no relation to the concepts being represented. Additionally, the images still depend upon the trailing lines as salient features to reflect speed which fail to contain associations of movement and speed, especially when dominated by the eye. Examining the ways we represent and make meaning of images through research investigating salient could improve the design choices of AAC symbols.

As stated by Light and Drager (2002), “future research is urgently needed to improve the design of AAC technologies” including the design of AAC images, layout of pre-programmed lexicon, and processing demands on the user to enable faster location and use of symbols (p. 28). Light and McNaughton (2012) echo the urgent call by adding that future research is needed to explore how representation styles effect quick comprehension to empower people who use AAC to more readily connect with people, rapidly develop associations, use the symbols, and remember and use and lexical locations of symbols, because AAC systems inhibit language development through their own constraints (p. 38). My research starts to engage a conversation about the intersections of representation, familiarity, and the ways designers choose to employ the elements and principles of design to create accessible and immediately recognizable symbols for AAC. My research addresses the need for studies to explore representational styles of images used in AAC through exploration of how familiarity, abstraction, and realism effect the gaze of someone who has used various AAC devices in the last nine years. During the study, I had no expectations or presumptions for Liz's gaze patterns, but I did hypothesize that she would prefer abstracted images either due to familiarity or aesthetic preference.

CHAPTER THREE

Contexts and Augmentative and Alternative Communication

The following chapter serves as an introduction to Liz and her connections with East Carolina University's School of Art and Design, and how these have influenced practices and research. I will describe my working history with Liz and how the experience informed my practices. Augmentative and Alternative Communication will be described in general and in the contexts of Liz's history and use of high-tech AAC technologies. Her history with the research setting likely reinforced her attentiveness to an activity and provided the least distraction.

Ethnographic Information and Context

Liz is twenty four and lives with Angelman syndrome, which was first documented in 1964 and associated with microdeletions on chromosome 15 with the syndrome in 1987 (Williams, Peter, & Calculator, 2009, p. 3-4). Angelman syndrome is a neurogenetic disorder that has been identified by the deletion or mutation of the UBE3A gene (Williams, Peter, & Calculator, 2009). Common characteristics of Angelman syndrome are

- fine and gross motor impairments
- balance issues
- ataxia or lack of muscle control during voluntary movements, possibly linked to abnormal EEG patterns not associated with seizure events
- seizures
- high muscle tone or consistent and involuntary musculature contractions related to tremulous movements & ataxia
- hypermotoric or bodily restlessness
- lack of or severely minimal speech, but greater ability for receptive language skills and non-verbal communication
- excitability and generally happy demeanor (frequent smiling and laughing)
- excessive chewing
- attraction to sensory input
- impulsiveness
- short attention span
- strabismus.

(Williams, Peter, & Calculator 2009, p. 6-7)

In 1997, the UBE3A gene was identified as the cause of Angelman syndrome and confirmed by either whole or partial deletions in UBE3A (Williams, Peter, & Calculator, 2009, p. 4). The extent to which the gene is altered shifts the extent to which these characteristics manifest. To determine Liz's diagnosis, genetic testing in the early 1990s confirmed Liz's deletion of the UBE3A gene located on chromosome 15 (Mother, personal communication, August 5, 2014). Liz shares many of the common symptoms and behaviors that correlate with Angelman syndrome. These characteristics describe ways that Liz's body works against her, such as: high desire to walk, move, and do things but is at high risk of falling due to an unconscious response that causes sometimes severe falls whether seated, standing, and walking; the desire to engage with people socially, but lacking adequate communication methods to do so; or wanting to dictate her life and what she wants, but unable to voice it. However, she works to overcome these barriers to be an active, connected, independent agent in the world and her community.

Liz began working with students and faculty at East Carolina University's School of Art and Design in 2011, which allowed her to develop familiarity with faculty and activities associated within the art classroom. Liz first began by participating with an all-ages, inclusive art class, however during these classes, she focused was on watching classmates and teachers rather than engaging in her own work. In response to observing this behavior, Liz began experimental art sessions to work on developing psychomotor skills and engagement in arts activities.

During August 2012, I began working with Liz through a national service agency and became invested in developing Liz's skills as she continued to participate in individual art sessions in alignment with goals related to her support services. For over three years, Liz has been participating in individual and small group art sessions, allowing her art instructor at the School of Art and Design to develop a good rapport with Liz, while we discovered interventions that promoted her engagement in new and diverse arts experiences, cognition, communication, and psychomotor skills. The social aspects of her art sessions are her greatest motivator, as she would seek physical attention after successful participation through various tasks and activities, and would exhibit the most joy when receives hugs, praise, and active engagement from another person. These social art opportunities would also serve to motivate use of communication tools as she continued to develop communication skills.

Augmentative and Alternative Communication (AAC)

Augmentative and alternative communication tools and technologies often employ images, symbols, and signs as a representation of language, to be used by child and adult emerging and advanced communicators with disabilities, but may inhibit communication due to compositional and representational choices made by the designers. The symbols are part of a larger category or stylistic grouping of images called “symbol-sets” which are dedicated to communication purposes on AAC devices. A common symbol-set is Picture Communication Symbols (PECS™), designed by Tobii Dynavox/Mayer-Johnson, which includes thousands of images (Tenny, 2014, p.12). It should be noted that if one wants to directly access the multitude of symbols available on PECS™ symbol system, one must purchase Boardmaker® software from Tobii Dynavox/Mayer-Johnson. On the AAC device itself, the programmer must use different search words to see the available images. In my experience with the Maestro, it was often frustrating to enter the needed the search words in attempts to find the ‘best’ symbol on the device. Although the high-tech devices often have embedded cameras, the Maestro does slow its operations significantly when too many images were uploaded as symbols, and resulting in non-functional device for Liz due to the significant delays.

The display methods used on current high-tech AAC devices use digital displays paired with an input method (touchscreen, physical buttons or triggers, eye tracking). Their screen displays are high-resolution and typically use grid and/or scene displays for symbols. The grid display has symbols or text arranged in a grid, while scene displays use an image to fill the screen. The selection method on a grid display is more user-friendly in that the selections are separated via a grid. Scene displays only show the picture of the scene and usually without visual cues to highlight active areas that would open a new page of options related to the thing touched in the scene. The lack of visual cues in scene displays requires additional associations that must be taught. One example might be an image of a kitchen filling the display and touching a drawer would open a new page displaying things the user might want from the drawer.

Experience Informing Practice

The complexity and abundance of the knowledges I will discuss in relation to working with, teaching, and researching with Liz are critical to her development and safety; however, these knowledges are considerations educators and researchers must use to develop, interpret, observe and assess when working with individuals or groups/classes. Educators are taught to recognize, understand, respect, and acknowledge the many characteristics and intersections of learners and their identities, abilities, cognition, methods and modes of learning, character, motivations, development, communication, and numerous other influences, factors, and intersections. Educators are also required to continue development of these knowledges during their career to improve student learning outcomes; therefore, the proposed knowledges are essential and also heightened when teaching students with profound disabilities and complex communication needs. During my time being Liz's service worker, I kept copious notes, much like taking field notes in research, about her progressions, reactions, and factors that may have influenced something else. The notes provided context and knowledge about Liz that informed my interpretations and decisions about how to approach learning objectives. Researchers must also develop best practices for designing studies where the stakeholders themselves can have influence. People who use AAC have extremely diverse abilities and disabilities, requiring researchers to account for each individual's characteristics. Because people with profound or more complex disabilities and/or (communication) needs have issues with access and use of communication tools, their voices are hardest to hear, but so critically needed to inform the design of AAC images and systems.

Work and research with Liz allowed me to employ skills learned through art education experiences as well as develop new knowledges, strategies, and rationales related to working with and supporting Liz. Although the agency's case workers lacked best practices for teaching and supporting Liz, her mother has twenty five years of in-depth experiential and professional knowledges that inform best practices for promoting Liz's independence, voice, learning, and well-being. Observation skills developed through drawing from life and developing visual acuity (the ability to measure by eye) had trained my gaze to look for subtle visual aspects. I used these observation skills to understand the subtle ways in which Liz communicates, cues, signals, and reveals information, while also accounting for context and informing interpretations with previous knowledge. My interpretations are of course only interpretations, but others have also been patient enough to develop awareness, patience, and understanding of how she communicates to get to know her. Liz's progress is sometimes highly subtle, requiring the feedback and assessment of her progress to be well-informed and well-timed. Feedback needs to be immediate and meaningful, so that she can understand what was being asked of her and why, what her body needs to do or which muscles to engage, and to clearly tell her that she has progressed. When I began teaching Liz the motor movements to wave by closing and opening her four fingers together, her progress began with a small twitch and continues to develop into a more articulated movement to this day, exemplifying the sensitivities instructors and researchers need to develop when engaging complex learners in research and meaningful experiences.

For one to fully engage with and promote Liz's development and safety, there are several complex knowledges about Liz to develop in direct relation to approaches, methods, and advancement toward goals of independence, voice, and level of engagement during arts experiences. The knowledges defined below are numerous and complex, however, these competencies are directly relevant to Liz and are highly crutial to her safety, how workers and educators provide opportunities for independence and growth, and how she participates and makes connections with people, the community, society, concepts, and communications. These knowledges can be isolated, but all of these influences occur within the complex system of the human body, its relationships to environments, and identities:

- Health and well-being
- Development (cognitive, social, psychomotor, etc.)
- Communication styles
- Preferences
- Mobility
- Motivations
- Behaviors
- Supports
- Learning styles
- Functional skills
- Sensory attractions, distractions, and aversions
- Ecology
- Psychobiology
- Musculoskeletal biomechanics
- Pace and processing

The first device Liz introduced me to was the Tobii tango!, designed for a teen user and utilizing expressive abstract visual representations. The tango! symbol display areas were each 0.9 in. x 1.5 in. To accommodate Liz's tremors and motor skills, the device had a key guard, which provided three-dimensional boundaries for the six areas on the screen dedicated as buttons. Liz could be highly communicative using the device, her efforts often resulted in her other fingers activating additional selections successively which could over-ride her intended communication and/or navigate the screen to a new set of six symbols. This device offered access to pre-programmed, age-appropriate imagery using dynamic designs for young adults called "InterAACt" symbols (see Figure 5). The language, and phrases were also more liken to syntax that teenagers might use, as well as customizable buttons and phrase/word speech outputs, allowing quick programming of digital images taken with the device and voice recording capability for speech output, however, because the display areas for each button on the tango!, the image areas could become compositionally crowded. With the guidance of Speech-Language Pathologists and the participant's mother, I contributed to modifying and programming the device.

Figure 4. **tango! (PACER Center, 2008).**

To respond to Liz's need for a larger display areas within selections of a grid display and an increased number of display options and choices, Liz was upgraded to the Maestro in January 2013, one of the latest devices from DynaVox. The Maestro was designed to provide a greater display area and it allowed Liz to use 'key guards' designed to frame 12 buttons, twice the number of choices than her previous device. However, the increased choice came at the cost of

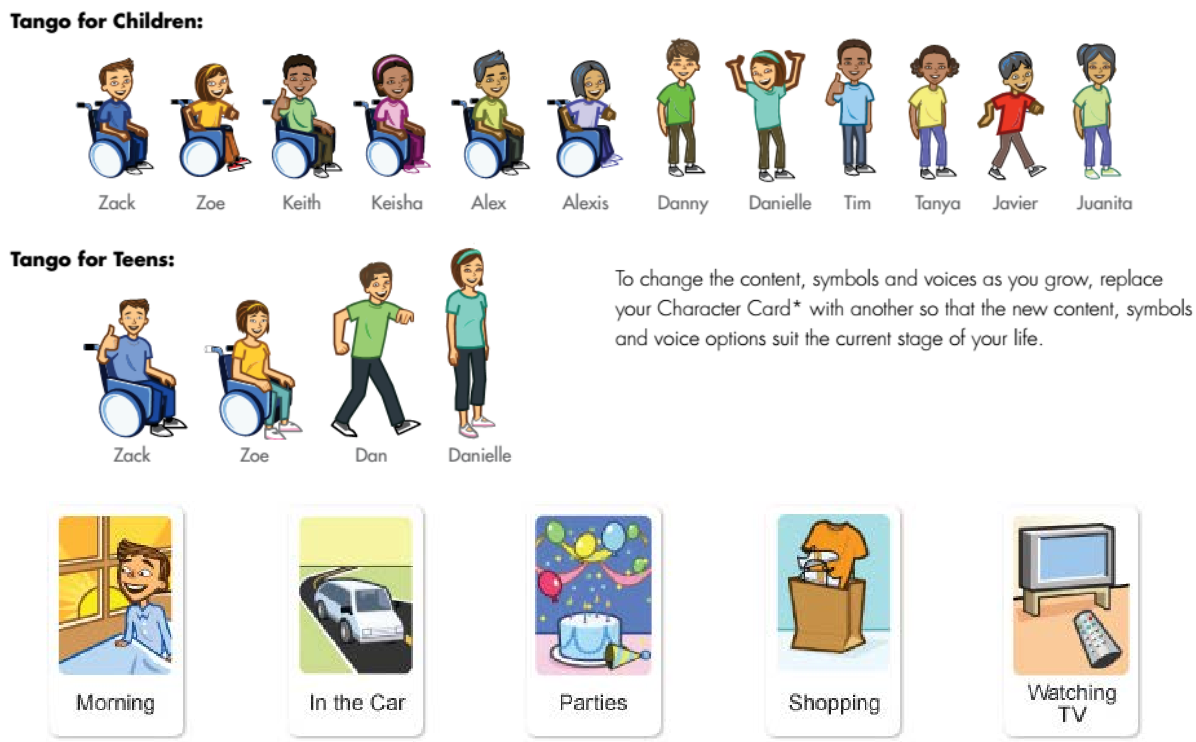


Figure 5*. *InterACCt avatars and symbols **(Tobii Dynavox, 2014)**

the specialized visual representations she had built associations and communicated with on the tango!. My role in programming the device increased exponentially as we reconstructed, reorganized, and redesigned Liz's lexicon.

Participant's History in the Research Setting

With few exceptions, Liz participated in art sessions in one particular art classroom, allowing her to develop an association with the space over the past five years. The room is so familiar, that she can lead new staff through the building to the art room, much to their amazement since the building is quite confusing for new-comers. The room consists of eight large, wooden tables and is equipped with many materials found in most art classrooms. This classroom is used for our after-school inclusive art class, which again associates the room with art activities. When setting up for an art session or research, relevant materials are either laid out or conveniently placed. Liz has participated in a variety of arts experiences in this room: dancing, drawing, music, ceramics, painting, writing, tracing, and singing. She is able to make it clear through her device that she knows where she is going when we talk about going to art, she has preferences in activities, she will negotiate less preferred activities if its followed by a favored one, and shows us things about herself through her ways of communicating and conveying meaning through interacting with another person.

CHAPTER FOUR

Methods

To respond to the urgent call from AAC researchers to explore how representation styles affect comprehension, I used current scholarly research to inform the design of my study investigating the effects of familiarity, abstraction, and realism have on the gaze of someone who uses AAC and has complex communication needs. I defined four thematic the areas of interest (AOIs) based upon familiarity and representation style: familiar and abstract, familiar and real, unfamiliar and real, unfamiliar and abstract. To determine trends toward one of the four categories of images, I measured the total durations quantitatively analyze higher occurrences within a particular area of interest (familiar abstract, unfamiliar abstract, familiar real, and unfamiliar real). To interpret aspects of images Liz finds most salient, I will qualitatively analyze the gaze patterns using Kress and van Leeuwen's theory of salience and theory of vectors. The assumption was that Liz would spend more time looking at images with more salient information and that she may prefer a particular kind of image.

Participant

Liz represents populations of adults and children who have both a complex and/or profound disability and have more complex communication needs that require the use of an aided communication system or technology. As stated by Blackstone, Williams, and Wilkins (2007), People who use AAC must be sought to represent their "characteristics, experiences, preferences, priorities, opinions, suggestions, and expertise must be sought, respected, attended to, understood, and employed in the [research], design, development, delivery, and evaluation of AAC systems and services" (p. 193). Liz is non-verbal and is a user of AAC devices and technologies to communicate using a speech-generating device as her voice. Liz represents adults who are emerging communicators and have complex disabilities and communication needs. There is no documented information pertaining to how many adults who are non-verbal that have profound disabilities are without communication tools. The lengthy process and dedication required to obtain, learn to use/program AAC devices, and develop the user's communication is more than what families are likely to pursue. People like Liz who use AAC are often excluded from research studies because their complexities bring more variables into the research; however, these are the people who will *use* the device.

Liz is a twenty-five year old female with Angelman syndrome. She received her first high-tech AAC device at sixteen and her prior experiences with communication tools were inconsistent and/or not practiced enough to enable her to communicate. She has also used handheld, laminated picture cards. Since the age of sixteen, she had/has three different communication devices, each with different visual vocabularies. She is able to successfully use her current device, the DynaVox Maestro, accordingly within contexts. Liz also exhibits her ability to understand receptive communication (thought to an unknown extent) to verify or decline questions using verbal terms that have been consistent over time. While verifying her ability to wear the eye tracker and participate in the study. I confirmed her abilities to direct her gaze in joint attention (as directed by someone so that both communication partners are looking at the same area), demonstrate her ability to identify named objects, and to differentiate like objects from one another. Liz was an excellent candidate for investigating the gaze patterns when viewing differing representations of like and differing images of varying familiarity to determine potential preferences, because she does extend more visual attention to preferred things.

Research Setting

To provide an environment and supports that would least interfere with Liz's participation in the study, I considered several aspects to create a study she could successfully participate in. Blackstone, Williams, & Wilkin (2007) note that participants with disabilities may require differing supports to participate in research effectively. To provide a space that would be familiar, comfortable, and therefore be less novel or distracting, I chose to conduct research in the room Liz has been coming to for art sessions for the past three years. Liz is familiar with a routine of coming into this space to participate in various arts activities, sometimes familiar and sometimes introducing new experiences.

Because this room already meets ADA standards and is spacious, there is ample room for movement. The classroom is also void of hazardous materials and care is taken to be aware of where Liz is seated and the proximity of materials and objects to prevent mouthing/chewing behaviors that could cause injury. During eye tracking sessions, Liz would be seated on the long side of a table, flanked by her service worker and the research assistant. In the middle of the table was a large computer display that I sat behind to control the slides and calibrate the eye tracker. The rationale for sitting behind the monitor is that Liz will turn her head toward whomever has spoken, and for eye tracking purposes I needed her to look at the computer screen. We found early in the study that if I spoke from behind the monitor, she would look for me by leaning to the side to peer past the monitor. To encourage her to look at the screen, voice recording was used and will be described further on.

Instruments and Measurement

To collect data in regards to how someone who uses AAC and has Angelman syndrome looks at images, I used eye tracking technology to capture areas of interest (AOIs) and durations of visual attention to analyze her gaze patterns. I used the ASL Mobile Eye 5 eye tracker, which captures high video quality and is minimal in design. The video quality was very clear, which allowed me to see details within images that caught her attention. The minimal design of the eye tracker

Figure 6. **Mobile Eye 5**

also enabled Liz's participation in the study because the only equipment she wore was a lightweight pair of clear glasses (Figure 6). The glasses are mounted with two small cameras over the right eye, attached to a wire going behind her back to the recorder/display box. The minimal equipment allowed Liz more freedom of movement and fewer distractions than more cumbersome eye tracking equipment. The ASL Mobil Eye 5 auto-calibrates to lighting conditions in the environment, making the calibration process more expedient and user-friendly. The visual range the eye tracker's environment capture area is sixty degrees horizontally and forty degrees vertically, but the eye tracking area is a 30° cone that expands out from the environment camera and collects the tracking data. The Mobile Eye 5 calibrates and captures gaze data through monocular tracking, meaning only one eye is tracked to collect data. Liz has slight strabismus in her right eye that potentially affected calibration and data collection to an unknown degree. During the study, her strabismus was not noticeable.

The eye tracker collected both qualitative and quantitative data, as presented during the analysis through eye tracker software that displays durations of the gaze within different areas and durations of fixations where the eye rests for more than 100 milliseconds. The software displays overlays of the gaze pattern over a period of time in the video recording of the eye tracking experience, which I analyzed over 3 – 6 second time periods. The gaze patterns were then visually analyzed using Kress and van Leeuwen's (2006) theories of the effects of salience and vectors on the viewer's gaze when looking at images to find visual patterns in Liz's gaze to interpret their potential relationships and indications of learned cultural patterns. I expected to find that she would view familiar abstract images in similar patterns as unfamiliar but real images. Additionally, I experimented with different design elements in unfamiliar abstract images and compared them to unfamiliar real and familiar abstract images, expecting to find preferences toward a style of representation.

Research Design

To gain insight into how someone with Angelman syndrome perceives representations of faces conveying emotion, I designed the eye tracking study to identify potential preferences toward salient aspects of facial representations and as supported by the fixations within areas of socially salient facial features. I chose images based upon various criteria that the image either

- displays similarity to an abstract representation of the emotion and its expression to selected symbols from the AAC device
- contains some self-identifying characteristics (such as young women with hair color similar to Liz's fair hair and the dark hair of her mother and siblings)
- is rendered with a higher level of expressiveness (typically by exaggerating facial features and using line for contrast and expression).

The images were divided into four categories of areas of interest AOIs: unfamiliar real, familiar real, unfamiliar abstract, and familiar abstract. The unfamiliar real images were of people similar in visual characteristics to Liz's appearance (light hair) or her family's (dark hair). Familiar real images were of family or friends. To compare representation styles of abstract images, I used symbols from her device that she either uses currently or has used within the last year for familiar abstract images and used unfamiliar abstract images found through Internet searches.

Sessions began with a preferred activity that engaged Liz in an activity and alleviated any wait time if equipment required set-up. Liz becomes excited and hypermotoric when seeing familiar people and activities like music provided an output for excess energy and a way to connect and communicate in a non-verbal manner. Methods to reduce wait periods was also needed to prevent safety hazards and dislodging equipment due to behaviors related to her disability. Experience informed me that periods of waiting, proximity to things in her environment, and/or my own inattention, however momentary, can result in sensory-seeking or safety hazards. I learned through work experience with Liz that periods of self-directed sensory behaviors lasted too long, it sometimes resulted in a notable decrease in her attention and inability or unwillingness to transition to another focus or activity. Her active curiosity enabled her to participate in the research well. The study did not require that Liz perform any motor movements, which alleviated the need for physical supports such as assistance with balance or countering tremulous/hypermotoric movements through highly variable levels of physical supports from minimum to full support.

To ensure her safety during participation, I was trained over the course of my employment with her to recognize seizure activity and certified in First Aid/CPR also including the service worker who accompanied her to the sessions. I paired and placed the images on the square display to allow enough visual area for each image to allow maximum size and distinction. The enlarged images on the display for eye tracking provided more space to discern specific areas the viewer is directing their gaze. The placement of the images also needed to be distinct in its area of either the right or left of the screen, which more genuinely reflected whether Liz was looking at the image on the right or left. Liz has identified vision issues to an unknown extent, but providing her with images that were as large as they could be while still occupying a distinctive side was important to inform the analysis. Placing the images in the lower portion of the display was closer to Liz's eye level while seated in a typical classroom chair. Because the calibration of the eye tracker and movements of the wearer can affect the accuracy of the data collected, these aspects had to be critically considered for my study.

During the first seven eye tracking sessions, we had to teach Liz what we wanted her to do to participate in the study and work out issues related to the study procedures. I began testing the procedures study with two control slides to test her visual acuity, a 'neutral' slide of a common object, and two test slides comparing various images. The control slides contained four images arranged 2 x 2 with the first slide having only two similar choices to find a directed item, the second control slide was arranged the same but had four similar looking items. I knew from experience that Liz's favorite thing eat is chocolate and she devotes her visual attention to it when in view, either as an image or the real food. When Liz eats snack mix that includes pieces of similar items to the chocolate pieces, she seeks them as priority and will lay down pieces mistaken as chocolate to then find chocolate. I hypothesized that she would direct her gaze to the chocolate chips when presented with control slides, and which confirmed my presumption of Liz's visual acuity. Sessions eight through thirteen, repeated most images in order to gather data across different days to accommodate Liz and to find patterns across different sessions. The fourteenth through the sixteenth session displayed images that are not AAC images, but uses different methods to convey expressive feelings through representational styles.

A favored computer program of Liz's also informed the design of the eye tracking sessions to cue and capture her visual attention. Liz seemingly demonstrates hyperactive gaze patterns from observation, but clearly demonstrates the ability to maintain visual attention to images and videos, which was validated during the fourth session when I played Leslie and the Lys music video for "Tight Pants Body Rolls." A puzzle game she plays at home could maintain her visual attention for 10-30 minute durations as she would touch the screen to reveal images (usually familiar and/or of family). Once the puzzle was complete, the screen would display intensely colored shapes and patterns while playing music. The eye tracking session was divided by sequences of four slides: cueing slide, a directive slide, the test slide, then a sensory/reward slide. To reinforce her performance in the study, she was highly praised and celebrated during the sensory slide. I employed bright and luminescent color, sound, animation, display size, and music to appeal to Liz's senses and request that she spend time looking at images that I showed her.

Sessions eight through sixteen all followed the sequence of the cueing, directive, test, and sensory slides. The sensory slides that contained animated gifs found through google searches that were highly animated, dynamic in motion, and appealed, as I anticipated based upon observation, to her. I rotated in new sensory slides when she seemed to become less interested in particular slides. Animation is documented as being highly attractive to people's gaze (Mineo Perschl & Pennington, 2008; Roche et al., 2014), so both the cueing and directive slides were animated gifs. Liz demonstrates an interest in Justin Beiber music videos through requests for more, so I chose full screen animated gif of Beiber. His head filled the cue slide and he would look up at the viewer while opening his eyes. I chose this representation because of its appeal to Liz and the visual performing what I wanted Liz to do: look up to the screen. To further request that she look, myself knowing that Liz has acute hearing and will look when her name is called from the correct direction, I recorded my voice to play during the slide to say “Hi [Liz]!” with enough inflection to convey a sense of excitement with my tone and inflection. The words “Hi [Liz]” were also typed on the screen in a contrasting color. I also sat behind the large monitor, because she knew that I was sitting in front of her and this positioning further enforces the idea of looking at the monitor.

Before presenting the slides I used for data collection, the directive slide followed the visual, textual, and auditory modes to call for her attention. I had to include directions for Liz so that she knew what I wanted her to do when presented with the image slides, so I designed a slide directing Liz to “look with her eyes” through an auditory and textual prompt; a familiar phrase for Liz. This slide displayed a bright red screen, anticipating the color might be eye-catching, with a rectangle defining the middle third of the slide. The middle area contained an animated gif of someone opening their eyes and framed to only display the eye area of the real person’s face, while simultaneously zooming in to a small degree, the viewer then being closer to the eyes as they open. The cueing and directive slides were found to be effective and were repeated as necessary until she looked at the screen for more than a glance.

After her attention was engaged, I displayed the image slide containing a pair of images. The rationale for selecting images to include varied by the type of representation. Most importantly, I wanted to include symbols that she uses or has used for an extended period of time on her current AAC device. I took pictures of the pages I have programmed into the Maestro, and cropped them to display on the image slides

For purposes of consistency in data, only sessions 8-11 and 14 are represented in this thesis and rationale for including only these sessions will be discussed, so that the focu.s on describing the rationale for choosing images that were displayed during these sessions is presented first. I designed displays using 231 of varying repetition, but depending upon study conditions, the sequences were flexible and allowed Liz freedom to retract her participation, communicate, or intensity of her desire to engage in a different activity. During the sessions analyzed, Liz viewed a total of 65 familiar-abstract, 63 unfamiliar abstract, 34 unfamiliar-real, and 9 familiar-real images. Only nine familiar-real images were used because we already confirmed her attention to familiar pictures of friends, family, pets, and activities through her puzzle computer game. The exclusion of the first seven sessions has been identified as the time spend teaching Liz to participate in the study; the twelfth and thirteenth sessions were excluded because Liz was still recovering from minor surgery that affected her ability to participate at her previous levels. The fifteenth and sixteenth sessions are more expressive, including artistic representations, but these sessions lack the consistency needed to reveal trends.

Procedures

Once sessions began after greetings were exchanged, we often played music, Liz's most requested activity, before the eye tracking began. I adjusted Liz's position in the chair to square her shoulders to the table. I placed and adjusted the eye tracking equipment on Liz, I explained to Liz in familiar language that the session has begun and what we would be doing. Service workers were directed to be aware of Liz's movements to prevent the glasses from being touched and affecting calibration. The service workers were also asked to encourage Liz to look forward due to Liz's tendency to tilt her head back and look down her nose to view and examine things she sees, which would be detected by the eye tracker as being out of range from the image capture area.

Calibration of the eye tracking equipment was the most critical in the process of collecting data. Because Liz has hypermotoric movements and impulsive behaviors (such as reaching for any new item within her proximity), all aspects of the study had to maintain her engagement. The eye tracking glasses had to be secured using a soft, adjustable band (as typically seen to hold glasses around one's neck). When adjusting the monocle so the beam of (invisible) light reflected correctly into her eye, I explained to Liz that I would hold her head so I could "fix the glasses." Liz often engages in rapid, successive nodding, sometimes throwing her head back, so gently support her head while I calibrated the monocle prevented injury to Liz and the equipment. Once the glasses were on and adjusted, her service work and my research partner would help Liz to keep from moving the glasses. The wire attached to the box displaying the camera directed at her eye and saving the data was conveniently placed behind Liz's back and prevented dislodgement.

To redirect her attention during the calibration, we used interventions to assist with the calibration process. We were unable to ask Liz to look at a calibration point (such as a dot on a screen), so we used an incentive that captured her gaze reliably and for longer durations. From direct observations over two years, Liz almost always fixates her gaze on food items until it is available or she is redirected. The calibration points were small, colored chocolates or nut that my research assistant would hold out of arms reach until I matched the camera with her gaze on the target. The food was then placed on the table, which required her to work on fine motor goals identified and created by Liz's occupation therapist. She had to grasp the food using her thumb and forefinger, and we would continue this process until we had at least five calibration points.

We often could calibrate more than five points, which increased the accuracy of the wearer's eye movements. We calibrated as many points as possible and then checked as she looked at small candy and the eye tracker detected her gaze directly on the candy.

After performing calibration procedures and confirming its proximate accuracy, I would begin playing the slideshow sessions. The recorded eye tracking sessions tended to last around twenty minutes, but the durations of exposure for the image slides was highly variable. Depending upon Liz's attentions, desires, and enticements, I toggled the four slides in the sequence as a device to re-attract her attention in efforts to entice her to spend time of her choosing to look at and examine the images.

During durations when the image slide was displayed, the service worker and research assistant would also cue Liz to look at the screen verbally or by pointing to/tapping the monitor in as 'neutral' and area as possible to not direct her attention by referencing a particular image. They were also asked to refrain from naming any images so as not to influence Liz's gaze. As sessions continued, the service worker and faculty member would be attentive to Liz's needs and requests at any given time.

The raw data was then uploaded into ASL Results Plus to define areas of interest, reveal gaze patterns/trails, and quantitative data of fixation durations collected during each session. The defined AOIs then output durations of visual attention in particular areas in millisecond increments. Sessions that did not record slide sequences due to user error were excluded from analysis. Between sessions eleven and twelve, Liz underwent an oral surgical procedure that greatly impacted her ability to eat. This inability made calibration difficult due to medications that might have affected her eyes and/or disinterest in the provided soft food items; which excluded session twelve. Sessions fifteen and sixteen were excluded because the images were of different emotional and situational renderings, although the decision to move to a new set of images was due to perceived disinterest in many sessions repeated viewing the some of the same images. Therefore, sessions eight, nine, ten, eleven, thirteen, and fourteen were used for analysis because the consistency of some images intended to reveal gaze patterns over time.

CHAPTER FIVE

Results

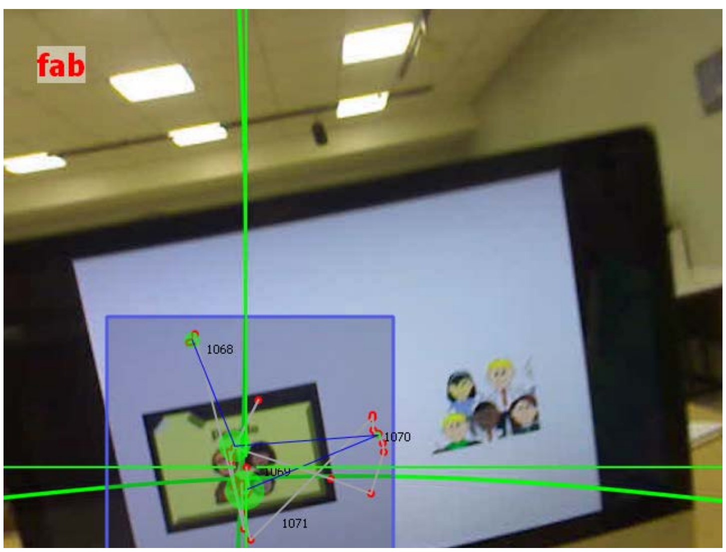
The total number of fixations for each of the four areas of interest (familiar abstract, unfamiliar abstract, familiar real, and unfamiliar real) were recorded as well as the average duration of fixations, but the data does not reflect the full scope of the participant’s visual attention. Due to factors related to restrictions of the eye tracker and Liz’s movement and postures for viewing the display, the equipment could not encompass all of her gaze patterns. Although several variables influenced data collection, the data does exemplify several interesting aspects of typical and culturally learned gaze behaviors.

As discussed in previous chapters, Liz’s range of motion exceeds the parameters of the eye tracker, which severely limits the total recorded areas of interest in conjunction with postural factors changing how much of the environment was captured. Musculoskeletal development and spinal fusion surgery for scoliosis has resulted in Liz having a twisted spine, and when seated, she tends to orient herself slightly left or right. These factors then influence how she looks at the display and restricting what the eye tracker could capture of the environment and tracking data. Liz also tended to lean toward the screen and/or look down her nose while viewing the images, which were known prior to the study.

The eye tracking capture radii start from the point of a 30° cone out toward the environment, creating a smaller capture area when close to the screen. At times, Liz would lean close to the display while viewing images, therefore restricting data capture. Liz has notable range of motion of her eye, in addition to a tendency to tilt her head back and look down her nose both of which also affect how much data can be recorded. Periods which required removing and recalibrating the equipment also altered how the data was collected for the remainder of a session. For quantitative analysis, the five analyzed sessions recorded information for each type of stimulus (familiar abstract, unfamiliar abstract, familiar real, and unfamiliar real). One session is missing data due to user error, further influencing the data that is represented.

Of the five sessions that were analyzed from this study, only one session generated fixation points. The four sessions that did not record fixation areas reflected hypermotoric eye movements, revealing that during these sessions, Liz's eyes were "constantly moving" or did not rest in an area long enough to show fixation points (areas where the eye rests within 1° of a point for more than 100 milliseconds). During analysis, the areas of interest (AOIs) were defined by rectangular shapes that would track durations of time spent looking within a proximal area around each image. Figure 7 demonstrates how an area of interest is recorded and subsequently analyzed. The AOIs recorded how long she spent looking within the defined area, as well as the sequential gaze pattern:

Figure 7. **Eye tracking capture**



Note. **"fab" in the upper left corner indicated the image within the area of interest (the blue box) is categorized as a familiar abstract image.**

The translucent blue box defines the area of interest around the left image, and in this example, a familiar-abstract (fab) image. The green crosshair show the point at which Liz's gaze is looking, which can be more or less accurate depending upon how well her eye is calibrated to the equipment. The lines and red dots indicate her gaze pattern and the numbers indicate the sequence of her gaze pattern. The green circles show definitive fixations on a particular area whose relative size indicates longer or shorter fixation durations (the larger the green circle, the longer the fixation duration). The data collected during all of the session also reflects her gaze trail, allowing me to view where her eye is moving directionally and chronologically, however, the chronological data can only be shown at a fixation point, therefore restricting some analysis of specific images.

Table 1. Fixation data

Areas of Interest	Average number of fixations	Average duration of all fixations	Average duration of fixation
Familiar abstract	94.5	22.165 seconds	0.231 milliseconds
Unfamiliar abstract	118.25	25.83 seconds	0.236 milliseconds
Unfamiliar real	83	17.46 seconds	0.211 milliseconds

The quantitative analysis seems confirm my hypothesis that Liz trended toward abstract images. As previously mentioned, observations have shown Liz's preference for photographs of familiar people, so familiar real images were not heavily used in the study. Table 1 reveals an increase of how many times Liz looks at unfamiliar abstract images. The average number of fixations shows the total number of times she looked at images of each category, and the average

Table 2. Image categories and number of views

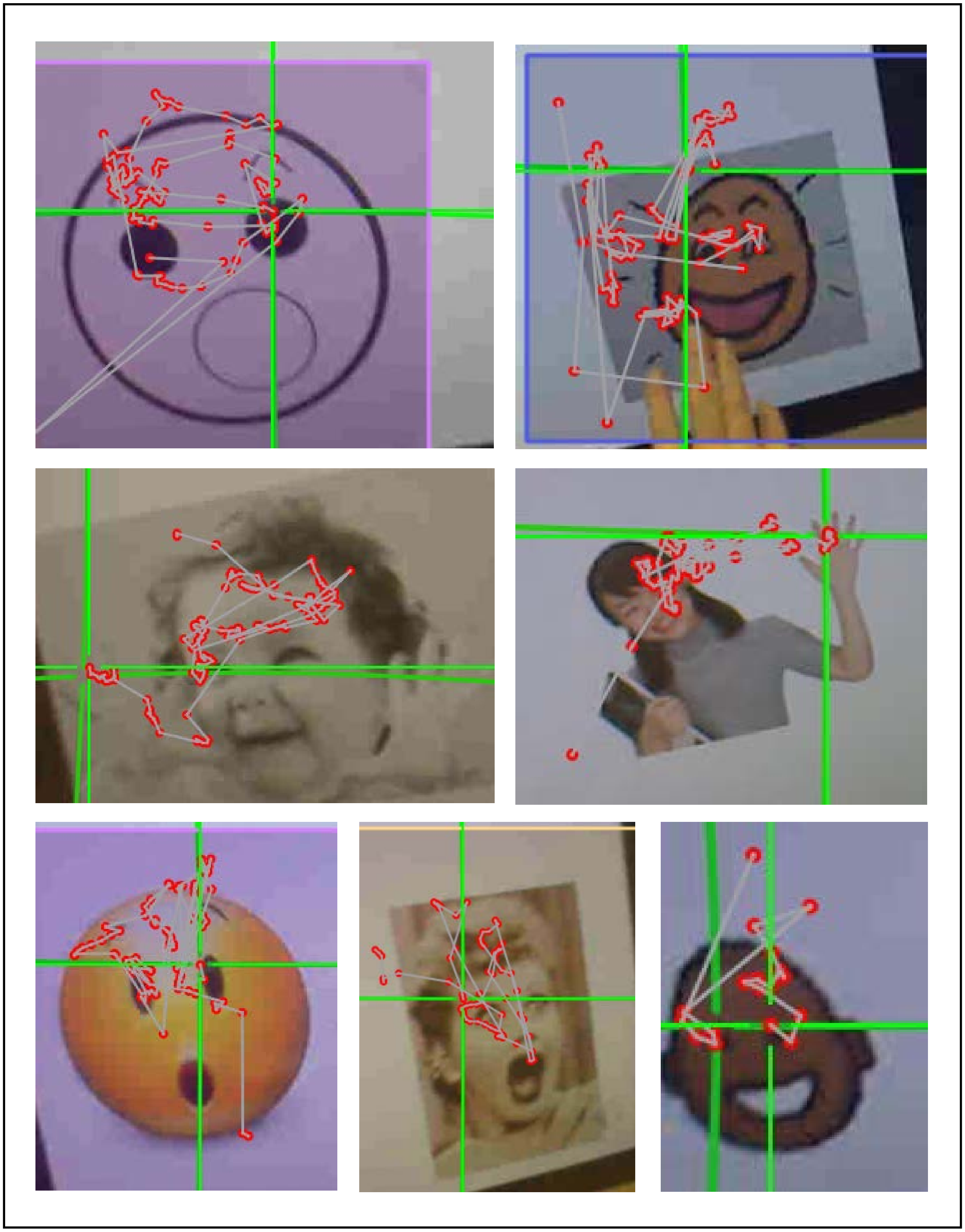
Image Category	Number of images viewed
Familiar abstract	65
Unfamiliar abstract	63
Unfamiliar real	34
Familiar real	9

duration of all fixations is the total average for all of the analyzed sessions. The average duration of fixations is the average of the amount of time she would fixate in an area, showing that while viewing an image, her fixations would last for over 200 milliseconds. Although the average fixation durations were longest with abstract images, the difference in time is minimal. However, the average number of fixations across all five sessions shows higher occurrences of looking at unfamiliar abstract images. When the total number of images from each category is compared with the averages (Table 2), the averages run slightly parallel to the total number of images. The abstracted images do show a longer amount of time looking at unfamiliar abstract images, but the increase may be due to the introduction of different images in the last analyzed session. As sessions increased in duration and we could go through more slides, I decided to add different images to help maintain her interest in viewing slides. During the latter sessions, Liz may have lost interest in some of the repeated images and shown more attention to newer images.

The images were shown with varying frequencies during the analyzed sessions. As previously mentioned, the recorded data does not reflect all of the images she was shown, so other images and increased frequencies were present either during other sessions or were not captured due to data loss. Half of the images were shown two to three times and the other half of the images were shown four or more times. The images on the test slides from the first analyzed session were shown most frequently (ten to eighteen times) because we repeated the slide session five times.

A trend that emerged from this study was visual attention to socially salient characteristics of the face (Figure 8). The event was first noted when reviewing video as she looked at the directive slide when her gaze followed the edge of the left eye counter clockwise. As seen in Figure 8, these samples demonstrate visual attention mostly to the eyes and around other salient and meaningful aspects that can be used to interpret emotions, such as the hands and mouth. Evidence from the study supports her attentiveness to socially salient features whether viewing images that are abstract, real, familiar, or unfamiliar. This trend will be further discussed in the following chapter in relation to Kress and van Leeuwen's theory of salience.

Figure 8. **Salience**



Note. **These recordings of gaze patterns demonstrates how her gaze tends to spend more time around the eyes, regardless of the images' color, contrast, realism, abstractness, or familiarity**

CHAPTER SIX

Discussion and Implications

The evidence collected during the study revealed captivating gaze patterns of how someone who is non-verbal looks at representations of emotions. There were many durations of looking that collected enough information to show her attention to the most salient characteristics of the face that convey emotions and that vectors may help to direct her gaze toward these characteristics. The following chapter will discuss quantitative data and qualitative data that supports Kress and van Leeuwen's theory of salience and theory of vectors.

Salience and Vectors

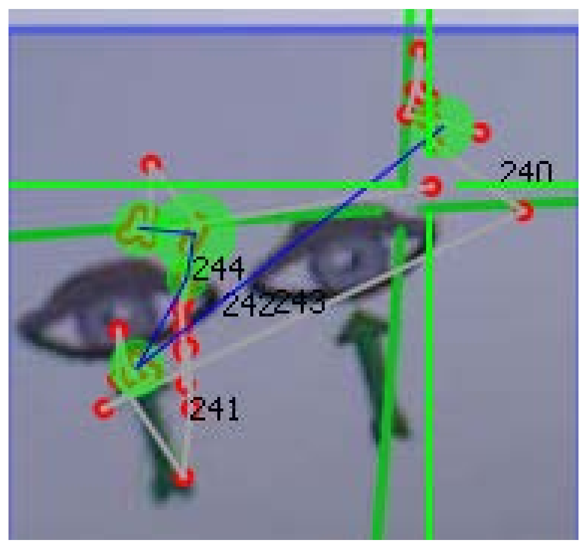
Evidence from the eye tracking study demonstrates that Liz is attentive to socially salient features on several styles and familiarity of images. Several studies support either real or abstract images to display the most salient features to enable faster processing of the image and ease for the user to make meaning of. The methods used to teach the person learning to use an AAC device also have an immense impact on acquisition of skills. Kemner, van der Geest, Verbaten, and van Engelland (2007) found in their study that participants with autism demonstrated greater fixation patterns in socially salient areas when the line drawings include more visually complex rendering, although the relevance of visual complexity specifically in regards to line may or may extend to emerging AAC users. My evidence supports attention to salient areas of the face, Liz's ability to be attentive to these features demonstrates her interpretations that salient features of the face (eyes and mouth) convey the most meaning, thus spending more time looking in these areas.

Kress and van Leeuwen (2006) define salience as "the degree to which an element [aspect of an image] draws attention to itself, due to its size, its place in the foreground, or its overlapping of other elements, its colour, its tonal values, its sharpness of definition, and other features" (p. 210). As shown in Figure 8 in the previous chapter, Liz demonstrates gaze patterns that focus on the most socially salient areas of the face in three categories of images: familiar abstract, unfamiliar abstract, unfamiliar real; the fourth category of familiar real can be and has been demonstrated daily, so few images of this kind were included in the study. The documented attention to the face's salient characteristics, regardless of representation style, indicates Liz's ability to successfully identify and attend to socially salient areas of the face in both realistic and abstract terms.

In Graham and LaBar's (2012) study examining visual attention to faces during functional magnetic resonance imaging (fMRI), they had participants look at faces both oriented normally and inverted, concluding that it is the upper area of the face that the eye gravitates toward, regardless of how the face is oriented. Their study showed participants looking at inverted faces would begin at the mouth, where the eyes would be, rather than looking at the eyes on the bottom (Graham & LaBar, 2012). However, their study fails to account for cultural or learned gaze patterns. Because many aspects of our culture orient text and images to be 'read' or looked at from top to bottom, participants are enculturated to gaze behaviors typically found in the US and many other countries.

Evidence from the eye tracking study demonstrates that Liz is attentive to socially salient features on several styles and familiarity of images. Several studies support either real or abstract images to display the most salient features to enable faster processing of the image and ease for the user to make meaning of. The methods used to teach the person learning to use an AAC device also have an immense impact on acquisition of skills. Kemner, van der Geest, Verbaten, and van Engelland (2007) found in their study that participants with autism demonstrated greater fixation patterns in socially salient areas when the line drawings include more visually complex rendering, although the relevance of visual complexity specifically in regards to line may or may extend to emerging AAC users. My evidence supports attention to salient areas of the face, Liz's ability to be attentive to these features demonstrates her interpretations that salient features of the face (eyes and mouth) convey the most meaning, thus spending more time looking in these areas. The salience of images, according to Kress and van Leeuwen's theories, can influence connections and disconnections of elements within the image through vectors, and decadence supports that vectors do function to move the eye. Art education explains vectors using the principles of design being organized to anticipate the viewer's eye movements. Their theory of vectors is related to connections within images, which are "the degree to which an element is visually joined to another element, through the absence of framing devices, through vectors and through continuities or similarities [elements] (Kress & van Leeuwen, 2006, p. 210).[2] Vectors direct the gaze creating connections or relationships between elements. Kress and van Leeuwen (2006) propose that vectors engage elements in a connection, even more so when the vectors are arrows, which may influence the gaze's directionality.

Figure 9. **Vector**



Note. **Gaze following the implied directionality of the left arrow from fixation points 240-242, then at 244, lingers longest at the eye, *Vector.***

Although studies have shown that children and adults on the autism spectrum generally exhibit atypical gaze behaviors, Liz

[2] Kress and van Leeuwen (2006) also have a theory of disconnection: the extent that visual elements are separate from each other through various visual devices through framing devices, empty space, discontinuation of a visual element, and others.

contradicts these results (Gillespie-Smith & Fletcher-Watson, 2014; Graham & LaBar, 2012; Riby, Doherty-Sneddon, & Whittle, 2012; Riby & Hancock, 2009). Many of these types of eye tracking studies compare people with autism to people who are neurotypical, and seek to understand how people with autism look at and process faces and emotions. While this type of research is needed, there has been little research investigating how other people with disabilities look at and use images, especially those who are non-verbal. Although Angelman syndrome is different from autism, many of her behaviors are similar to those characterized with autism. Considering that I was unable to find any eye tracking studies that included people with Angelman syndrome, my study demonstrates that someone who is atypical in neurocognitive development is able to attend to salient aspects that provide information about emotional states and is able to interpret images of varying representations.

Of the sessions analyzed, I found two examples of Liz following vectors within an image, reflecting Kress and van Leeuwen's theory of vectors, and possibly indicating that vectors used in AAC images could assist in meaning-making practices. The eye tracker recorded two instances fixation points following vectors, both literal and implied, that directed her gaze toward a particular path. In Figures 8 and 9, the fixations points are numerically represented and show the chronological order of where the gaze moving. In Figure 8, the gaze enters from the right and level with the eyes, then moves from the bottom of the left arrow underneath the eye and up in the direction of the arrow to the eye. Figure 9

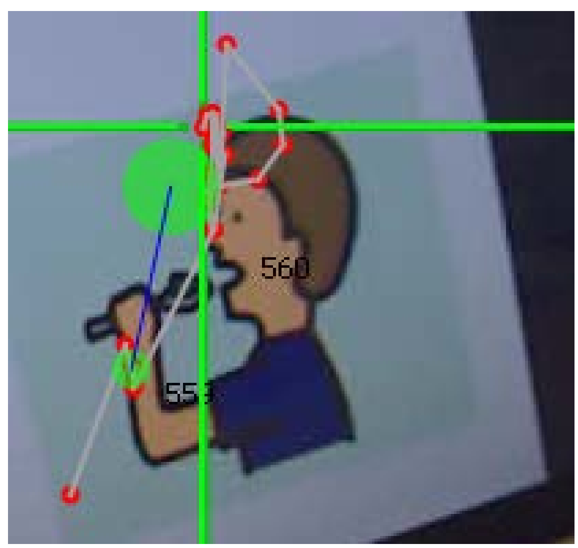


Figure 10. **Implied vector**

supports the implied vector/relationship of the hand holding a utensil with food. The hand/utensil/food precede her gaze moving to the head, which confirms an establishment of the relationship between these elements of a familiar abstract and also animated symbol. Further research could support and explore the use of vectors in images designed for AAC symbols, thus further enabling children and adults who use AAC to making meaning of AAC symbols quickly and effectively.

Implications

“The goal of AAC interventions is to provide children [and adults] with access to the power of communication, language, and literacy” (Light & Drager, 2002, 21). Literacy is “a learned capacity to use a complex set of abilities to identify, understand, interpret, and compute” visual texts (images), tactile texts (Brail), and written text that enables people to “achieve their goals, develop their knowledge and potential, and participate fully in their communities and wider society” (Balkom & Verhoeven, 2010, p. 149). Symbol systems on AAC devices must be informed by evidence supporting the designer’s representational choices so that people who use AAC can develop visual literacies. But the symbol systems are only as effective as the communication opportunities needed to develop visual literacies required to develop proficiencies in communication. For AAC interventions and devices to be successful, the individual must receive more input and opportunities to communicate (Blackstone, 2007; Alant, Bornman, & Lloyd, 2006). And, communication partners must develop a sensitivity for contextual information and the unique nature of communicating through symbolic visual representations (Alant, Bornman, & Lloyd, 2006, p. 146). To compound the issues of comprehension and access to communication opportunities, a lack of evidence and best practices for AAC strategies and interventions has been noted in this field of research (Alant, Bornman, &

Lloyd, 2006, p 143). Recognizing the complexities of issues surrounding AAC and the people who use it demands greater respect for how people communicate and how we can facilitate greater communication for people who require an alternative means to communicate.

The ability to consider the many facets, influences, and contexts of each student or participant allows educators and researchers to learn how to best communicate with, engage, and learn from people who use AAC and/or have a profound disability. The people who use AAC need to inform the research and the research needs to inform best practices. Specifically in the field of art education, we can do better to empower students with communication skills, whatever abilities and disabilities that person enter the classroom with. The investment into Liz's develop in the arts helped me to design and refine engaging and skill building experience facilitating development of her communication, independence, power of choice, psychomotor skills and motor plans, and experiences that some assessors claimed she would never do. Further expansion into research and learning interventions with learns who have profound disabilities to inform inclusive education practices and research in AAC design.

Although separate fields explore how we make meaning from images and art, synthesizing knowledge from these disciplines can help expand existing bodies of knowledge, including art education. Best practices for teaching students with profound disabilities is emerging into art education research to explore ways to create meaningful experiences in the art classroom to engage, include, and collaborate with, to design experiences that will facilitate development of psychomotor and communication skills (Coleman & Cramer, 2015; Derby, 2012; Loesl, 2012; Malley, 2014. Unfortunately, best practices for approaching, teaching, and assessing students with profound disabilities and complex communication needs are only now beginning to emerge. For over two decades (and likely more), the field of art education identifies that preservice art educators are unprepared to teach students with disabilities, but even more so to teach students with profound and complex disabilities (Bains & Hasio, 2011; Blandy, 1994; Guay,1994).

The art classroom is already primed to create, read, interpret, and use visual images and an appropriate space for developing experiences that teach visual communication skills to students who use or would benefit from AAC devices. An inclusive space where more abled students can learn about how their classmate(s) communicate and explore the development of images for a visual language allows connections with learners who communicate differently. Research remains sparse and fragmented when looking for best practices for teaching these students, but art therapy can inform education practices to understand how art is a crucial component to the education of these students. Art instructors are unique in that they are already primed to work with the visual, and with an informed approach, we can provide engaging opportunities to develop functional and communication skills for learners with complex needs.

Lund, Millar, Herman, Hinds, and Light (1998) found a great discrepancy in how children design visual representations compared to AAC images. The art classroom provides a great opportunity to design collaborative experiences that explore how we make meaning and what visual representations we associate with meaning. Then images can be used to explore how a student who uses AAC looks at representations to try and uncover preferred representations that the student can use to communicate, while also adding to urgent and critical research about AAC design and representations. “In order to close the gap between the state of the science and the state of the practice, we need to increase public awareness, improve preservice and inservice training for rehabilitation and education professionals” (Constigan & Light, 2010; Light & McNaughton, 2012, p. 42). Art educators can facilitate functional skills through well-designed art experiences and facilitate developments in visual communication skills for not only for learners who use AAC, but all learners. I hope to add to current practices and research possibilities so that underserved and unheard children and adults with profound disabilities can have access to voice, choice, and independence.

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APPENDIX: IRB Approval Letters

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From:	Social/Behavioral IRB
To:	Nicole Allen
CC:	Cynthia Bickley-Green
Date:	1/23/2015
Re:	UMCIRB 13-002380 Exploring Engagement

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 1/23/2015 to 1/22/2016. The research study is eligible for review under expedited category #6, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
IRB Consent form Nicole Allen.doc	Consent Forms
Protocols_NAllen2015	Study Protocol or Grant Application

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

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Amendment Approved

ID: Ame1_UMCIRB 13-002380

Title: Amendment 1 for IRB Study #UMCIRB 13-002380

Description: Your amendment has been approved. To navigate to the project workspace, click on the above ID.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

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Amendment Approved

ID: Ame2_UMCIRB 13-002380

Title: Amendment 2 for IRB Study #UMCIRB 13-002380

Description: Your amendment has been approved. To navigate to the project workspace, click on the above ID.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418