Efficacy of Color and Spatial Cues for Augmentative and Alternative Communication Boards

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EFFICACY OF COLOR AND SPATIAL CUES FOR AUGMENTATIVE AND
ALTERNATIVE COMMUNICATION BOARDS

A Thesis
Submitted to the School of Graduate Studies and Research
in Partial Fulfillment of the
Requirements for the Degree
Master of Science

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Indiana University of Pennsylvania
May 2013
We hereby approve the thesis of

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Candidate for the degree of Master of Science

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Timothy P. Mack, Ph.D.
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The current research examined how young children identify pictures of emotions and whether two types of visual cues help to increase accuracy and/or rate of response. There is inconsistent evidence supporting the use of these visual cues to facilitate communication with augmentative and alternative communication (AAC) devices. Forty-four typically developing children, ages four to six years, participated in two studies to examine the effect of cueing techniques on accuracy and rate of response of emotion icon identification. In Study 1, accuracy and latency were compared under four different cueing conditions: (a) no cues condition; (b) color cue condition; (c) spatial cue condition; and (d) combined color and spatial cue condition. In Study 2, participants were randomly assigned to one of four teaching groups: (a) use of color cues; (b) use of spatial cues; and (c) use of the combined color and spatial cues; (d) use of unrelated icons/ control group.
ACKNOWLEDGEMENTS

The completion of this thesis was only possible with the support and encouragement of the following people:

Joseph, Seth, Nathaniel, Reilly, and Mackenzie Morgan
Dr. Lisa Hammett Price
Dr. David Stein
Dr. Jill Brady
Dr. Cynthia Richburg
Shawnee Makin
Maggie Bodenlos
Kelly Zigarovich

Thank you all for the inspiration and guidance.
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Augmentative and Alternative Communication

Children with complex communication needs are children who experience difficulty orally communicating due to diagnoses such as autism, cognitive impairment, Down syndrome, traumatic brain injury, and cerebral palsy. Children with complex communication needs are typically nonverbal or have unintelligible speech that impedes communication with others. Because of this, they require augmentative and alternative communication (AAC) methods in order to express themselves. AAC methods include a variety of high-tech, low-tech, and lite-tech communication systems. High-tech AAC devices are typically speech-generating devices with a digital interface. Low-tech devices differ in that they use a more simplistic speech-generating setup without an interactive screen that opens new pages. Lite-tech is the most simple form of AAC, using simple communication boards or sheets of exchangeable, laminated cards to communicate without speech-generation.

Along with difficulties with oral communication, AAC users often have multiple diagnoses such as cognitive impairment or autism, which inherently result in further complications in communicating. The patterns of typical language concept acquisition pose just one challenge to children with complex disorders and diagnoses. Children begin to accept pictures as representations of actual objects or words around three-and-a-half years of age (Beukelman & Mirenda, 2005), and this age coincides with an important surge in language development. Children beginning to use AAC devices at this time,
therefore, have the joint task of learning language skills necessary to communicate and learning to manipulate the different elements of an AAC device, such as physical manipulation of print pages or a computer device, navigation of pages, and icon selection.

The rate at which children who use AAC communicate is much slower than rates for children who are typically developing and using speech. According to Beukelman & Mirenda (2005), AAC users’ message output is “often two to eight words per minute” (p.67). Comparatively, Goldman-Eisler (1986) found that non-disabled individuals with typical communication skills speak 150 to 250 words per minute. Rate of response, therefore, is an obvious factor in message delivery for users of AAC. This is because AAC devices typically rely on the user scanning an array of icons while also planning the order of multiple icons to transmit messages. These cognitive tasks impede speed and sophistication of transmitted messages. Locating and accurately identifying words or phrases represented by graphical icons on a device is the child’s first step to creating a message. The rate of communication can be improved by selecting icons that are easy for children to recognize, and by organizing icons on the device so that they can be located quickly.

Choosing icons is a difficult task. Concrete ideas like nouns and verbs are much easier to convey in line-drawn symbols or photographs than abstract concepts like emotions. The inability to express emotions creates frustration, which can in turn increase the occurrence of physical acts of aggression in lieu of communication. For a child without the means to orally communicate feelings, physical aggression may be the only available means of communication. Emotion icons need to be transparent or easily taught to prevent unnecessary hours spent on training children to use the AAC device rather than
focusing on learning language concepts (Light et al., 2004). When a device includes icons that the child can easily recognize, the focus of treatment can be on increasing the number of communication turns and the success of communication attempts. Greater success with communication will lead to a decrease in tension and negative feelings surrounding communication. Unfortunately, it is often easier and faster for children with complex communication needs to communicate by physical means when they are upset. Physical means are faster compared to the slow rate of message transmission using AAC devices. It is necessary to assist individuals with complex communication needs to communicate emotions more easily and more quickly via AAC devices. Any technique that creates easier access to communicating emotions, therefore, will be especially helpful for children with complex communication needs.

**Icons**

Words and phrases may be represented on AAC devices in a number of formats. For AAC users who are literate, text may be the only necessary representation of vocabulary. However, not all users of AAC are literate, and young children who are not yet literate need another way to represent words and phrases on a device. Picture representations provide an alternative. Pictures may range in format from actual color or black-and-white photographs to line-drawn symbols (Beukelman & Mirenda, 2005). Mirenda and Locke (1989) noted in their research that users of AAC ages four to twenty-one years old were able to identify targets with greater accuracy using colored photographs compared to black and white photos or line-drawn symbols. While photographs provide a more accurate depiction of the targeted vocabulary, it is unrealistic to use photographs as the sole representation on most devices. One reason is that high-
tech devices have large yet limited memory available to store the visual information used on the device; photographs use more memory, allowing for fewer photographs to be stored compared to the number of line-drawn symbols that may be stored. Using simpler representations like line-drawn symbols allows the addition of a greater number of vocabulary options to high-tech devices.

Simpler representations also allow children to generalize icons to multiple representations of similar objects. Photographs of specific items may limit a child’s understanding of that photo to the one item depicted. Similar to what occurs during normal child development, children move to use symbols or words to refer to general representations of the word rather than just one particular object. For example, typically developing children initially may use the word “dog” only when referencing Grandma’s pet golden retriever. From a language standpoint, the child would develop the ability to generalize the word “dog” to a broad category of canine representations. It is not until after the third birthday that typically developing children recognize the picture communication symbol (e.g., a line drawing of a dog) as a general symbol for a concept (Beukelman & Mirenda, 2005). The use of less concrete icons allows users of AAC to generalize words in the same way. The least concrete and thereby most abstract symbol that communicators use is the written word. As individuals move from photographs to picture symbols to written words, they are developing fluency with more abstract iconicity that begins the process of the development of literacy skills. For these reasons, photographs sometimes serve as an appropriate starting point for individuals needing concrete symbols but are not the ultimate goal or the most appropriate representation for all AAC users.
Currently, multiple collections of icons are commercially available for use on AAC devices. Icons in these collections vary in their degree of transparency. For example, words like “cookie” are considered to be transparent because the drawing or photo looks like the object itself. Words like “beautiful” are much more opaque or difficult to depict in a two-dimensional drawing or even a photograph of some kind. Transparent icons are easier for young children to understand compared to opaque icons. Opaque icons are especially problematic for young children initially learning to use an AAC device. They are already engaged in learning language with the added burden of learning to navigate and interpret the graphic displays of the device. Speech-language pathologists must find a way to implement AAC with young children who are still developing language skills in a way that does not overwhelm children or discourage communication due to the effort required. Successful communication compared to the effort needed to learn a system has been referred to as “the magic versus the cost of communicative competence” (Wilkinson & Jagaroo, 2004, p.124). The goal of the speech-language pathologist should therefore be to increase the magic while decreasing the cost. This includes facilitating recognition of icons that are not as transparent.

**Emotion Icons**

Depicting emotions through line-drawn symbols has proven to be a difficult task. Given the opportunity to group and organize AAC symbols, typically developing children are able to purposefully arrange concrete vocabulary more often than abstract vocabulary. For example, Fallon et al. (2003) found that children were able to pair together more pictures representing concrete vocabulary (i.e. “milk” and “cookie”) than abstract vocabulary. Emotion icons are considered to be abstract vocabulary and, therefore, pose a
problem for young children attempting to use pictures to communicate feelings. Children must be able to identify the icon as a representation of the referent in order to manipulate the icon and pair it with other icons for sentence creations. This is particularly problematic for children with special needs considering that even typically developing children struggle to accurately identify icons that represent emotions.

One study of the icons used to represent different emotions demonstrates that there is great variability in how young children who are typically developing choose the symbols (Visser, Alant, & Harty, 2008). Visser et al. (2008) found that although 99% of children picked the expected symbols for “happy,” the same children were less consistent with “sad” (73% average), “afraid” (74% average), and “angry” (85%). The authors of the study suggest that “happy” may have been more easily recognized as it is a feeling that is displayed universally with similar facial features, whereas the other emotions are expressed with greater variability among humans and, therefore, they are less recognizable. Similarly, Wilkinson and Snell (2011) found higher accuracy for positive emotions compared to negative emotions; for example, the children in their sample demonstrated a mere 30% to 45% accuracy for the emotion “scared” but a 72% to 100% accuracy for the emotion “loving.” Both of these studies demonstrate that recognition of emotion is challenging even amongst typically developing children, resulting in varied accuracy depending on the emotion depicted. Children with special needs who require AAC may expect to experience similar or even greater difficulty in identifying emotions through pictures.

In addition, users of AAC often have diagnoses that lead to decreased ability to identify emotions specifically. Children with autism are generally known to have
decreased ability to identify emotion in the faces of others (Beukelman & Mirenda, 2005). Because of their difficulties with communication, this population represents a large portion of AAC users and highlights the need for facilitating emotion icon identification in AAC systems. Research shows that children with autism identify emotions using only upper facial features at no more than chance accuracy (Gross, 2004). This is consistent with evidence that they avoid looking at the eyes of their communication partners (Beukelman & Mirenda, 2005). Instead, children with autism tend to rely upon features of the lower face to identify emotion (Gross, 2004). Patterns of errors exhibited by children with autism when identifying emotion in human and nonhuman faces suggest that they use the mouth as a primary determiner for emotion identification (Gross, 2004), and that they continue to misinterpret emotions using that information. Specifically, Gross (2004) found that children with autism selected upturned mouths in angry canine faces as “happy,” but labeled an angry orangutan face as “sad” possibly due to the downturned corners of the mouth. Relying on cues from the mouth without including the cues conveyed by the eyes is likely restricting their ability to interpret emotions. Such a focus on the mouth to determine emotion may further complicate the identification of emotions in photographs or icons used to represent those emotions in AAC devices.

Representations of emotions in commercially available icon sets rely heavily on facial features including the mouth, eyes, and eyebrows (Visser, Alant, & Harty 2008). Line-drawn icons have limited ability to vary mouth shape to indicate different emotions. Even with some variety of mouth depictions, emotion identification remains a difficult task for children with autism since many emotions share similar common mouth shapes.
The limitations of line-drawn symbols, therefore, pose a serious problem for emotion identification for children with autism who rely most often on lower facial features. Because of this, other visual cues that can assist in emotion identification might increase the accuracy of icon selection for some children. Speech language pathologists often add other cues to icons and AAC displays to aid in the accuracy and speed of icon recognition.

**Types of Cues**

There are various cues that SLPs could choose to add to icons to help AAC users locate icons more easily on a display. Two of the most common are color cues and spatial cues. Spatial cues assist AAC users by placing similar icons together on a page, creating a taxonomic grid that signals the user regarding the expected location of similar words. Spatial cues are often used to group categories and subcategories in AAC. One example of spatial cues is the use of a single page dedicated to food and additional clustering within the page for subcategories like drinks and entrees. Color cues add a color to the background or border of each icon to provide an extra clue about the meaning of the word or grammar usage. For example, a speech-language pathologist may add a light blue background color to all icons that are nouns in order to help children who are still learning to make complete sentences.

Although there is not a large empirical base to guide such use of cues on AAC devices, speech-language pathologists frequently organize displays on devices using color or spatial cues. In fact, such cues “are typically based on the conceptual models of adults who do not have disabilities” (Light, 1993; Light & Drager, 2002; Light &
Lindsay, 1991; as cited in Light et al, 2004, p.63). Using an organizational method that does not make sense to children does not facilitate learning how to use a device. Alternatively, organization techniques which are easily understood or taught to children ease the cognitive demands of learning the system, allowing for greater concentration on the communication task itself. Understanding the effects of the different cues used in AAC is important when investigating the efficacy of teaching these adult-oriented cueing techniques to children.

**Spatial Cues**

Spatial cues are one method used in an effort to increase communicative competence in AAC users. Spatial cues may occur on each page or within the nesting of the pages or levels of a communication system. Spatial cues may differ depending on the type of display that is used in the AAC system, either static or dynamic. Static displays are physically consistent; the icons are displayed in one format and do not change. An example of a static display is a communication board. The icons on the communication board cannot be moved around on the display without disassembling the finished product. Static displays offer a predictable and permanent location for each icon and limit the number of icons available for communication. Alternatively, dynamic displays change according to the interactions of the AAC user. The user may select an icon on a touchscreen, thereby causing a new set of symbols to appear. Additional levels of displays may be nested within the original display and all subsequent displays. Nesting allows for greater icon storage but also requires additional skill navigating within the device and typically relies on a users’ knowledge of categories. The type of display used varies depending on the user’s ability to generalize symbols or even with the number of
symbols that the user is capable of handling. An AAC user with a static display of core words, or the words most frequently used in everyday conversation, may still have more communicative fluency with one display than an AAC user with a dynamic display with multiple pages of icons. Both static and dynamic displays offer variety in the manner in which pages are displayed, but neither display type independently facilitates rapid and accurate communication.

Speech-language pathologists currently use a number of organizational strategies to facilitate navigation within AAC devices. Current research has compared the usability of static versus dynamic displays, but the type of display itself has not been found to effectively facilitate accurate and rapid icon selection. Light et al. (2004) found a benefit in using dynamic displays, including taxonomic grids, schematic grids, and schematic scenes on augmentative and alternative communication devices as compared to static displays. Data gathered on the effectiveness of the dynamic displays did not substantially support one type of dynamic display organization over the others. The variability of children’s responses to the different dynamic displays could suggest that physical organization of the device alone is not sufficient for aiding use of AAC devices.

Additional organizational features have been used in the field of AAC in an effort to increase user understanding of the spatial organization of icons. However, these strategies are largely based on adult conceptual models that may not be understood by children. The Fitzgerald Key is one of these organizational schemes (Fitzgerald, 1949). This setup presents icons from left to right in a sentence-building format according to basic sentence grammar. Such a setup may not be appropriate for a young child without advanced grammar knowledge or older children with communication delays. Another
organization scheme is the activity-based display (Goosens, Crain, & Elder, 1994), which presents icons related to a particular event. Again, this type of display involves knowledge of the activity and also requires the use of a category. Yet another type of organization involves scene-based displays, which depict physical scenes that correspond to the child’s environment (e.g., a playground, a kitchen). They allow a child to refer to part of a picture to communicate. Navigating this setup may require knowledge of categories. It can also require an understanding that vocabulary may be presented in a location different from the environment in which the child may need or naturally require a particular word or phrase. For example, a child may want to pick a red juice box at snack. The child may need to access the “red” icon from an art center scene or a school scene rather than the kitchen scene where the icon for “juice” is located. While all of these organizational strategies may eventually provide spatial cues to increase communicative competence, individual instruction is still necessary to learn, understand, and navigate the type of display.

All of the display organization schemes mentioned use the spatial grouping of icons in some form. The current study investigates the effect of spatial grouping within a page on accuracy and rate of response. The literature base does not currently provide adequate evidence to support the use of spatial grouping as an effective cue for facilitating communication with AAC. As manufacturers of AAC produce new device layouts in an attempt to better facilitate communication, further examination of the effectiveness of spatial grouping may allow manufacturers increased awareness of cueing strategies that work or may need reconsidered, thereby redirecting the course of device development.
Spatial cues use the location of icons on specific parts of a page or placement with similar concepts or categories to increase the AAC user’s knowledge of where to expect to find a symbol on a given page. For example, all drink icons might be grouped together in a similar location on a page while food icons are grouped together elsewhere. There is a very limited amount of research involving spatial organization of AAC icons. Wilkinson and Snell (2011) included a test of spatial cues in their study described above. They did this by placing emotion icons on displays in either a random location, in clusters at the top or bottom of a display page according to emotion valence, or in clusters combined with color cues. Emotions with negative valence, including angry, sad, scared, and bored, were located at the top of the display in the clustered condition. Emotions with positive valence, including surprised, happy, loving, and silly, were located at the bottom of a grid display in the clustered condition. Such use of grouping icons with similar emotional valence resulted in a statistically significant increase in rate of response but not in accuracy compared to responses under a random placement condition (Wilkinson & Snell, 2011). One limitation to this study was the sample size (n = 30) and the fact that this included three studies of about ten participants each. Another weakness of this study was the possibility of learning effects after some participants participated in more than one group. The effect of teaching the spatial cueing condition was not considered by this study. Therefore, there is a need for research to replicate Wilkinson and Snell’s 2011 study with a larger sample size, and to extend their study by including instruction on the cueing strategies.

Fallon et al. (2003) also studied factors that contribute to spatial cues. In their study, young children who were typically developing were instructed to put pictures
together on blank grids. The children decided how to group the pictures and had complete freedom to decide how many pictures were in each group. In order to successfully utilize spatial grouping of similar icons, children must have some knowledge of categorization. For example, children must know or learn which icons to expect to find on a food page compared to a toy page. The researchers found that 68% of AAC icon groups chosen by 4- and 5-year-old children were pairs, versus 32% in small groups of no more than 5 icons (Fallon et al., 2003). The results of this study suggest that young children have emerging knowledge of categories but still require assistance to move from using pair relationships to more broad categories. Their findings indicate that spatial grouping is a strategy that could be beneficial for adults who already have category knowledge but it may have less utility for children unless they are taught to understand the spatial cues.

**Color Cues**

Research regarding the usefulness of color cues has had mixed results. On the one hand, Wilkinson, Carlin, & Thistle (2008) found that internal icon color cues were effective in cueing typically developing children and children with Down syndrome. In this study, children more accurately and rapidly selected icons when icons with the same internal color were spatially grouped together on the display. For example, icons representing objects that are typically red were grouped together, including strawberry, apple, and stop sign. This study found that this grouping technique resulted in increased accuracy for younger typically developing children and children with Down syndrome than for older, typically-developing children. The findings of this study suggest that internal color cues may serve as an appropriate tool for increasing communicative competence in those with lower levels of language ability.
Organizing symbols in this manner, however, does not provide a valid long-term technique because symbols with similar internal colors may not have functional relationships that children or individuals with disabilities may understand. Internal symbol color also depends on the child’s environment. Some children may perceive cucumbers as a green food while children in another geographical area may only recognize yellow cucumbers. What is promising about the findings of this study is that children had quicker response rates when they connected searching for a particular item with searching for a specific color. This indicates that the children identified and used a strategy to search for symbols in a display and that strategy increased both their accuracy and their speed. Such findings suggest that color cues might have potential on AAC device displays for young children and their use deserves further investigation.

Unfortunately, there is also evidence that contradicts Wilkinson, Carlin, and Thistle’s (2008) findings. For example, Wilkinson and Snell (2011) examined the latency and accuracy effects when using color cues to identify emotion icons. They examined four types of displays on the identification of emotion icons: (a) displays with color cues alone; (b) displays with color cues combined with spatial grouping; (c) displays with spatial grouping cues alone; and (d) displays with random organization and no color cues. The researchers found no statistically significant benefit in using added color cues with emotion icons. Their data indicated lower accuracy and increased response time when color cues were added to spatial grouping and when color cues alone were used. There was not a statistically significant benefit to using color cues.

The Wilkinson and Snell (2011) study, however, had a flaw that makes it difficult to interpret their conclusions. As previously mentioned, they reported on three small
studies in which they assessed the effects of the cues with ten children in the first study, eleven children in the second study, and nine children in the third study. Each sample contained a small sample size and this was a substantial weakness. Even more problematic was that a number of the children reportedly participated in more than one group. By participating in more than one group, participants may have been influenced by learning effects, decreasing the validity of the data collected. This small sample size combined with participants who were included in more than one group decrease confidence in the findings.

The reason Wilkinson and Snell (2011) conducted three separate studies with such small sample sizes is that they varied the type of color cue across the three groups. They used a filled color background in the first study, a colored border in the second study, and a colored grid in the third study. The colored border provided a color cue around each icon set against a gray grid whereas the colored grid condition presented the color cue as a solid red grid at the top of the page and a solid blue grid at the bottom of the page. Changing the method of color cueing during the study allowed the researchers to systematically explore three variations of color cues. However, the small samples provide only limited evidence regarding the effects of color cues on accuracy and rate of emotion identification. A consistent cueing technique across the total number of participants would have increased statistical power and increased confidence in the findings related to the effects of color cues.

Another possible problem with the color cues in the latter study could be the use of color saturation of the entire symbol and its background. Wilkinson and Snell (2011) report that a solid colored background “reduced the color cueing effect because the
physical contrast between the black line of the symbol and its background was reduced” (Wilkinson & Snell, 2011, p.294). Minimizing visual clutter and distractions is a common teaching modification used by special education teachers when altering classroom materials for students with special needs. Dixon (1981) discovered that individuals with more severe disabilities achieved higher accuracy with photograph icon use when targeted objects were cut out of their colored backgrounds (c.f. Beukelman & Mirenda, 2005, p.53). Wilkinson and Snell (2011) did consider the lack of contrast between icons and background color as a possible limitation of their study. However, this flaw further decreases the confidence we can have in the findings of the study.

Teaching Color and Spatial Cues

The evidence reviewed above regarding color and spatial cues reveals that these cues have some potential to be helpful to children; however, it is unlikely that children will benefit fully from such cues without some instruction in what they mean and how to use them. Children using AAC already require instruction to navigate and use a device. Therefore, the speech-language pathologist must consider the organization of icons within the device, choose cues that can support icon selection, and then determine what a child needs to be explicitly taught about the content and organization of the device. Color cues are options; however, there is always a degree of spatial organization within a device. Grouping icons on AAC device pages is unavoidable regardless of the type of display organization chosen. All displays use categories of some kind and, therefore, spatial grouping is involved: what words belong in this scene/ category/activity? However, spatial grouping can be especially problematic for abstract concepts like emotions. Emotions do not have physical attributes that people can touch or see to easily
classify or group similar emotions. Emotions may instead be grouped according to how they make a person feel, either good or bad. These groupings are not common categories like “food” or “toys,” and may need to be explicitly taught. Children’s difficulty with finding or applying similar characteristics when grouping abstract vocabulary suggests that young children need explicit instruction in order to organize these concepts. The lack of any research on teaching spatial cues creates a gap in the field in an important area.

Color cues are optional in the organization of an AAC device, and the research to date is in conflict regarding the effectiveness of color cues in helping children identify icons accurately and rapidly. None of the literature on color cues has quantified the effects of teaching color cues to increase accuracy and rate of response. There is a need for research assessing outcomes for teaching color and spatial cues. The mixed research results on the effectiveness of color and spatial organization cues does not resolve the question regarding the clinical usefulness of using these two cueing strategies. Previous research only analyzed initial responses after exposure to novel cues; however, most children learning to use an AAC device will receive instruction on the cueing systems being used to help them learn to use the device. Presenting the cueing strategies without training children to respond to the techniques does not provide children with explicit knowledge or access to understanding and implementing use of the cueing strategies. Like the symbols used on AAC devices, the cueing strategies are not transparent, especially to young children. Teaching children to use color and spatial cues may increase the understanding of the graphic setup and scaffold children’s acquisition of icon knowledge. Using color and spatial grouping cues may allow children to learn new
vocabulary according to the already learned cueing format, increasing the power of the cues over time.
CHAPTER 2

PURPOSE

The purpose of this study was to replicate the study by Wilkinson and Snell (2011) in Study 1 and to extend it in Study 2. The first study replicated Wilkinson and Snell (2011) and compared children’s response time and accuracy when selecting emotion icons presented without cues or with color, spatial, or color and spatial cues. The following research questions were answered in Study 1:

1. Does the addition of a color cue border to AAC icons representing emotions result in increased accuracy and faster response time by young children compared to icons without color cues?

2. Does the addition of a spatial cue to AAC icons representing emotions result in increased accuracy and faster response time by young children compared to icons without spatial cues?

3. Does the addition of a combined spatial and color cue border to AAC icons representing emotions result in increased accuracy and faster response time by young children compared to icons without combined spatial and color cues?

The second study extended the Wilkinson and Snell (2011) research and compared changes in children’s responses before and after one of four different teaching tasks. Data collection before and after teaching a cueing technique expands the current research base by considering the effects of teaching color and spatial cues. The following research question was posed in Study 2:
4. Does teaching young children the color or spatial cues result in increased accuracy or faster response time compared to a control group who received the same amount of unrelated individual attention?
CHAPTER III

METHODS

Design

Two studies were included in the current investigation. Study 1 was a repeated measures within-subjects design that replicated the research of Wilkinson and Snell (2011) to examine the effects of four cueing conditions on accuracy and response time of emotion icon selection. A total of 44 participants participated in four different cueing conditions applied to the emotion icons. The independent variable in this study was cueing condition. The four conditions were (a) random placement with no color border (no cues condition); (b) random placement with a color border (color cue condition); (c) grouped by valence with no color border (spatial cue condition); and (d) grouped by valence with a color border (combined color and spatial cue condition). Accuracy and rate of response were the dependent variables.

In Study 2, the 44 participants from Study 1 were randomly assigned to one of four groups in order to determine the effects of teaching on accuracy and rate of icon identification. Participants were randomly assigned to one of four groups with each group receiving a different teaching condition. Three groups of participants were taught how to use one of the types of cues including (a) use of color cues; (b) use of spatial cues; and (c) use of the combined color and spatial cues. The fourth group participated in a control task involving recognition of a set of picture cards not related to the study (control task). Following the teaching task, the cueing condition task was repeated to determine whether teaching had an effect on the accuracy and response time of icon identification. Group
was the independent variable in this study. Accuracy and rate of response were the
dependent variables. Use of an experimental design allowed for comparison to a control
group and examination of possible cause and effect relationships between the
independent and dependent variables.

Participants

Recruitment

Written permission from each site was obtained prior to distributing informed
consent forms. Participants were recruited through letters to parents sent home with
children attending various daycare and preschool facilities in and around Johnstown,
Pennsylvania. All parents of children invited to participate received copies of the
Informed Consent Form (see Appendix A). The consent form included a description of
tasks that children would be asked to complete, inclusion and exclusion criteria, risks,
and benefits of participating in the study. A verified signature on the Informed Consent
Form was required before any contact with the child took place as per the research
protocol approved by the Indiana University of Pennsylvania Institutional Review Board.

Inclusion and Exclusion Criteria

Participants in this study were male and female children ages four years, zero
months (4;0) to five years, eleven months (5;11). This age range was chosen for two
reasons. First, children in this age range have the developmental ability to identify
emotions and attend to tasks. Second, previous research in this area has included children
of the same age range, and the purpose of Study 1 was to replicate that previous research.
Therefore, children of the same age as in that study were selected for inclusion.
Children were included in the study if they demonstrated average or above average language skills and hearing within normal limits. Children with diagnosed disabilities were excluded from this study. Research using typically developing participants was necessary to ensure that results were indicative of the effects of color and spatial cues rather than interference from the symptoms of a disability. Several methods were used to ensure that children met the criteria for participation. Parents completed a checklist that elicited information regarding disabilities and delays. If parents reported a disability, they were excluded from the study.

In addition, all participants were assessed prior to data collection to ensure that they met the criteria for inclusion and to rule out factors that could interfere with completion of research tasks. Children were required to pass a hearing screening on the day of data collection to prevent the effects of hearing loss from impeding reception of oral directions. Hearing screenings were performed at 20 dB for 1000, 2000, and 4000 Hz (ASHA, 1997). All participants were required to pass all three frequencies in both left and right ears in order to participate in the study. A receptive vocabulary test, the Peabody Picture Vocabulary Test- 4th edition (PPVT-4), was used to verify language development within the average or above average range. Children who received standard scores less than or equal to 85 were excluded from participating in the study. During this test, the children indicated understanding of the meaning of words by pointing to the picture from an array of four that best represented the word spoken by the examiner. Expressive language abilities were not assessed in this study because all experimental tasks were receptive in nature.
Sample Size

The sample size needed for the study was determined by conducting a power analysis using the MorePower calculator (Campbell & Thompson, 2002). Study 1 examined the effect of four cueing conditions on rate and accuracy. An ANOVA with 4 within factors of interest (α = .05, power = .8, \( \eta_p^2 = .25 \)) produced a necessary sample size of thirteen total participants for Study 1. This study included forty-four participants for Study 1 which exceeded the minimum number of necessary participants.

Study 2 involved a four-way group comparison for accuracy and rate variables. An ANOVA for 4 within factors, 4 between factors, 4 within effects of interest, and 4 between factors (α = .05, power = .8, \( \eta_p^2 = .25 \)) resulted in a required four participants per group or sixteen total participants. Study 2 used eleven participants per group for a total of forty-four participants, which exceeded the minimum number of necessary participants.

Final Sample

Forty-six children were invited to participate in both studies. One child was unable to pass the hearing screening and therefore, was not included in the study. Another child was identified as having ADHD after data collection commenced, and therefore, was excluded from the study. The 44 children who met inclusion criteria completed data collection. The final sample included 44 children between the ages of 4;0 and 5;11 years old. The mean age for all forty-four participants was 59.36 months (SD = 7.47 months, range = 48-71 months). A total of twenty-one males and twenty-three females participated in the study. The forty-four participants from Study 1 were randomly
assigned to one of four teaching groups for study two. In Study 2, a one-way analysis of variance (ANOVA) confirmed that there was no statistically significant difference between groups in age \((F[3, 40] = .257, p = .86)\).

The forty-four children included in the final sample scored greater than a standard score of 85 on the Peabody Picture Vocabulary Test-IV. The mean PPVT-IV standard score for all participants was 110.34 \((SD = 11.88, range = 88-135)\). There was no statistically significant difference between groups on the PPVT-IV \((F[3,40] = .081, p = .97)\).

**Data Collection Procedures**

Data collection took place in a quiet area within the children’s familiar settings at preschool or daycare. Children were asked to complete five tasks within one session that took approximately thirty minutes total. Each child participated in the following tasks in this order: (a) completion of the receptive language screening, the PPVT-IV; (b) completion of a hearing screening; (c) completion of the experimental task on a computer (Study 1); (d) participation in a teaching activity (Study 2); and (e) repetition of the experimental task on the computer (Study 2).

**Experimental Task**

Children were asked to complete the experimental task on a touchscreen computer. Past research involving color and spatial cues has largely relied on participant input via a computer mouse. The ability to use a mouse served as an additional requirement for participation in previous studies (Wilkinson & Snell, 2011; Wilkinson, Carlin, & Thistle, 2008). Only one study of color cues was found in which participant
input was received by use of a touchscreen (Wilkinson, Carlin, & Jagaroo, 2006). Use of a touchscreen in this instance resulted in significantly decreased latency compared to response time using a computer mouse. Increased latency is understandable considering the added demanded of the motor skills required to accurately use a computer mouse. Touchscreens are now commonplace and children are exposed to various types of touchscreens (e.g., iPads, iPhones). Use of a touchscreen in the current study is consistent with technology children are exposed to and consistent with AAC devices currently on the market. Therefore, the use of the touchscreen increases the applicability of the findings to clinical practice.

The experimental task utilized a program created by the researcher using E-Prime 1.1 (Schneider, Eschman, & Zuccolotto, 2002), a normed research software program noted for high reliability for tracking response time in experimental research. Two practice items allowed participants to become accustomed to using the touchscreen by touching one of two animals. The experimental task began with a photographic stimulus that appeared until the child touched the screen to move to the next page. The next alternating page contained eight emotion icons presented in one of the four cueing conditions. Participants were instructed to find the matching emotion. The stimuli and icon grids alternated through a total of sixteen presentations. Each emotion served as the target stimulus twice during the program.

**Pictures for Stimuli**

Participants were shown a face using either the International Affective Picture System (IAPS; Lang & Cuthbert, 2008) or similar photographs, each representing one of
six emotions considered in this study: angry, sad, scared, bored, surprised, happy, loving, and silly. The IAPS includes real, color photographs of people, including babies, toddlers, children, and adults, representing various emotions and human conditions that are used to elicit emotion or various arousal levels in the viewer. The photograph collection was specifically created for research purposes. All of the photographs were normed to provide other researchers with consistent and reliable stimuli for research involving photos of emotions. Wilkinson and Snell (2011) used the IAPS as stimuli in their study. Replication of that study required the use of similar stimuli in the current research. Although photos of preschool-age children expressing each emotion might have been preferable in the current study, the IAPS did not contain photos of children in this age range for every emotion required. As in the Wilkinson and Snell study, the IAPS photos included a combination of babies, toddlers, children and adults. Two emotions, silly and surprised, were not available within the IAPS but were needed for the study. A second representation of “happy” was also necessary and was supplied using additional photography. Examples of each emotion were photographed by the researcher using volunteer subjects from the Indiana University of Pennsylvania’s speech-language pathology students and a child known by the researcher. First-year graduate students within the same program then voted on the photos. They were asked to select the two best examples of each emotion, silly and surprised. One additional example for “happy” was also chosen. The photos with the highest number of votes were used in the study.

The other type of icon presented during the study was a set of icons from Mayer-Johnson’s Boardmaker® symbol set. Eight emotion icons were chosen from this symbol set to better replicate the research conducted by Wilkinson and Snell (2011). A color
border, either red or green, was added to the perimeter of the icon square in the color cue condition. A red border was used to denote emotions with negative valence while a green border was used to denote emotions with positive valence. This method of color cue was chosen to maintain the contrast with a white background. All eight symbols were presented on a four-by-four black button grid with empty squares separating each emotion icon.

**Study 1 Task**

In Study 1, research participants were asked to select the corresponding emotion icon from a four-by-four grid of eight emotions presented in one of four cueing conditions. Four of the emotions were positive emotions (happy, loving, surprised, and silly) and four of the emotions were negative emotions (angry, scared, sad, and bored). The accuracy of the icon selected was recorded by the researcher on a chart within the participant folder while response time was recorded by the E-Prime software. The complexity of programming E-Prime to collect accuracy data was not resolved prior to data collection, thereby making manual tracking of accuracy necessary.

**Study 2 Task**

In Study 2, each child was randomly assigned to one of four groups, with each group receiving a different teaching condition: (a) use of color cues; (b) use of spatial cues; and (c) use of the combined color and spatial cues; (d) use of unrelated icons/control group. The researcher engaged each child in a teaching exercise for six minutes. Children were taught one of the four cueing techniques depending on their group assignment. Children within the color cue group were taught to find all of the positive
emotions by looking for the icons with a green border and all of the negative emotions by looking for icons with a red border. The participants in the spatial cue group were taught to find all of the negative emotions by searching the top rows of the grid and all of the positive emotions by searching the bottom two rows of the grid. Children in the combined cue group were taught to find the negative emotions by searching the red-bordered icons within the top two rows of the grid and the positive emotions by scanning the green-bordered icons at the bottom of the page. Errorless teaching was used first to teach cueing techniques to the groups learning the cues. Errorless teaching involved giving an instruction (“Happy is in a green box because it makes us feel good. Find happy.”), prompting the correct response with zero second delay (moving the child’s hand to the correct icon), and providing immediate reinforcement (verbal praise).

Participants then practiced locating and sorting the icons into boxes on a grid display with prompts from the researcher. For example, the researcher instructed the child to find “silly” and immediately provided a prompt to pick up the small laminated icon by tapping the correct one. The child was then prompted to place silly at the bottom of the communication board with the emotions that make people feel good. A third repetition of icon manipulation briefly required the child to tell where they would look or what color they would look for when searching for a certain emotion. This final repetition allowed children to use the learned cue without a prompt.

Participants in the control group identified and placed unrelated icons including various toys, foods, and vehicles on a blank grid in whatever manner they thought best. This group then explained how they chose where to place each icon. This control task provided children in this group with individual attention from the researcher, thus
controlling for the effects of personal adult attention and increased familiarity and comfort with the researcher. The control task also controlled for practice effects on the experimental task.

After the teaching or control task, all participants repeated the experimental task on the touchscreen computer. Data were collected on the same type of chart and using the same software as the pre-teaching trial. This post-teaching data collection provided information on changes in accuracy and response time after participating in the teaching task or the control task. All children were given a scratch-n-sniff sticker for participation.

**Measurement Procedures**

Measurement of accuracy for each cue condition and emotion was tracked on paper charts for the pre-teaching and post-teaching experimental tasks. Participants were required to find the corresponding emotion icon for the previously presented photograph in order to consider the response accurate. To determine the accuracy of each response to each cue for each participant, the author added the total number of correct responses for each condition and divided that number by four, the number of presentations for each cue. Accuracy within each group was obtained by averaging the accuracy for each cue type from all participants within that group.

Response time was tracked by the research software e-Prime. The constructed program tracked response time to 1/1000 of a second. The examination of response time allowed for noticing possible small but significant differences in user response time. Average response times for all presentations of like cues were calculated for each
participant. The average response time for each condition within groups was averaged from all corresponding individual averages.

**Ethical Use of Data**

Identifying information of participants was kept separate from data collected to protect the privacy of research participants. Only the researcher and research supervisor had access to the data and personal information collected on the *Informed Consent Form* for use during this study. Participants’ *Informed Consent Forms* will be retained in a locked office. All data collected will be retained for seven years in accordance with federal regulations.

**Statistical Analysis**

Three *t*-tests were used to compare accuracy and response rate between the different cueing techniques and the random condition in Study 1. *T*-tests compared the following groups: (a) random condition and spatial cue condition; (b) random condition and color cue condition; and (c) random condition and the combined color and spatial cue. The Bonferroni adjustment for increased risk or error was used due to the multiple comparisons made during analysis. Therefore, the *p*-value for significance was .017.

A mixed-model ANOVA was used to analyze data from Study 2. Study 2 used a repeated measures within-subjects factor of cueing condition with four different levels and a between-groups factor of treatment, also with four levels. Box’s Test of Equality of Covariance Matrices was used to determine whether the covariance matrices of the dependent variables were equivalent across the four groups. Mauchly’s Test of Sphericity
was used to test the equality of the variances in the difference among the four repeated measures.
CHAPTER IV

RESULTS

Study 1

The accuracy and rate of response in Study 1 were calculated for all forty-four participants. Data is listed in Table 1.

Table 1

*Study 1 Mean Accuracy and Response Time Within Cue Conditions*

<table>
<thead>
<tr>
<th>Cue Condition</th>
<th>Accuracy M</th>
<th>Accuracy SD</th>
<th>Response Time M</th>
<th>Response Time SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>70.45</td>
<td>30.15</td>
<td>7.16</td>
<td>4.37</td>
</tr>
<tr>
<td>Color</td>
<td>69.32</td>
<td>32.29</td>
<td>6.84</td>
<td>3.96</td>
</tr>
<tr>
<td>Spatial</td>
<td>61.93</td>
<td>33.45</td>
<td>6.00</td>
<td>2.82</td>
</tr>
<tr>
<td>Color + Spatial</td>
<td>61.36</td>
<td>30.72</td>
<td>6.84</td>
<td>3.39</td>
</tr>
</tbody>
</table>

The mean accuracy by cueing condition is depicted in Figure 1 and the mean time by cueing condition is depicted in Figure 2.
**Figure 1.** Study 1 Mean Accuracy by Cueing Condition

**Figure 2.** Study 1 Mean Response Rate in Seconds by Cueing Condition
Three *t*-tests were used to analyze response accuracy for items within each cue condition. Only the paired samples test of random versus combined color and spatial condition produced a significant result, *t*(43) = 2.79, *p* = .008. The *t*-test comparing the random condition and the spatial condition was not statistically significant, *t*(43) = 1.73, *p* = .092. The difference between accuracy in the random and color condition was also not statistically significant, *t*(43) = .25, *p* = .803.

Response times in Study 1 were analyzed with three *t*-tests. Response time in the comparison of the random condition versus spatial condition was not statistically significant, *t*(43) = 1.53, *p* = .13. Response time in the comparison of the random versus color condition was not statistically significant, *t*(43) = .38, *p* = .70. Finally, response time in the random versus combined color and spatial condition was not statistically significant, *t*(43) = .51, *p* = .62.

**Study 2**

A mixed-model ANOVA was used in Study 2 to examine the relationship of percent accuracy between groups for each of the four cueing conditions. Descriptive statistics are provided in Table 2.
Table 2

Means and Standard Deviations for Percent Accuracy of Responses for Each Type of Cue Across the Four Groups after the Teaching Task

<table>
<thead>
<tr>
<th>Group</th>
<th>Random $M$ (SD)</th>
<th>Color $M$ (SD)</th>
<th>Spatial $M$ (SD)</th>
<th>Color + Spatial $M$ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control- No Tx</td>
<td>79.55 (29.19)</td>
<td>63.64 (34.21)</td>
<td>61.36 (34.21)</td>
<td>61.36 (35.99)</td>
</tr>
<tr>
<td>Color Tx</td>
<td>70.45 (26.97)</td>
<td>84.09 (16.86)</td>
<td>77.27 (28.41)</td>
<td>77.27 (20.78)</td>
</tr>
<tr>
<td>Spatial Tx</td>
<td>77.27 (20.78)</td>
<td>65.91 (30.15)</td>
<td>84.09 (20.23)</td>
<td>70.45 (29.19)</td>
</tr>
<tr>
<td>Color + Spatial Tx</td>
<td>75.00 (22.36)</td>
<td>81.82 (25.23)</td>
<td>72.73 (30.53)</td>
<td>70.45 (35.03)</td>
</tr>
</tbody>
</table>

Tx = Treatment

Mean accuracy in the random condition in the control group was compared between Study 1 and Study 2 for evidence of practice effects. The mean accuracy of the control group in the random condition increased from 72.73 in Study 1 to 79.55 in Study 2, which suggested practice effects; however, the paired samples $t$-test was not statistically significant ($t[10] = -1.94, p = .08$). Additional analyses compared the accuracy of the control group in each cueing condition from Study 1 with the corresponding cueing accuracy in Study 2 to compare the practice effects between the two studies. The paired samples $t$-test revealed no statistically significant difference between the paired accuracies from Study 1 to Study 2 ($p = .21$ to .28). Accuracy actually decreased from Study 1 to Study 2 in the other three cueing conditions. Another set of paired sample $t$-tests compared the response time of the control group in each condition between Study 1 and Study 2. Participants responded more rapidly from Study 1 to Study
2 in every cueing condition, yet none of the values were statistically significant ($p = .02$ to .15). The $p$-value for response time in the spatial condition from Study 1 to Study 2 approached statistical significance ($p = .022$) after applying the Bonferroni correction for family-wise error ($p = .05 / 4$ tests $= .0125$).

A figure was developed to organize the cues taught to each group with the performance in each cueing condition during Study 2. For every group, performance in Study 2 was most accurate in the cueing condition that each group was taught. In the case of the control group, accuracy was highest in the random condition. Accuracy peaks by group were depicted in Figure 3.

![Figure 3. Study 2 Accuracy in Four Cueing Conditions by Group](image)

To test whether treatment group had an effect on accuracy in the four cueing conditions, a mixed model ANOVA analysis was conducted. The mixed model ANOVA
included a between-groups effect, with four groups, and a within-subjects effect, including four cueing conditions. The dependent variable was percentage of accurate responses. First, the assumptions of this statistical analysis had to be tested. Box’s Test of Equality of Covariance Matrices was used to test this assumption and it was not statistically significant, $F[30, 4399]= .97, p = .52$. Mauchly’s Test of Sphericity also was not statistically significant, $W[5]= .80, p = .13$. Thus, all assumptions for the mixed model ANOVA were met.

Results for the mixed model ANOVA for the dependent variable of accuracy revealed that the main effect for the between-groups effect was not statistically significant, $F[3]= .41, p= .75, \eta^2_p = .03$. The main effect for cueing condition was not significant, $F[3, 120]= .99, p= .40, \eta^2_p = .02$. However, the interaction effect of cueing condition-by-group was statistically significant, $F[9, 120]= 2.44, p=.01, \eta^2_p = .16$. This interaction effect explained 16% of the variance. To follow up this significant finding, the data file was split by group and four repeated measures ANOVAs were run in order to determine which group had significant differences across the four cueing conditions. Results for the color group, spatial group, and combined color and spatial group were not statistically significant ($p$-values ranging from .12 to .35). However, results for the control group were statistically significant ($F[3,30]= 3.81, p= .02, \eta^2_p = .28$).

Post hoc contrasts were used in order to identify significant differences in accuracy across cueing conditions for the control group. Three $t$-tests compared accuracy in three pairs: (a) random and color ($t[10]= 2.61, p = .026$); (b) random and spatial ($t[10]= 3.73, p = .004$); and (c) random and combined color and spatial ($t[10]= 3.07, p = .012$). Given the change to $p= .017$ for the Bonferroni adjustment, the $t$-tests resulted in
statistically significant differences between the random condition \((M = 79.55)\) and spatial cues \((M = 61.36, p = .004)\) and the random condition and combined color and spatial cues \((M = 61.36, p = .012)\). Compared to their performance in the random cueing condition, the control group showed a significant decrease in accuracy in the spatial cueing condition and the combined color and spatial cueing condition.

Another mixed-model ANOVA was used in Study 2 to examine the relationship of response time between groups for each of the four cueing conditions. Descriptive statistics are provided in Table 3.

Table 3

Means and Standard Deviations of Response Time in Seconds for Each Type of Cue Across the Four Groups after the Teaching Task

<table>
<thead>
<tr>
<th>Group</th>
<th>Random (M(SD))</th>
<th>Color (M(SD))</th>
<th>Spatial (M(SD))</th>
<th>Color + Spatial (M(SD))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control- No Tx</td>
<td>4.42 (1.88)</td>
<td>3.85 (1.84)</td>
<td>3.85 (1.81)</td>
<td>3.82 (1.15)</td>
</tr>
<tr>
<td>Color Tx</td>
<td>5.76 (3.35)</td>
<td>4.97 (2.34)</td>
<td>5.19 (2.55)</td>
<td>5.24 (2.40)</td>
</tr>
<tr>
<td>Spatial Tx</td>
<td>5.80 (3.05)</td>
<td>6.06 (4.69)</td>
<td>5.57 (2.00)</td>
<td>5.58 (2.52)</td>
</tr>
<tr>
<td>Color + Spatial Tx</td>
<td>4.44 (1.84)</td>
<td>5.75 (4.04)</td>
<td>4.77 (1.75)</td>
<td>4.91 (2.93)</td>
</tr>
</tbody>
</table>

Tx = Treatment

Mean accuracy in the random condition for all participants was compared between Study 1 and Study 2 for evidence of practice effects. The mean response time in
the random condition decreased from 7.16 seconds in Study 1 to 5.10 seconds in Study 2, which indicated practice effects. Mean response times in Study 2 are depicted in Figure 4.

![Figure 4](image.png)

**Figure 4.** Study 2 Mean Response Time in Seconds in Four Cueing Conditions by Group

To test whether treatment group had an effect on rate of response in the four cueing conditions, a mixed model ANOVA analysis was conducted. The mixed model ANOVA included a between-groups effect, with four groups, and a within-subjects effect, including four cueing conditions. The dependent variable was the response time in seconds. First, the assumptions of this statistical analysis had to be tested. Box’s Test of Equality of Covariance Matrices was used to test this assumption for response time. This measure was statistically significant, $F[30, 4399]= 1.94, p = .00$, which indicated a violation of the assumption of equivalence among the covariance matrices. Mauchly’s Test of Sphericity also resulted in significant findings, $W[5]= .76, p = .06$, using an alpha of .10 that is typical for tests of assumptions.
Results for the mixed model ANOVA revealed that the main effect for the between-groups effect was not statistically significant, $F[3]= 1.49, p = .23, \eta^2_p = .10$. The main effect for cueing condition (using the Huynh-Feldt correction for violation of the assumption of sphericity) was not significant, $F[2.94, 120] = .26, p = .85, \eta^2_p = .007$. The interaction effect of cueing condition-by-group (also using the Huynh-Feldt correction for violation of the assumption of sphericity) was not statistically significant, $F[8.83, 120] = .43, p = .91, \eta^2_p = .03$. Thus, there were not differences in response time across the four cueing conditions that could be explained by group. Figure 2 shows that following a decrease in response time from pretest to posttest (i.e., practice effects), there was little difference in response times across conditions. Unlike in the results for accuracy of responding, the data for response time did not reveal an advantage in the cueing condition that the children were taught to use.
CHAPTER V

DISCUSSION

The results of statistical analyses served to answer several research questions. In Study 1, results indicated that the addition of a color cue border to AAC icons representing emotions did not result in a statistically significant increase in accuracy and faster response time by young children compared to icons without color cues. Results also indicated that the grouping of emotion icons with similar valence did not result in a statistically significant increase in accuracy or response rate compared to random spatial organization. Finally, the combination of spatial and color cue did not result in statistically significant increases in accuracy or response time compared to random spatial organization of icons without color cues. In the case of the combined color and spatial cue, participants actually experienced statistically significant decreases in accuracy compared to the random condition. This may indicate that the presentation of combined color and spatial cues without instruction overwhelmed the children.

In Study 2, results revealed that teaching young children the color or spatial cues did not result in a statistically significant increase in accuracy or faster response time compared to a control group who received the same amount of unrelated individual attention. The only significant finding was for the interaction effect of group-by-cueing condition, and post hoc tests revealed that the accuracy across cueing conditions only differed in the case of the control group. The control group exhibited the highest level of accuracy in the random presentation condition. Compared to the random presentation condition, they exhibited significantly lower accuracy in the spatial condition and the
combined color and spatial condition. Thus, the color and combined color and spatial cues appeared to make the task more difficult for them. The decreased accuracy during cueing conditions suggests that color and spatial cues are distracting or unnatural for children without instruction in how to use them.

The purpose of Study 1 was to replicate the research of Wilkinson and Snell (2011) using a much larger sample size. The results differed from those found in that previous study. In this experiment, participants performed best in the random and color conditions while participants in the Wilkinson and Snell (2011) study performed best in the random and spatial cueing conditions. This difference may be due to the inconsistent color cues used in the Wilkinson and Snell (2011) study. Both experiments found the highest accuracy in the random condition. Both experiments also found that the addition of cueing techniques did not produce a statistically significant increase in accuracy.

The current study also found differing results in some respects from past research in the response time under cueing technique. Study 1 of this experiment found that the response time in the random cueing condition was slower than the response time of the other cueing conditions, although not statistically significant. Response time was quickest in the spatial cueing condition, although again not statistically significant. Wilkinson and Snell (2011) also found that participants’ response time was quicker under the spatial cueing condition compared to the random, color, or spatial and color cueing conditions. Although not statistically significant, both experiments found that participants responded the quickest in the spatial cueing condition.
While not statistically significant, patterns in the data across the groups in Study 2 presented an interesting finding. Each group achieved the highest accuracy when presented with the cue which that particular group was taught. In other words, children in the random group were most accurate in the random condition, children in the color group were most accurate in the color condition, and children in the spatial group were most accurate in the spatial condition. This pattern did not hold true for children in the combined cue group; they were most accurate in the color cue condition, indicating a possible benefit from the color aspect of the combined cue but not the spatial aspect. This suggested that teaching the cueing condition had some positive effect on the children’s accuracy. However, these same patterns were not true for the dependent variable of response time. Several limitations of the study likely affected the results and these are discussed below.

**Limitations**

Certain limitations of the study must be considered when interpreting the results. First, this study examined the effects of cueing techniques within a sample of children who were typically-developing and within a limited age-range. Such design choices created strong internal validity but limit external validity. Therefore, the findings can only be applied to this population. Second, efforts were made to ensure that participants were typically-developing children, yet reliance on parent report, hearing, and language screeners does not control for undiagnosed or unnoticed differences among participants. It should be noted that all participants were able to complete the tasks required by the study and were considered attentive during that time.
Third, visual stimuli presented during this research also warrant further consideration. The photographs used for emotion stimuli represented a combination of baby, child, and adult faces. Participants may have performed differently if presented with only photographs of children in their same age range. Children may also have performed differently if the study explored icons other than emotions. Emotions icons were used in this study because they are abstract concepts which may need cues to help children understand them. It may be that color and spatial cues are effective for increasing accuracy or decreasing response time for more concrete vocabulary in a child’s AAC system. The children may also have performed differently given a different symbol set for the emotion icons. There are multiple symbol sets available for use on communication boards, yet only icons from one widely available commercial icon set, Boardmaker®, were used in this replication study. The possibility of differences between sets should be considered a limiting factor.

Fourth, the study relied on a small number of presentations within each cueing condition. Every cue was used four times in Study 1 and four times in Study 2. Therefore, there were only four possible accuracy levels for each cue by each participant. Furthermore, eight emotion icons were used in this study, which means that not every emotion icon was presented under each cueing condition. Fifth, a larger sample size also would have been preferable for Study 2. The multiple variables of Study 2 would be better examined using a larger sample to allow for detection of smaller effect sizes. The combination of a larger sample size and more presentations of each cueing technique would allow for the best analysis of the effects of teaching color and spatial cues on accuracy and response rate of icon selection.
Sixth, the use of just one teaching task with immediate retesting limits the understanding of the full effect of teaching color and spatial cues compared to random presentations. As with teaching any material, repeated teachings would allow the participants to fully learn the cues and utilize each as an active search strategy. The trend of the data showing that children performed best in the cueing condition for which they received instruction suggests that teaching influenced the participants’ responses. However, this was not statistically significant. A larger sample size and a larger number of trials for each condition would strengthen the confidence we may have in the results. Also, teaching over several sessions would be a better test of the effects of teaching these cueing strategies. Users of AAC would have ongoing interactions with the cueing strategies and repeated teachings, allowing for learning over time. The findings indicate a need for continued research in this area.

Finally, this study examined the effect of cueing conditions only in children. Color and spatial cues may provide benefit to adult users of AAC, which requires further investigation. Also, it may be that cues assist adults who interact with children who use AAC. Adults in the environment may benefit from the added cues to learn the system and provide quicker and more precise prompts to help direct children to use a specific icon. Alternatively, cues may support adults in the natural environment to better understand the child’s use of AAC, which in turn may increase the confidence of support personnel and translate into better services for the child AAC user. Further research analyzing the effects of cueing strategies on adults is necessary to understand the full impact of such cues on AAC support for children.
Implications

Several implications were drawn from the results of this study. First, cueing conditions are not naturally of significant value to children. The addition of color cues, spatial cues, or combined color and spatial cues did not increase children’s accuracy for locating emotion icons, at least in this sample of preschool-age children. There was a slight advantage for response time when spatial cues were provided; however, this was not statistically significant. Therefore, speech-language pathologists should question spending extensive time adding spatial and color cues to AAC systems. The findings of the current study were consistent with previous research and indicate a lack of evidence supporting benefits of such cues.

Second, the results of the current study suggest that cueing conditions must be explicitly taught to provide even small benefits to young children. Without explicit instruction, the cueing conditions actually may provide little to no help for children who use AAC or worse they may be detrimental. The current findings also suggest that one teaching episode was not sufficient to result in statistically significant increases in accuracy of emotion icon identification or decreases in response time. If cues are added to an AAC device, students will require support for more intensive and extended teaching to help them understand and use such cues. Given the limitations of Study 2, additional research with more participants over repeated teachings will be necessary to have full confidence in results related to the benefit of teaching cueing techniques. It is possible that even with repeated teaching episodes, children may not benefit sufficiently from such cues to warrant their use.
Third, there was a learning effect in this study for accuracy and for response time just from repeated exposure to icons. Therefore, speech-language pathologists may assist users of AAC by providing repeated opportunities for icon selection to increase accuracy and response time.

**Future Research**

The results of this study created questions for further research. First, the control group achieved notably decreased accuracy in the cueing conditions compared to the random conditions, suggesting a need to explicitly teach the cueing techniques commonly used by speech-language pathologists. However, the lack of statistical significance following the brief teaching exercise in Study 2 obviously did not result in sufficient learning for participants in the teaching cue groups. Further research is necessary to provide realistic timeframes for acquisition of sufficient skill with each of the cueing conditions. Further studies may also identify if specific children respond better to certain cues. More research in this area could identify the effect of multiple teaching episodes with cueing conditions or reveal a trend in which cueing techniques serve as a distraction to children compared to a random presentation of icons.

Second, additional research is warranted for the combined color and spatial cue because of the discrepancy between accuracy in the color cue condition and the combined color and spatial cue condition. It is possible that the combined cue was too overwhelming for participants in this study. Additional research in this area may examine immediate and long-term teaching effect which introduces each cue separately for a specified time period before introducing the combined cue. The split teaching of the cue
may allow children the added benefit of two cues instead of a distraction from two competing cues.

Third, the use of color and spatial cues should be researched with an older population. The creation of pages and devices using such techniques has been based upon adult taxonomic systems and cueing strategies. These cues may still provide substantial benefit for older children and adults. Additional research within this area would examine possible benefits to neurotypical individuals as well as individuals with acquired communication disorders such as traumatic brain injuries and aphasia.

In conclusion, until further research validates the efficacy of using color and spatial cues as a method to increase accuracy and response time for young children, speech-language pathologists should be cautious in assuming that color or spatial cues will facilitate increased accuracy or increase speed of icon selection. They should also be aware that a single teaching episode is insufficient to result in improvements in children’s performance. Clinical contact time with children using AAC may be subject to time limitations. Therefore, clinicians should consider the caregivers and teachers who will interact with children as the best support system for facilitating icon selection for young children. While this study did not reveal statistically significant support for the use of color and spatial cues by accuracy or response time, the same cueing conditions may still provide substantial support for the adults learning the child’s AAC system as well.
References


Appendix A

Informed Consent Form

Your child is invited to participate in this research study entitled “The Efficacy of Color and Spatial Cues for Augmentative and Alternative Communication Boards.” The following information is provided in order to help you to make an informed decision whether or not to allow your child to participate. If you have any questions please do not hesitate to ask. Your child is eligible to participate because he or she is between the ages of 4 and 5 years, 11 months old with no known disabilities or delays.

Purpose of the Study

The purpose of this study is to see how well young children recognize emotion pictures on a picture board. The study will find out whether color borders or grouping similar emotions together can help children find the correct pictures, or help them to find the pictures faster. This information will help us know how to organize pictures on picture communication boards used with children who cannot talk. In this way, it can help us better serve children who have disabilities.

Procedures

Participation in this study will require approximately 30 minutes of your child’s time and is not considered part of the daycare/preschool curriculum. Participation or non-participation will not affect the evaluation of your child’s performance at daycare/preschool. If you give consent for your child to participate, he or she will do the following:

1. Respond to questions for a brief language screening (5 minutes),
2. Complete a hearing screening (5 minutes),
3. Pick emotion pictures on a computer touch screen (5 minutes),
4. Play a game to practice sorting emotion pictures (6 minutes), and
5. Pick emotion pictures on a computer touch screen again (5 minutes). Your child will be thanked for his or her time with a scratch-n-sniff sticker.

Risks and Benefits

No risks are expected for your child. Most children enjoy the tasks; however, if your child becomes distressed or wishes to stop, the session will be discontinued and finished at a later time.

Your child may find the tasks enjoyable. If your child has difficulty on the hearing screening, you will be notified and provided with information on how you can follow up. This could be beneficial to you and your child. The information gained from this study will help us to understand whether color borders or grouping similar pictures together can help children with disabilities to communicate more easily using pictures.

Confidentiality

Your child’s participation in this study is voluntary. You can decide not to allow your child to participate in this study. You can stop participating at any time without giving a reason and without penalty. If you withdraw, all information pertaining to you and your child will be destroyed.

If you choose to allow your child to participate, all personal identifying information will be kept confidential. Your child will be given a number all information collected during the study will be marked with that number, not with your child’s name. The information obtained in the study may be published in scientific journals or presented at scientific meetings but your child’s identity will be kept strictly confidential.
If you are willing to allow your child to participate in this study, please sign the statement below and return to your child’s teacher. Keep the extra unsigned copy for your records. If you choose not to participate, simply do not return a signed consent form.

Student Investigator: Dottie Morgan
Rank/ Position: IUP Graduate Student
Department Affiliation: Department of Special Ed & Clinical Services
Campus Address: 203 Davis Hall Indiana, PA 15705
Phone: Phone: 814/242-4376

Faculty Sponsor: Lisa Hammett Price, PhD, CCC-SLP
Rank/ Position: IUP Associate Professor of Speech-Language Patho
Department Affiliation: Department of Special Ed & Clinical Services
Campus Address: 203 Davis Hall Indiana, PA 15705
Phone: Phone: (724) 357-5687

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (Phone: 724/357-7730).
VOLUNTARY CONSENT FORM:

I have read and understand the information on the form and I consent to my child volunteering as participant in this study. I understand that my child’s responses and personal identification are completely confidential and that I have the right to withdraw at any time. I have received an unsigned copy of this informed Consent Form to keep in my possession.

Name ______________________ Child’s Name______________________
(PLEASE PRINT)    (PLEASE PRINT)
Signature ________________________
Date___________________
Phone number: ________________________________
Best days and times to reach you:______________________________________

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participating in this research study, have answered any questions that have been raised, and have confirmed the above signature.

_________________________   ________________________________
Date      Investigator’s Signature

Child Assent: The above named child willingly agreed to accompany the researcher and complete activities on the day of testing.

_________________________   ________________________________
Date      Investigator’s Signature
**Child Assent Script**

Children will be asked to participate in the research in a way that four- to five-year-old children can understand. The following script will be used to ask each child if they are willing to participate:

“I have some pictures in a book and on a really cool computer, and I have headphones that make some neat beeps. Will you come with me to play with them?”
**PARTICIPANT INFORMATION**

The Efficacy of Color and Spatial Cues for Augmentative and Alternative Communication Boards

Child’s Name: ______________________________

Date of Birth: _____________________________

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
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<tbody>
<tr>
<td>Has your child ever failed a hearing screening?</td>
<td></td>
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<tr>
<td>If yes, please explain:</td>
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<tr>
<td>Does your child have a family history of hearing loss?</td>
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<td>If yes, please explain:</td>
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<tr>
<td>Does your child have speech or language problems?</td>
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<tr>
<td>If yes, please explain:</td>
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<tr>
<td>Does your child have any known disabilities or developmental problems?</td>
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<tr>
<td>Does your child have any known visual difficulties?</td>
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<tr>
<td>(If child wears glasses, they should wear them the day of participation.)</td>
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<tr>
<td>When asked to do so, will your child point to a picture?</td>
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Thank you for your time.
Appendix B

Site Recruitment Letter

Dear Administrator or Site Director:

My name is Dottie Morgan. I am a graduate student in the Speech-Language Pathology program at Indiana University of Pennsylvania (IUP). As part of my Master’s degree, I am planning research in order to complete a thesis. I am working on this research with Dr. Lisa Hammett Price who is an associate professor at IUP and a nationally certified speech-language pathologist. I am contacting you today to invite you to serve as a site for my intended study. This would involve allowing me to:

- distribute fliers to parents about the study,
- distribute informed consent forms for parents to give permission for their child to participate, and
- find a quiet place on site to do several activities with each child.

The purpose of my research is to learn about how young children identify emotion pictures and whether two types of visual cues help them to identify emotions more accurately and/or more quickly. This is important because some children cannot communicate using speech and so we often help them use pictures to communicate. Emotions are particularly difficult for children with autism and we need ways to help them identify and express emotions using pictures. First, we need to understand how typically developing children identify pictures of emotions and whether two types of visual cues can be helpful. Then we can do a better job of assisting young children with autism and other disabilities to use these pictures to tell others how they feel.

What I need to complete my research are children with no known disabilities between the ages of 4 and 5 years, 11 months to participate. Here is what I will ask children to do:

- respond to questions on a brief receptive language screening (10-15 minutes)
- complete a hearing screening (5 minutes)
- select emotion pictures on a computer touch screen (5 minutes)
- participate in a brief teaching exercise to help them learn one of the visual cues (6 minutes)
- select emotion pictures again on the computer touch screen (5 minutes)
Children must pass the receptive language screening and the hearing screening in order to participate in the computer and teaching tasks. I will notify parents of any child who does not pass the hearing screening and provide information on resources for follow-up and assistance. Many parents find this screening helpful.

Children will receive a sticker as a thank you for participating. Children typically find these activities fun and engaging. If at any point they do not want to continue, the tasks will be discontinued and I will try to complete them at another time. While there is minimal risk to participants in this study, every effort will be made to prevent fatigue or disinterest.

I will provide you with approval from the Institutional Review Board at IUP prior to beginning to work with you at your center. Participation in this study is voluntary. Children and parents may choose to discontinue participation at any time during the study with no consequence. Participant identity will remain confidential and separate from all data.

I would so appreciate being able to seek participants for my research at your center. I will follow up with a phone call next week. Thank you for considering my request. I look forward to talking with you soon.

Sincerely,

Dottie Morgan

qhfq@iup.edu

cell: (814)242-4376
Appendix C

IRB Approval Letter

Indiana University of Pennsylvania

Institutional Review Board for the Protection of Human Subjects
School of Graduate Studies and Research
Stright Hall, Room 113
210 South Third Street
Indiana, Pennsylvania 15705-1948

June 7, 2012

Dottie Morgan
2763 Bedford Street
Johnstown, PA 15904

Dear Ms. Morgan:

Thank you for submitting the revisions to your Human Subjects Review Protocol titled, “The Efficacy of Color and Spatial Cues for Augmentative and Alternative Communication Boards,” (Log No. 12-307) as requested by the Institutional Review Board for the Protection of Human Subjects (IRB). On behalf of the IRB, I have approved the revisions for the period of May 16, 2012 to May 16, 2013 and will so inform the Board at the next meeting.

It is also important for you to note that IUP adheres strictly to Federal Policy that requires you to notify the IRB promptly regarding:

1. any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented),
2. any events that affect the safety or well-being of subjects, and
3. any modifications of your study or other responses that are necessitated by any events reported in (2).

Should you need to continue your research beyond May 16, 2013 you will need to file additional information for continuing review. Please contact the IRB office at (724) 357-7730 or come to Room 113, Stright Hall for further information.

Although your human subjects review process is complete, the School of Graduate Studies and Research requires submission and approval of a Research Topic Approval Form before you can begin your research. If you have not yet submitted your RTAF, the form can be found at http://www.iup.edu/page.aspx?id=91683.

This letter indicates the IRB’s approval of your protocol. IRB approval does not supersede or obviate compliance with any other University policies, including, but not limited to, policies regarding program enrollment, topic approval, and conduct of university-affiliated activities.

I wish you success as you pursue this important endeavor.

Sincerely,

[signature]

John A. Mills, Ph.D., ABPP
Chairperson, Institutional Review Board for the Protection of Human Subjects
Professor of Psychology

JAM:jeb

cc: Dr. Lisa Hammett Price, Thesis Advisor
    Ms. Jean Serio, Secretary
Appendix D

Sample No Cue Condition
Appendix E

Sample Color Cue Condition
Appendix F

Sample Spatial Cue Condition
Appendix G

Sample Combined Color and Spatial Cue Condition