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IMPROVING SEARCH FOR EMOTION SYMBOLS: STRUCTURAL CHARACTERISTICS OF THE DISPLAY

JULIE T. SNELL
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Reviewed and approved* by the following:

Krista M. Wilkinson
Professor of Communication Sciences and Disorders
Thesis Supervisor

Carol A. Miller
Associate Professor of Communication Sciences and Disorders
Honors Advisor

*Signatures are on file in the Schreyer Honors College.

Abstract

An understudied area in aided augmentative and alternative communication (AAC) is the representation of emotions, particularly those with similar facial characteristics (surprised, scared). We examined whether identification of line-drawing symbols for emotions could be facilitated through structural changes to the display, specifically through colored backgrounds and judicious arrangement of the symbols. Color-coding the background detracted from both speed and accuracy of finding the target by nondisabled preschoolers. Clustering symbols by their valence (positive, negative) improved both accuracy and speed.

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Introduction

People depend on communication every day for social, educational, occupational, and emotional needs. Most individuals usually use a combination of both written and spoken language. People with developmental disabilities may not be able to use oral language in the same way that typically developing people do. In this circumstance, a person may depend on augmentative and alternative communication for his/her communication needs. Unaided augmentative and alternative communication involves any sort of signing system as well as facial expressions that help assist communication. Aided augmentative and alternative communication (AAC) is any sort of aid that a person may need to enhance or allow for communication. AAC can be anything from a pencil and paper to a high tech computer system. Children who use high tech augmentative and alternative communication systems depend on symbols to represent semantic meaning. Often they use picture symbols. There are several different types of picture symbol sets such as Blissymbols, PCS, and Picsyms. Symbols are chosen based on the communication needs of the individual using the system. Both the choice of the symbol set and the arrangement of the symbols vary from individual to individual (Glennen & DeCoste, 1997).

Emotions are often difficult for children to label, identify, and even convey at times (Moore, 2001). Children with intellectual disabilities often have particular difficulty in this area. Many times these children are using AAC systems to communicate. The symbols used to represent emotion may be difficult for the children to recognize due to the similar features of each symbol. In this research, I sought to examine the effect of color cuing in emotion symbols.

Emotion

Many children with developmental disabilities have difficulty identifying line drawings that match emotion expression. According to Moore (2001), children with intellectual disabilities perform worse on emotion-perception tasks in comparison to typically developing peers of the same chronological age. Moore (2001) discussed a study done by Harwood, Hall and Shrinkfield (1999) with 12 individuals between the ages of 19 and 54 with a mean IQ of 62. This study used videos and photographs of posed emotions that examined the emotions *happy*, *sad*, *angry*, *fearful*, *surprised*, and *disgusted*. The task involved picture labeling as well as matching. The individuals were shown moving and static photograph and video displays that expressed emotion. The task required the individual to choose the target emotion that was displayed from six choices. The choices included both a picture and a written label of each emotion. The study found that adults with intellectual disabilities (ID) had a lower performance level in comparison to typically developing peers of the same chronological age. Individuals with ID and individuals who were typically developing both performed better with moving displays than with static photographs (Moore, 2001, p.487).

Moore (2001) also discussed a study conducted by Simon, Rosen, and Ponpipom (1996) examining emotion perception. Their study involved a group of 42 men and 44 women varying in age from 20 to 59. The stimuli used were line drawings of the face representing the emotions Happy, Sad, Angry, Fearful, Surprised, and Disgusted. The individuals completed three tasks. The first task involved picture identification in which the participants were read a word and asked to select the line drawing to go with it. The second task consisted of story labeling in which the individuals were read a small passage and asked to pick the word that best went with the passage. The third task consisted of story-picture matching in which the participants were read a short passage and asked to select the line drawing to go with it. Simon et al. (1996) found that performance on all tasks was dependent upon IQ. They also found that the younger participants performed better on the story-picture matching and picture labeling tasks than the older participants (Moore, 2001).

Moore (2001) discussed a third study involving the examination of emotion perception in individuals with ID that was done by McAlpine, Kendal, Singh, and Ellis (1992). This study included 80 individuals ranging in age and degree of ID. The stimuli used were Ekman photos representing the emotions *happy*, *sad*, *angry*, *fearful*, *surprised*, and *disgusted*. The participants were required to do a picture-identification task. McAlpine et al. (1992) found that performance across all age groups and severities of ID performed significantly poorer than the group of typically developing peers (Moore, 2001).

Moore suggested that one possibility for this deficit may be that emotion related tasks involve additional task demands such as information processing capabilities. These additional demands may rely more on IQ rather than the mental age of the individual (Moore, 2001). Many of these tasks involve recognition, encoding, memory, discrimination, and a verbal response. Kasari, Freeman, and Hughes (2001) suggested that children with Down syndrome may not get the appropriate input needed to learn emotions. It has also been suggested that the lack of dynamic movement of photos and symbols of emotion are difficult for people with intellectual disabilities to determine. A photograph is unable to represent movement in facial expressions and is rather a frozen instance in time (Moore, 2001). This may cause difficulty in recognizing certain emotions. Moore (2001) also suggested that children have a more difficult time recognizing emotions that are more neutral, especially children with intellectual disabilities. They were able to recognize faces that represented *happy* and *sad* more easily than those faces that lacked such a prominent emotion.

Emotions such as *happy*, *angry*, *afraid*, and *sad* have distinct facial features that make them distinguishable among other emotions (Visser, Alant, & Harty, 2008). For example, *happy* usually involves the corners of the mouth being turned upwards, whereas *sad* and *afraid* involve the corners of the mouth pointing down. The position of the mouth is just one of the characteristics that help distinguish one emotion from another. The other two characteristics are the upper portion of the face, such as eyes, eyebrows, and forehead and the middle portion of the face including the nose and cheeks. All of these characteristics can be combined in different ways to represent specific emotions. Emotions that have similar characteristics are often confused for each other. For instance, Surprised and Scared may often be confused in line drawings. Both emotions typically involve the eyebrows being raised, the eyes being open, and the mouth being open (Visser et al., 2008). Emotions are often hard to describe, let alone represent as a line drawing.

Emotion Representation in AAC Symbols

There are currently multiple options for emotion symbol sets in augmentative and alternative communication and each set has a different way of representing emotion. Before this research was conducted, there was not much information regarding children’s perceptions about what these line drawings represented as far as emotion is concerned. In one of the only studies, Visser, Alant, and Harty (2008) examined perceptions by 26 typically developing children between the ages of 48 and 59 months of line drawings representing emotion. They were trying to determine which of four possible representations best depicted the emotional state. Thus, there were four symbols representing Happy, four representing Sad, four representing Afraid, and four representing Angry. All 16 symbols (four representations of each of four emotions) were presented at once. Participants were asked questions to elicit responses. For instance, a participant might be told: “Peter is going to play at his friend's house. He is *happy*. Show me the Happy face.” The individual pointed to the emotion on the display that s/he felt best answered the question asked by the researcher. A total of 12 questions were asked for each participant (Visser et al., 2008).

Children were most consistent in selecting from among the four symbols for happy than for any of the other 3 emotions. Generally, the percentage of out-of-emotion selections for Sad, Afraid, and Angry was 15-26%. Within the four options for each emotion state, there were preferences for certain symbols, however, all four symbols were chosen at some point during the study. It would appear also that the choice of symbol may have been related to the form of the question asked. The study was not designed to determine what characteristics of each symbol influenced these choices.

Clearly, emotions with similar characteristics need to be taken into consideration when they are placed on an aided AAC system. The person using the system needs to be aware of what each symbol represents. Given the similarities across line drawings of faces, and the difficulties in representing emotions we described, we sought to examine the possibility that background color cuing could be a means to help participants distinguish those emotions with similar characteristics.

Color Cuing

Wilkinson et al. (2008) suggested that design will impact the child’s ability to locate symbols and utilize the augmentative and alternative communication system efficiently. According to Wilkinson et al. (2008), it has been suggested that color cuing can help direct the attention of individuals with intellectual disabilities. Wilkinson et al. (2008) discussed the research done in the field of visual cognitive neuroscience involving color cues. Findings include the positive effect that color has on categorization of stimuli, initial responding, immediate recall, and long-term retention of information. It has also been observed that color aids in guiding attention when searching for a target. Much of the research that has been done involving color cuing in the field of visual cognitive neuroscience has used nonmeaningful stimuli (Wilkinson, Carlin, & Thistle, 2008; Wilkinson & Jagaroo, 2004).

Not much research has been done on color cuing in AAC, and the research that has been done involves symbol internal color. As would be predicted from visual cognitive neuroscience, color affects initial responding, immediate recall, long-term retention, and categorization of stimuli. It has also been shown that symbol internal color can help guide attention while searching for stimuli in an AAC context (Wilkinson et al., 2008). For instance, peas, broccoli, lettuce, cucumbers, and peppers may all be represented as green. The child's knowledge about the colors of these foods may help them locate them within a grid-layout. This may also hold true for activities. A child may be able to associate that activities involving water will have an overall blue scheme to them. If the child is able to make this association, these activities will also be easier to locate. This may not necessarily be the case for clothing. The color of clothing is often more ambiguous than food or activities. Clothing can be represented as any color.

Wilkinson et al. (2008) conducted a study looking specifically at foods, clothing, and activities. In this study, the researchers used two experimental conditions. The first condition arranged AAC symbols so that the symbols that shared internal color were clustered together. For example, foods such as bananas, squash, cheese, and corn, which all share an internal color of yellow, were grouped together. This created a subgroup from which the children could search the symbol of interest. In another condition, symbols that shared internal color were distributed throughout the display, so that no subgroups were created. In this study, the use of color within a symbol requires the child to rely on his/her knowledge about the color of foods or activities. (Wilkinson et al., 2008)

This study involved 16 typically developing children. Eight of the children were under the age of four and eight children were above the age of four. In addition, the study involved 10 children with Down syndrome. This study specifically looked at the speed and accuracy of finding the target. Wilkinson et al. (2008) found that when same-color symbols were clustered together, participants were able to locate the target symbol with better speed and accuracy, than with the other condition

Wilkinson et al. suggested background color cuing might be used in similar ways to guide attention when symbol – internal color could not be manipulated. For instance, in symbols of emotion, it is not possible to change the internal color of the face to represent different emotions. We sought to test the speculation of background color empirically by using color cuing to cue for valence of emotion symbols that represented four cardinal positive and negative emotions (Happy and Loving, Angry and Sad, respectively) and four more neutral emotions (Surprised and Silly, and Bored and Nervous).

Methods

Participants

Consent forms were signed by parents or guardians for 23 typically developing preschool aged students from two local preschools. The decision to use typically developing children was made to be certain that the effects seen in the results were due specifically to the conditions rather than to the presence of physical or intellectual disabilities. Although this is not the population that would typically be using AAC, it was important to get accurate results that could later be applied to the population of children that may have physical or intellectual disabilities (Higginbotham, 1995).

All children were given the Peabody-Picture Vocabulary Test – IV (Dunn & Dunn, 2007) to test for receptive vocabulary. One participant scored more than one standard deviation below the mean for the PPVT-IV, and was excluded from study. The average standard score for the Peabody-Picture Vocabulary Test (PPVT-IV) for the remaining 22 participants was 96.4. None of the participants had any uncorrected hearing or vision impairments. The mean chronological age of the participants was 4 years, 9 months (3;08 – 6;0).

Eleven of the participants underwent the study when the background color was fully saturated, in comparison to a white background. The remaining 11 participants experienced color cuing in borders rather than the entire background. For both of these studies there were four different conditions.

Materials and Display

Each array contained eight different emotion symbols (Happy, Love, Angry, Bored, Silly, Surprised, Scared, and Sad). The symbol set used in this research was

Picture Communication Symbols (PCS; Mayer-Johnson, 1992). Each trial consisted of an array of eight symbols representing different emotions.

How do you determine how pleasant or unpleasant an emotion is? People can generally tell if an emotion is negative or positive, but a problem arises when asked to arrange emotions in order from most pleasant to least pleasant. In order to increase validity, we decided to use photos from The International Affective Picture System (IAPS). This was a large study that had participants analyze pictures and rate them from most pleasant to least pleasant. All of the results were compiled and each picture was given a valence of pleasantness. We used these numbers to arrange our emotions according to how the photos were rated nationally. Our research included 16 sample photos to allow for two photos per emotion. The samples that we chose to use were real life photos of both children and adults displaying the emotions that we were interested in studying. These emotions include *happy, love, surprised, silly, bored, scared, sad,* and *angry.*

The computer program that was used allowed for a grid layout of 4x4. Our research looked at eight different emotions, so the grid included eight spaces without any symbols. These spaces were placed in between the emotion symbols in an alternating fashion. The four conditions required the development of four grid-layout displays. Each array was unique in arrangement between conditions. The program presented participants with a stimulus photograph and then required them to select the appropriate target from the array by clicking the symbol with a computer mouse. The program recorded both the child's accuracy and reaction times of each trial. The output provided also included the response that the child made when there was an error. When the child chose the appropriate target symbol, the program elicited a sound to alert him/her that the response was correct. When the incorrect target was chosen, no sound was elicited.

Arrangement Conditions

We decided to look at four different arrangement conditions in order to see which conditions would be most efficient and most accurate for a person using an AAC system, specifically relating to emotions.

Manipulation #1

- Condition A presented eight emotion symbols in random order and did not contain any color cuing. Refer to figure 1 for a representation of condition A.
- Condition B presented the emotions according to valence and had no color cue. Refer to figure 2 for a representation of condition B. The most negative valenced emotions (most unpleasant) started at the top of the array with Angry and Sad. The second row in the grid had a moderately negative valence (moderately unpleasant) and contained the emotions Scared and Bored. The third row of the array contained moderately positive valenced emotions (moderately pleasant) and included the emotions Silly and Surprised. The last row included the most positively valenced emotions (most pleasant) and contained the emotions Love and Happy.
- Condition C was constructed to determine if color had any factor in the speed and accuracy of selection of a target symbol. The emotion symbols were in random order and contained color cuing. Refer to figure 3 for a representation of condition C. Background colors were selected according to the valence of the emotion. The most negatively valenced emotions, Angry and Sad, were given a

red background. The moderately negative valenced emotions, Bored and Scared, were given a pink background. The moderately positive valenced emotions, Silly and Surprised, were given a light blue background. Finally, the most positively valenced emotions, Happy and Love, were given a bright blue background.

- Condition D aimed to determine if background color and organization of emotion symbols improved the speed and accuracy of selection of a target symbol. This condition clustered symbols according to their valence and utilized color cuing. Refer to Figure 4 for a representation of condition D. In this condition, symbols were arranged in order from most negatively valenced to most positively valenced, in the same way that condition B was arranged. These symbols contained the same background colors as those symbols used in the condition C. This means that the first line of the array represented the most negatively valenced emotions, Angry and Sad, with a red background. The second line of the array represented the moderately negative valenced emotions, Bored and Scared, with a pink background. The third line of the array represented the moderately positive valenced emotions, Silly and Surprised, with a light blue background. The fourth line of the array represented the most positively valenced emotions, Happy and Love, with a bright blue background.

Manipulation #2

Children underwent the study in one of two groups; either the background color cue consisted of a "saturated" color background (e.g. the entire background was blue) or a "border" background, where only the border of the symbol was colored. The second experimental group had conditions that were very similar to the first experimental group.

The only difference between Group 1 and Group 2 was that the use of color cuing was seen in the border of the symbol rather than in the background color; otherwise the conditions and all stimulus presentations were identical across both groups. The colors used in the borders were the same colors that were used in the backgrounds of Group 1. Refer to figures 5 and 6 for a representation of the bordered conditions.

To control for the placement of all of the symbols within the array, we made sure that none of the conditions contained symbols in the same locations. Not only did we change the rotation of the blank squares and the squares that contained the symbol, but we also switched the symbols within the category. A category would be defined by the line that the emotion is on, or the valence that the emotion has. This means that an emotion found on the second line is considered moderately negative in valence. The emotions within this category are rotated within the second and fourth condition, but they still remain on the same line and resemble the same valence. For example, in condition B, the first line has a blank square, Sad symbol, blank square, and then the Angry symbol. In condition D, the first line has the Angry symbol, blank square, Sad symbol, and then another blank square. Condition D differs both in the alignment in the blank squares and in the order of the emotions from condition B. These two conditions differ enough so that the children are not able to learn the location of all of the emotion symbols.

Procedures

The children were seated in front of the computer with the test administrator sitting to the side, or slightly behind the child. The administrator did not give any positive reinforcement regarding whether or not they were choosing the appropriate target. General encouragement was given when needed in order to keep the child on task. The participants completed the four conditions during one day. This included 16 trials where the child was first shown a photograph and then had to choose the target from the array shown. After completion of the task, the child was able to choose a sticker.

As in the research done by Wilkinson et al. (2008) we used the *visual search* paradigm. This required a matching-to sample task. Participants were shown a sample photograph and then asked to locate the target stimulus from an array that best represented the sample photograph shown. This sort of testing represents what AAC users go through every time they wish to create a message. Users are constantly trying to locate the symbol they wish to use with the best accuracy and in the most efficient manner (Wilkinson et al., 2008). The participants were then asked to select the target symbol from an array of all of these emotions that were represented as line drawings. Each one of the line drawings was from the Boardmaker software, so each had the same general scheme to them.

Similar to Wilkinson, Carlin, and Jagaroo (2006), this study used a 0-delay matching-to-sample task (0-d MTS). Using this method the child was shown a stimulus photograph in the middle of the screen. Using the cursor via the mouse, the child had to click on the photograph after he/she had examined it. Once the child clicked the photograph, it disappeared and an array of eight symbols appeared in the center of the screen. The task was to choose the symbol from the array that best represented the photograph previously shown. In order to choose the symbol, the child used the cursor and the mouse to click the desired symbol. The 0-d MTS task is used among many researchers to answer a variety of questions and is used in many different human and nonhuman populations. Dube (1991) developed the software that was used for this research. Using the software, the order of which the stimuli appeared and their location on the screen was able to be pre-programmed. The pre-programmed file allowed for consistency and the recording of the participants' responses (Wilkinson et al., 2006).

Measures and Data Analysis

The dependent variable for this research was reaction time and accuracy. The software recorded the reaction time beginning when the array first became visible to the participant. The reaction time was terminated when the participant chose his/her response from the array by clicking the target. The software also recorded the responses of each participant. This made it possible to view both the correct and incorrect responses. Data analyses were completed on both the accuracy and the mean reaction times of correct trials.

Integrity of Data Entry

To ensure integrity of the data, an individual not involved in the research compared the analysis of the data on the master spreadsheet to the computer output data. The master spreadsheet was used in the data analysis. About 20% of the files were randomly selected and analyzed by the individual. Each output file involved the calculations of both the accuracies and the mean reaction times of all four conditions. The individual ensured that all calculations done by the original researcher were inputted correctly into the master spreadsheet.

Results

Saturated Experimental Group

Group 1 was the experimental group that underwent color cuing within the background of the symbol. Refer to figures 1 through 4. The average latency for condition A (no color, distributed) was 13.1 seconds with an average accuracy of 89%. The average latency for condition B (no color, clustered by valence) was 9.2 seconds with an average accuracy of 84%. The average latency for condition C (color, distributed) was 14.8 seconds with an average accuracy of 73%. The average latency for condition D (color, clustered by valence) was 15 seconds with an average accuracy of 68%.

Border Color Cuing

Group 2 was the experimental group that experienced color cuing within the border of the symbol. Refer to figures 7 and 8. The average latency for condition A (no color, distributed) was 10.9 seconds with an average accuracy of 73%. The average latency for condition B (no color, clustered by valence) was 7.9 seconds with an average accuracy of 70%. The average latency for condition C (color, distributed) was 11.6 seconds with an average accuracy of 70%. The average latency for condition D (color, clustered by valence) was 10.6 seconds with an average accuracy of 61%.

Discussion

This research suggests that the clustering of symbols according to valence improved reaction time in both experimental groups when color cuing was not used. We found that when color cuing was used it created distraction and eliminated the positive effects attributed to the clustering of symbols according to valence. Independent from the organization of the symbols, color cuing did not assist individuals in either the speed or accuracy of selecting the target symbol.

Color cuing was used in the background color and in the border of the symbol. The use of color cuing in this situation found different results than the research that was done using color cuing in reference to the symbol internal color. The research done by Wilkinson et al. (2008) suggested that symbol internal color could assist AAC users in their ability to locate desired symbols.

Grid-layout displays are a common method of organization on aided AAC systems. Many problems may be presented with this set-up due to the large number of symbols that need to be represented on an individual's AAC system. Many times individuals who are using these systems have intellectual disabilities. These individuals may have trouble recognizing emotion, expressing emotion, retaining attention, and possibly problems with motor control. The ability to communicate emotions is important to social functioning, as well as emotional well-being. If an individual is already impaired in emotion recognition or expression, setting up an appropriate system for him/her may prove to be a large feat. For this reason, we felt that it was important to determine a way to represent emotion symbols on a grid-layout display in a way that could assist these individuals in both locating and utilizing the necessary symbols.

Displays should be organized according to what makes communication easier for the individual using the system. Many times these systems may be set up at a time when children are young. When this is the case, another person must decide on the type of symbol set, what symbols will be placed on the system, and how they will be organized. There are many pre-made grid-layout displays that are available for purchase. Oftentimes these pre-made displays utilize color cuing in the background of the symbol. Little research has been done concerning the use of background color, but it has been assumed that this method would aid AAC users in communication. Our data showed that the use of color in both the background and the border slowed reaction time by up to six seconds. This is a significant amount of time when considering the speed of communication. This slowed reaction time could lead to communication breakdowns as well as reduction in communication in general due to frustration.

This study was designed to avoid learning effects in order to isolate the effects of color and organization. When an individual uses an AAC device he/she is able to learn the location and organization of the system. In this sense, the research that we did was different from the situation that AAC users are in. However, it suggests that background color is not a useful method of organization in emotion symbols. The research did show that organizing the emotions according to valence significantly decreased reaction time by up to four seconds when color cuing was not used. Again, this is a significant amount of time when considering rate of communication and the number of symbols that must be located and selected in order for an AAC user to formulate a message.

The results provide support for the use of clustering symbols on a grid-layout display. However, the same support is not seen in the use of color cuing. We did find that the use of color in the borders had an advantage over background color by about five seconds in the clustered condition and 3 seconds in the distributed condition. This research should be highly considered among clinicians and professionals who create grid-layout displays for AAC users. With this discovery, it uncovers the need for more research in this area.

Future Research Directions/Limitations of Current research

In relation to emotion symbols on an AAC device, we were presented with difficulty when analyzing the "neutral emotions" such as Surprised, Sad, Silly, and Bored. Emotions that had a more neutral valence seemed to be harder to recognize than the emotions with either a positive valence or a negative valence. These inconsistencies that we found in our data relating to the emotions Surprised and Sad reflect the difficulties that individuals have identifying and labeling these emotions from the PCS symbols. For this reason more research needs to be done to determine a better way to represent these emotions. New symbol development, a new method of organizing the symbols, or a new method of labeling the emotional symbols may be an area for more research.

We obtained data that will be analyzed further in relation to emotions based on valence. The reaction times and accuracies differed depending on the emotion being tested. It is important for researchers and professionals to understand what emotions are more difficult to represent and to determine what it is that makes these emotions more difficult to identify in PCS line drawings.

After doing this research, we decided that it would be interesting to determine if a "blocked" region of color would be more beneficial than simply background color. A “blocked” region would contain multiple symbols imbedded in distinct blocks of color. The symbol itself would not have a background color and would maintain the white contrast between the symbol and the background. This additional “block” of color may be less distracting to the individual than the background color or border color that we were studying. Due to the fact that the use of color in the border of the symbol had an advantage over background color of the symbol, it suggests that the contrast between the symbol and the background is necessary for improved search time.

It may also be beneficial to run the same study on an older group of participants. It is expected that the results would to be similar, but the difference in reaction times may be smaller. It is important to understand that children may require different methods of organization depending on their age. It may also be beneficial to do this study with participants who have intellectual disabilities to determine what factor help or hurt these individuals with speed and accuracy of communication because this population of individuals is usually the group that utilizes AAC systems.

Acknowledgements

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Figure 1. Condition A with no color and random order

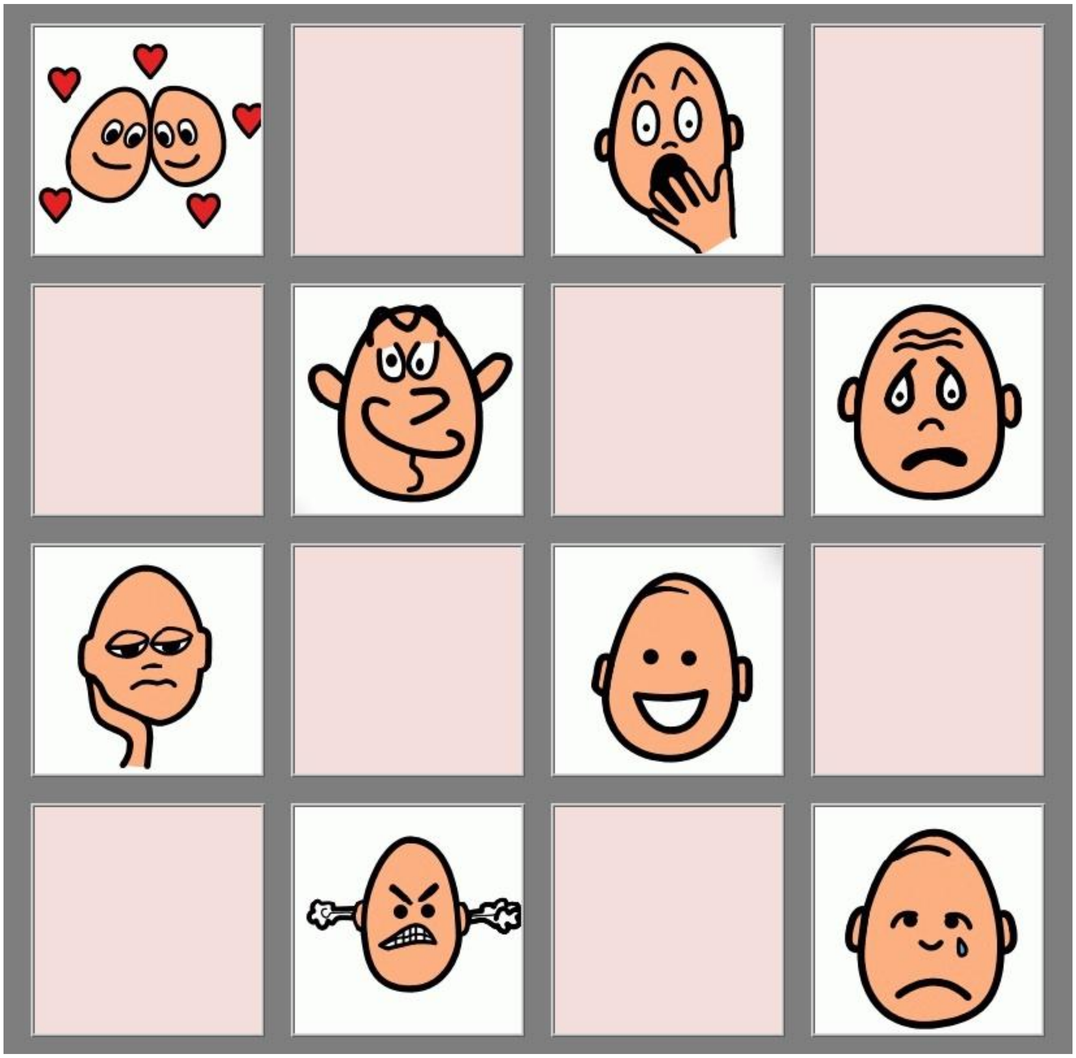


Figure 2. Condition B with no color and clustered according to valence

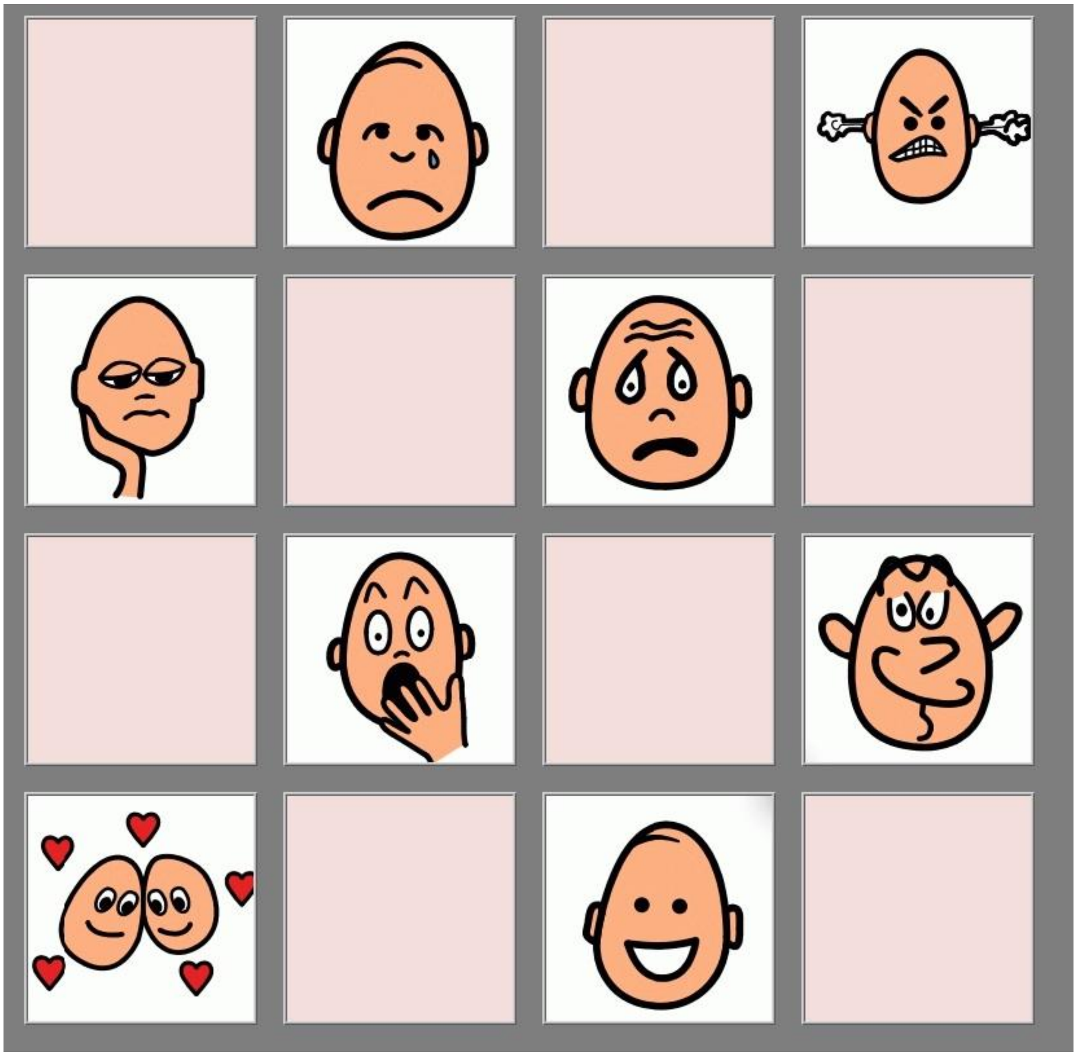


Figure 3. Condition C with color cuing in saturated background of symbol and random order

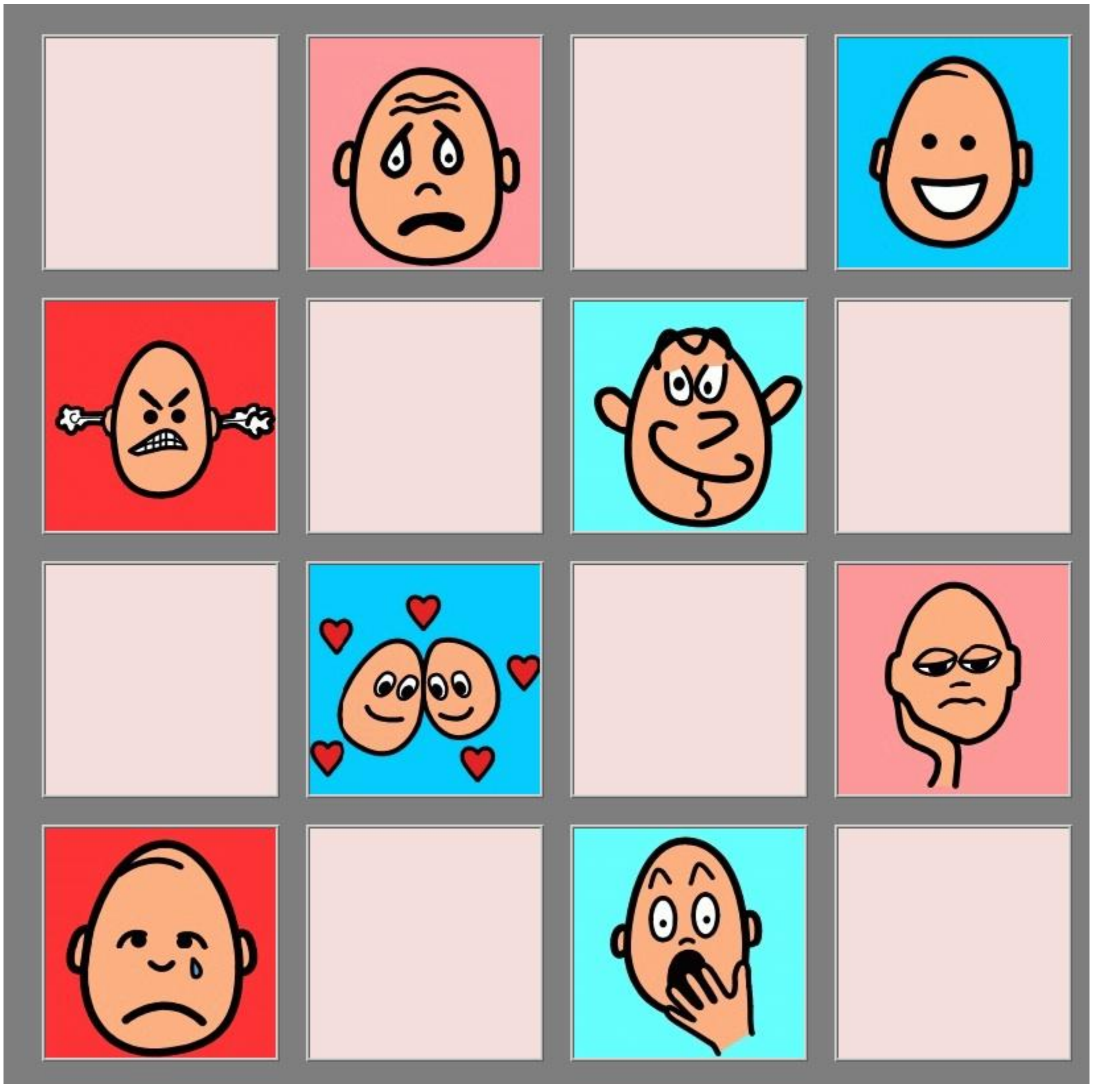


Figure 4 – Condition D using color cuing in saturated background and organized according to valence

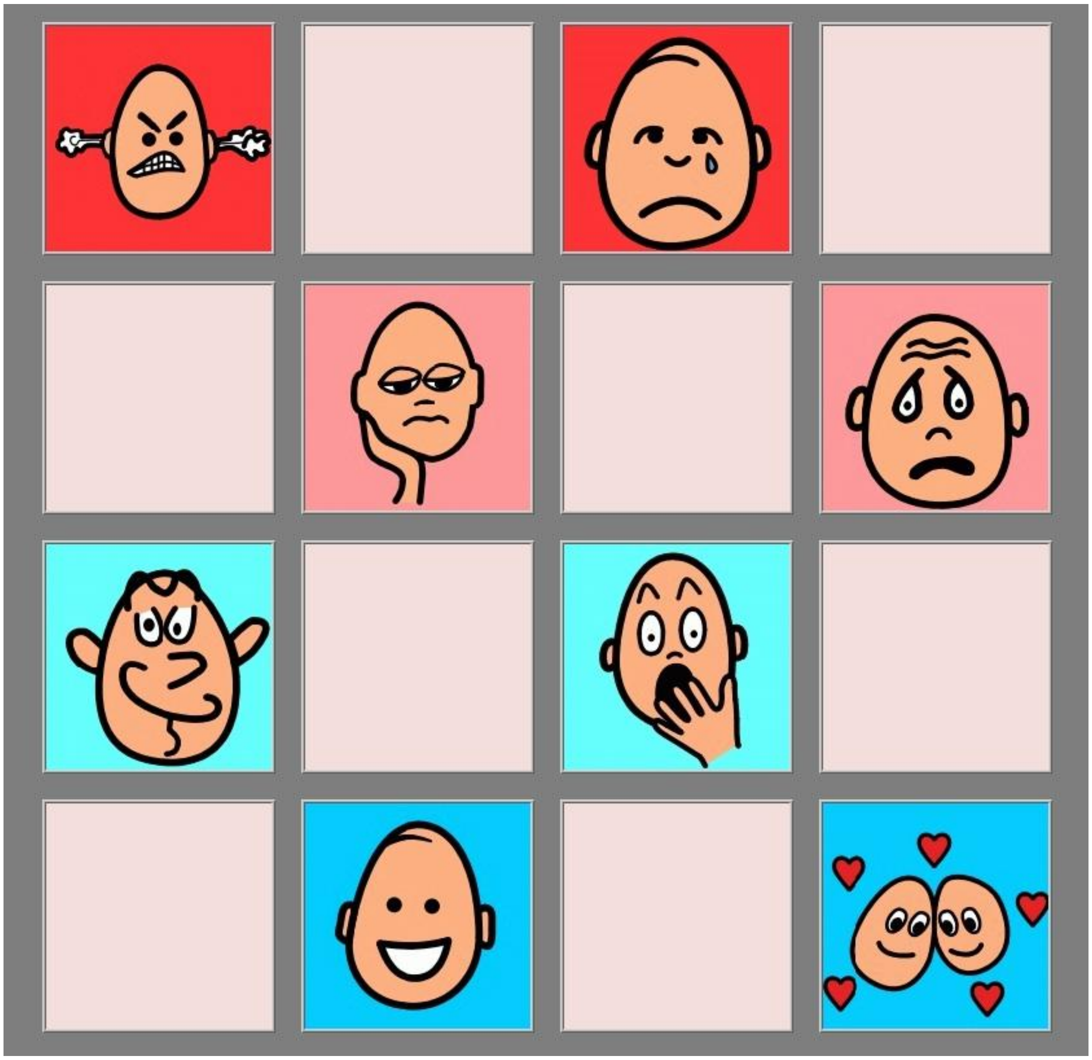


Figure 5 – Color cuing in border of symbol and random order of organization

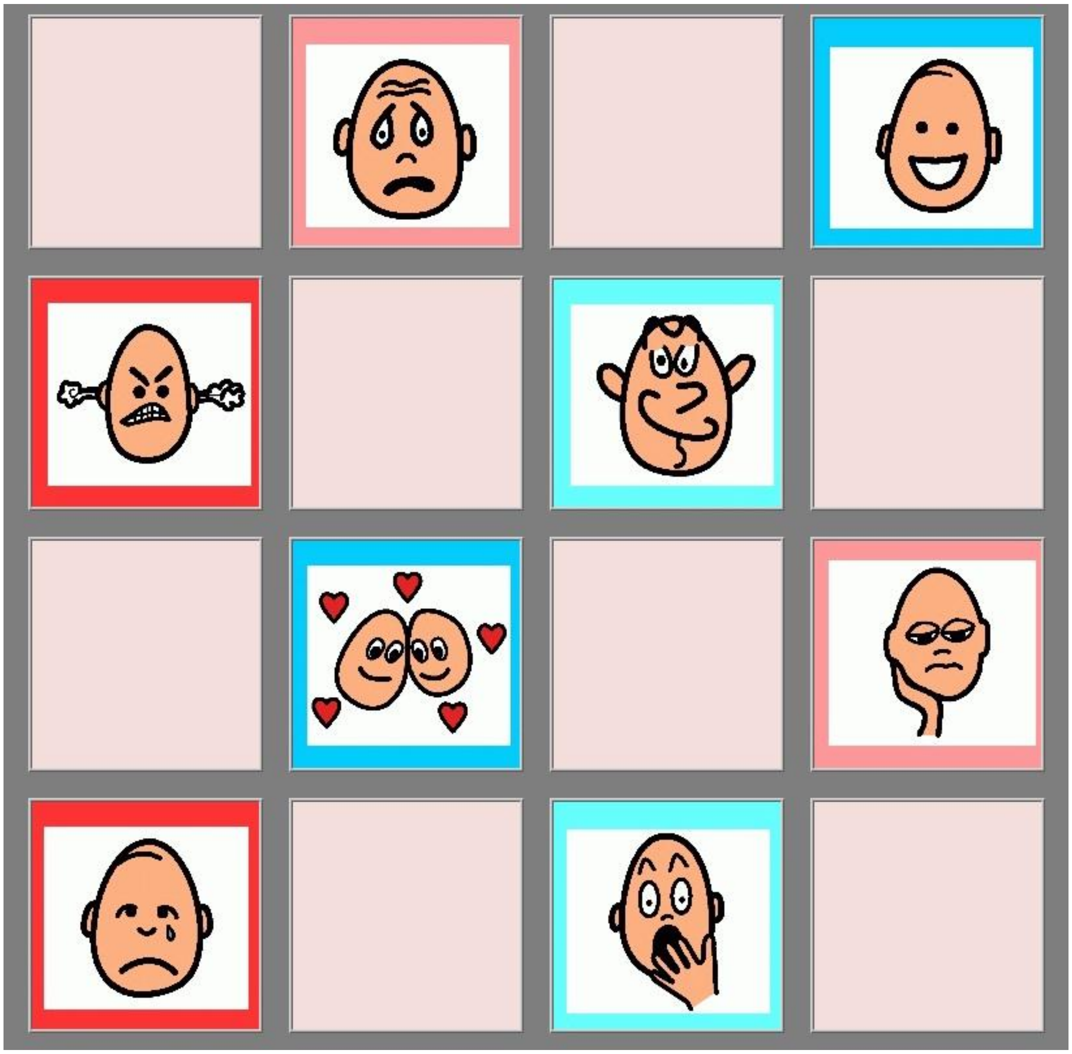


Figure 6 – Color cuing used in border of symbol and organized by valence

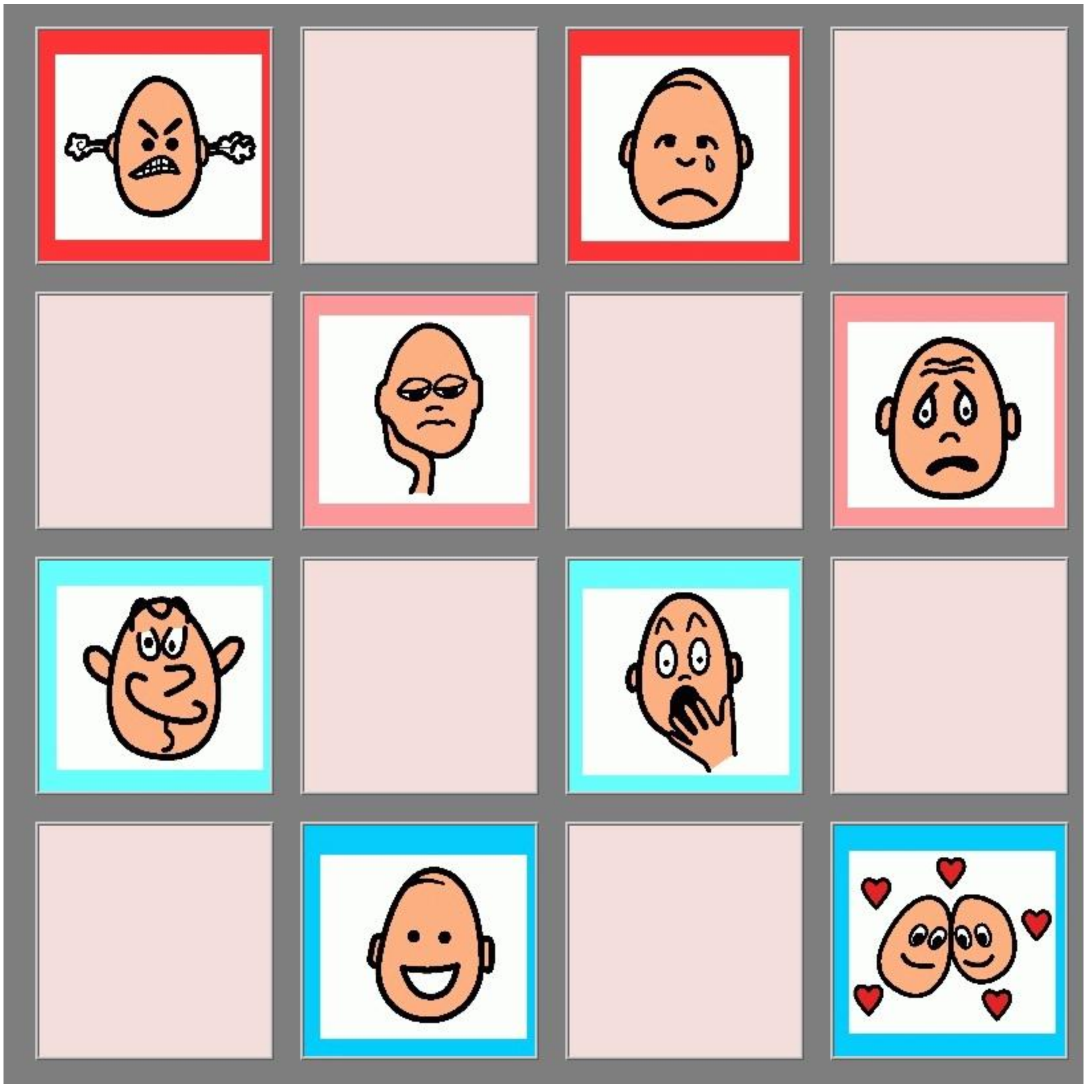


Figure 7. Accuracies of border and saturated symbols in clustered and distributed organization patterns

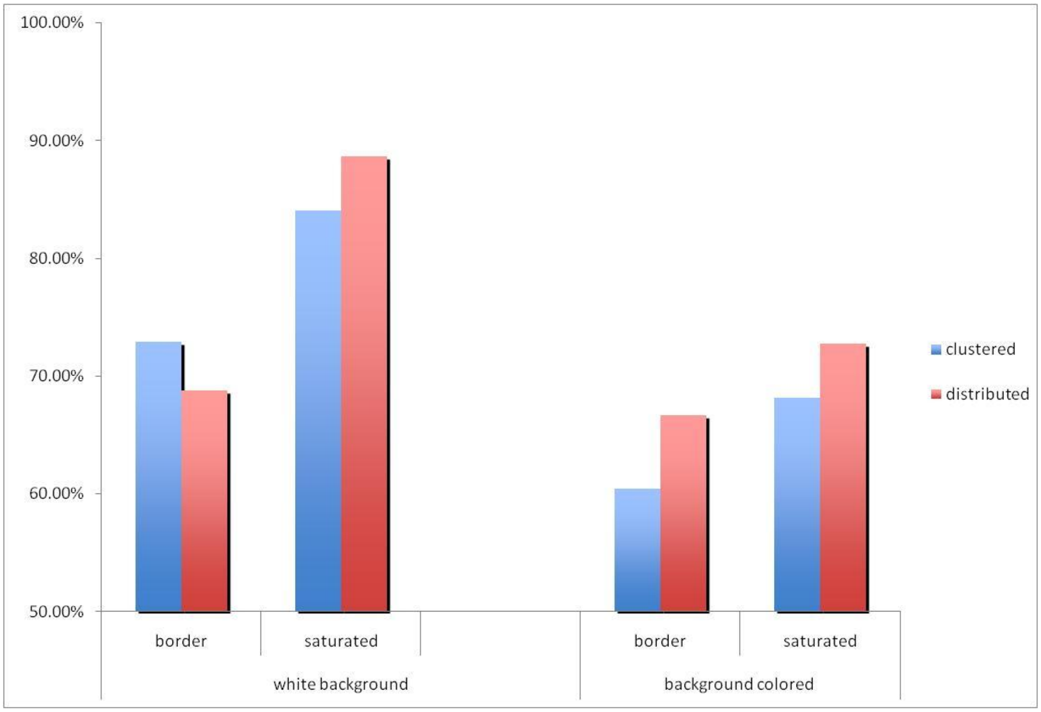
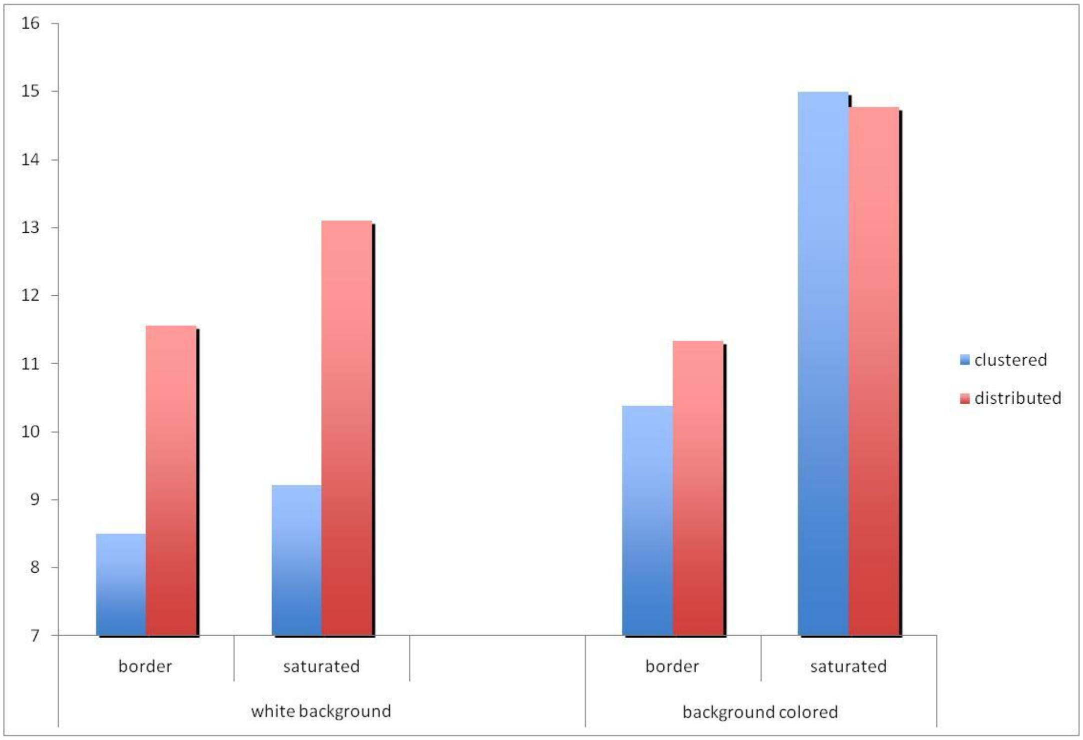


Figure 8. Reaction time of bordered and saturated symbols in clustered and distributed organization patterns.



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ACADEMIC VITA of Julie T. Snell

Julie T. Snell
955 Southgate Drive
State College, PA, 16801
Julietsnell@gmail.com

Education:	Bachelor of Science Degree in Communication Science and Disorders, Penn State University, Fall 2009 Honors in Communication Sciences and Disorders Thesis Title: Improving Search for Emotion Symbols: Structural Characteristics of the Display Thesis Supervisor: Krista M. Wilkinson
Related Experience:	25 hours of clinical observation at The Pennsylvania State University Clinic
Awards:	President's Freshman Award Dean's List Phi Eta Sigma National Honor Fraternity
Activities	Habitat for Humanity National Student Speech Language and Hearing Association Sign Language Organization Costa Rica Reforestation Program Project COMET and GOALS