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A Comparison of the Performance of Typically Developing 5-Year-Old Children Using Iconic Encoding In AAC Systems With and Without Iconic Prediction on a Fixed Display

Kathryn D.R. Drager and Janice C. Light
Department of Communication Sciences and Disorders
The Pennsylvania State University
Correspondence: Kathryn Drager, Department of Communication Sciences and Disorders, 308G Ford Building, The Pennsylvania State University, University Park, PA 16802, USA, Phone: 814-863-6247, Fax: 814-863-3759, Email: kdd5@psu.edu

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Abstract

Iconic encoding, or the use of a sequence of icons to retrieve a word or phrase from augmentative and alternative communication (AAC) technologies, has previously been shown to be challenging for young children to learn to use (Light et al., 2004). It is possible that the use of iconic prediction may facilitate learning in such systems by providing additional visual cues. The goal of the current study was to determine the effect of using iconic prediction on the performance of 5-year-old typically developing children who were learning to locate and generalize vocabulary prestored in AAC technologies using iconic encoding. Twenty 5-year-old children were introduced to 30 vocabulary items and asked to locate them using iconic encoding during four learning and testing sessions. Ten of the children completed this task without iconic prediction, and 10 completed the task with iconic prediction. They were also asked to locate an additional 30 vocabulary items, not previously introduced, during one generalization session. The results indicated that the children in the iconic prediction group did not perform more accurately than the children who did not have prediction available. There was some evidence, however, that using iconic prediction may help to facilitate generalization of use of iconic encoding to novel vocabulary. Potential implications, limitations, and future directions for research are discussed.

Keywords: aided communication, assistive technology, augmentative and alternative communication (AAC), children, iconic encoding, prediction

Young children with complex communication needs require access to augmentative and alternative communication (AAC) systems that appropriately address their stage of language learning and development. Recent research investigated the ease of learning of dynamic display AAC technologies and iconic encoding with young typically developing children, ages 4-5 (Light et al., 2004), and dynamic display AAC technologies with younger children, ages 2-3 (Drager, Light, Curran Speltz, Fallon, & Jeffries, 2003; Drager et al., 2004) across four learning and testing sessions. This research suggested that young children with severe communication disabilities may face significant difficulties learning some AAC technologies.

One system that the typically developing children had significant difficulty learning, at least initially, was iconic encoding. Iconic encoding is the use of a sequence of icons to retrieve a word or phrase from augmentative and alternative communication (AAC) technologies. Light et al. (2004) found that typically developing 4- and 5-year-old children were more accurate locating target vocabulary in a play scenario using the dynamic display conditions than using iconic encoding. They suggested several reasons why iconic encoding may have been difficult for young children, including a possible lack of understanding of the semantic associations of the icons, a lack of conceptual knowledge required to understand multiple associations, and limited knowledge of parts of speech (several icon combinations required the use of a speech marker for adjective, preposition, and interjection).

An iconic encoding technique might be described as relying on recall of an icon sequence with the icon set serving as a retrieval cue (Light, Lindsay, Siegel, & Parnes, 1990). It may be possible to further facilitate the use of iconic encoding by providing additional visual cues to signal possible or appropriate available choices. By signaling only those options that are available for selection, the field of choice becomes smaller. This strategy, iconic prediction, offers the potential to increase learning and efficiency of iconic encoding because the number of response options is smaller and the options that are available for selection are visually apparent. Message prediction is available in a number of types of AAC systems, and may consist of offers from the system of single letters, words, phrases/sentences, or icons. Theoretically, prediction can be used to increase communication rates, by eliminating necessary keystrokes and narrowing the field of choices. In iconic prediction specifically, when beginning an utterance, only the icons that are used to begin symbol combinations are “lit up”. Once an initial selection is made, only those icons that have been programmed to be paired with the first icon will be lit, decreasing the field of available options.

Although iconic prediction may help to facilitate the use of iconic encoding, its success relies on the ability of children to recognize and use the visual cues. To date, there are no data available on the benefits of iconic prediction for young children. This follow-up study to Light et al. (2004) addressed the following research questions: (a) What is the effect of iconic prediction on the accuracy of 5-year-old children’s performance locating vocabulary prestored in AAC technologies using iconic encoding? (b) Does the children’s accuracy improve across learning and testing sessions with iconic encoding with and without prediction? (c) Are the children able to generalize learning of iconic encoding with and without prediction to facilitate learning of novel vocabulary items? The technology used in this study to address these research questions was designed to be used with iconic encoding on a fixed display, rather than on newer, dynamic display technologies. This choice was made for two reasons: 1) this technology is still in use currently, and 2) it allowed for an examination of children’s approach to iconic encoding and the cues that they pay attention to, without the additional confound of the dynamic display component.

Method

Participants

Twenty typically developing children participated, with 10 children in each of two groups. The children were between the ages of 5 years 0 months to 5 years 11 months (*M* = 5 years 6 months). Participants were recruited from day care centers within Central Pennsylvania and were primarily from middle class families. Approximately 10-15% of the children were from diverse ethnic and cultural backgrounds, and all spoke English as a first language. None of the children had any identified speech, language, cognitive, or physical disabilities, and all had parental consent to participate. All children were reported by teachers and other school personnel to be functioning within normal limits for hearing and vision (or vision corrected to within normal limits).

Ten of the children (5 girls and 5 boys) were assigned to each of two groups: iconic encoding without prediction (hereafter referred to as without prediction) and iconic encoding with prediction (hereafter referred to as with prediction). The mean ages for the two groups were 5 years 7.7 months in the without prediction group and 5 years 5.4 months in the with prediction group. The children in the without prediction group, and their performance, were previously summarized in Light et al. (2004). (The iconic encoding without prediction group was the same one used in the Light et al. study, referred to in the previous study as the iconic encoding group, and the data presented here for that group are identical.) The without prediction group was completed first, followed by the with prediction group. Thus, the children were not randomly assigned to the two groups.

Materials

The learning and testing sessions were completed in the same manner as the previous Light et al. (2004) study, and will be summarized here. The play context was a birthday party scenario, selected because of its familiarity and its interest for children. The birthday party scenario was recommended in the BUILLD[1] curriculum guide as a context that would be appropriate for introducing iconic encoding (using Unity™ software[2]; Valot, 1995). The props for the birthday party included a stuffed teddy bear ("Bobby"), a wrapped birthday present, a variety of small presents (e.g., cars, books), and birthday accessories (e.g., birthday hats, birthday themed plates, cups, etc.). Stickers were also available for each child at the end of each session.

Vocabulary

Sixty vocabulary items were selected from lists of frequently used words by young children (Beukelman & Mirenda, 1998). These vocabulary items included 30 concrete items (such as mommy and dog) and 30 abstract items (such as more or what). Concreteness of vocabulary was a variable of interest in the earlier research by Light et al., but not in the current study. Of the 60 vocabulary items, 30 (15 concrete and 15 abstract) were taught to the children during a series of four learning and testing sessions. The remaining 30 items were used to assess generalization. See Appendix A for the list of vocabulary items used for the learning and generalization sessions.

The Condensed Unity software on a Liberator™ [3] was used to present the vocabulary items. This software was used to encode words with sequences of two icons, which were organized on a fixed 128-location grid display on the Liberator™ using the standard Minspeak™ icons. To access the 60 vocabulary items, 49 of the icons were required; the remaining icons were removed from the display to reduce visual and cognitive demands on the children. The standard two-icon sequence codes from the Condensed Unity software were used, with three exceptions: neat (as in awesome), present, and not. A code was not available for neat; the code for awesome was used in its place. A code was also not available for present, which was coded by a clinician with experience with both Condensed Unity and young children. Lastly, the code recommended for not was composed of a single icon. To maintain consistency in requiring two selections for each vocabulary item this single icon was repeated (*KNOT + KNOT)*. The iconic encoding sequence for each item is presented in Appendix A.

Conditions

There were two conditions: without prediction and with prediction. Children in both groups used iconic encoding to retrieve vocabulary. In the without prediction condition, a red light was visible in the corner of each icon, and iconic prediction cues were not available. In the with prediction condition, iconic prediction was activated, and the red light was only visible in the corner of the icons that were available for selection. For example, initially the *BOY* icon would not be accompanied by a red light, since that icon did not begin an icon sequence for any of the vocabulary words used in this study. In both conditions, the children were required to select the correct two-icon sequence on the Liberator™ to retrieve the target vocabulary word.

Procedures

The procedures were the same as those described in Light et al. (2004). The children participated for a total of five sessions. Four sessions were learning and testing sessions where the children were asked to locate the 30 target vocabulary items. One session was a generalization session (with a group of 30 novel vocabulary items). Sessions took place in the children's daycare, in separate rooms whenever possible. Prior to each session, the instructor ensured that the child could see the display on the Liberator™ and could hear the speech output. At the beginning of the first session, the child was introduced to the teddy bear, "Bobby", and told that the bear was not able to speak, but rather used the computer to speak for him. The children were then asked to help Bobby say words using his computer during a pretend birthday party. The system was demonstrated for the child, using the target word blue. The instructions for the two conditions were identical, with the exception that for the children in the with prediction group, an additional instruction was added before demonstrating the first icon in the two-icon sequence for blue: "First we look at the pictures with a red light. We can only pick one that has a red light." Prior to choosing the second icon in the sequence for blue, the child was reminded: "Remember, we can only pick one that has a red light."

Learning and Testing Sessions. The first three sessions were scheduled at 2-4 day intervals and lasted 20-30 min. The fourth learning and testing session was approximately 2 weeks after the third learning and testing session, and was intended as a measure of maintenance of the vocabulary. The children were asked to locate all 30 target vocabulary items during these sessions, using one of five previously generated random orders. Each of the target vocabulary items was elicited within a context described for the children (e.g., "Bobby likes to play with his dog. Please show him how to say DOG.") Each target word was probed once. If the child made a correct response resulting in speech output that matched the target vocabulary, the instructor engaged the child in a short play activity using the props. If the child did not respond within 1 min or made an incorrect selection, feedback was provided. The feedback included a demonstration to the child where the appropriate vocabulary was located, along with a rationale for the location. An example of corrective feedback is, "We need to find DOG. We start with this picture [DOG] because a dog is a pet. We use this picture for things about pets. Next we push this picture [DOG] because it is a picture of a dog." The eliciting contexts and the feedback were identical for the two groups, except that at the beginning of the feedback for the children in the with prediction group were again reminded, "Remember you can only pick a picture that has a red light." See Light et al. for further examples of contexts and feedback provided. The children were also shown how to "clear" a selection if they made a mistake.

Generalization Session. There was one generalization session, scheduled 2-4 days after the third learning and testing session. This session had two parts: the first was to assess generalization of learning to novel vocabulary, the second was to assess generalization of use of the system during a free play context. The procedures for the first part of the generalization session were the same as for the learning and testing sessions, except that the children were only shown the location for incorrect items, they were not provided with the rationale for the icon sequence. The 30 generalization vocabulary items had been accessible throughout the study, but the children had not previously been asked to locate them. This part of the generalization session lasted approximately 15 min.

The second part of the generalization session was a 6 min free play activity. The child was told, "Now we can play at Bobby's birthday party. Remember to help Bobby talk by pushing the pictures on the computer." The free play was predominantly unstructured, using procedures recommended by Miller (1981) for eliciting spontaneous language samples. The instructor prompted the child to use the system at 1-min intervals (i.e., "What would Bobby say?"). Children's selections on the Liberator™ were coded as spontaneous, or following the verbal prompt.

Procedural Reliability

Instructors were trained on specific procedures prior to data collection until they achieved at least 90% accuracy. Each session was audiotaped. An independent judge reviewed the procedural sequence for five randomly selected vocabulary items. Using the formula (number of steps followed correctly / total number of steps) × 100, procedural reliability was 98% (range = 84–100%).

Dependent Measures and Data Analysis

The dependent measure was the accuracy of the children's selections in locating target vocabulary items. A response was coded as correct if the speech output of the Liberator™ matched the target vocabulary item. This would only occur if the child accurately selected both of the icons required to retrieve the target word, in the appropriate order. A response was coded as incorrect if the speech output did not match the target vocabulary item. Self-corrections were only coded as correct if the corrections occurred prior to the speech output. A response was coded as a "no response" if the child did not make selections resulting in speech output within 60 sec. Inter-rater reliability of the data was calculated for 17% of the vocabulary items in each session for each child, which were randomly selected. Using the formula (agreements / agreements + disagreements) × 100, the point-to-point reliability was 100%.

Frequencies of correct responses were calculated for each child for each of the learning and testing sessions and the generalization session. To assess the potential differences in the learning curves for the two groups, an analysis of variance (ANOVA) was conducted. A two factor mixed design was used, with a between-subjects factor of group (without prediction and with prediction) and a within-subjects factor of session (Session 1, Session 2, Session 3, and maintenance). In addition, two paired-samples t-tests were conducted comparing the children's accuracy of locating novel vocabulary during the first learning and testing session and the generalization session for each group.

Results

Learning Across Groups and Sessions

Figure 1 shows the learning curves for the children in each of the two groups. During the first session, the children in the without prediction group were able to locate a mean of 1.0 item out of 30 (3% accuracy; *SD* = 0.8). Children in the with prediction group were able to locate a mean of 2.3 items out of 30 (8% accuracy; *SD* = 1.9). The children in both groups made gradual increases in accuracy across the learning and testing sessions. By the fourth session (maintenance), the children in the without prediction condition were able to locate a mean of 8.1 items (27% accuracy; *SD* = 3.9), and the children in the with prediction group were able to locate a mean of 9.6 items (32% accuracy; *SD* = 4.0).

The main effect for group was not statistically significant. There was no difference in performance between the groups with and without prediction. The main effect for session was statistically significant, $F(3, 54) = 22.917$, $p < .0001$. The mean gain in vocabulary items from the first to the last session for the children in the without prediction condition was +7.1 items (*SD* = 3.9, range = +1 to +14). Similarly, the mean gain in vocabulary items from the first to the last session for the children in the with prediction condition was +7.3 items (*SD* = 3.9, range = +1 to +14). The children's accuracy did improve across learning and testing sessions. The session x group interaction was not statistically significant, suggesting that there were no differences between the children's performances with or without iconic prediction across the sessions.

Generalization

Figure 2 shows the performance of the children in each group for the first learning and testing session and the generalization session. For each of these sessions, the vocabulary items being probed were novel to the children. Two paired-samples *t*-tests were conducted to compare the children's performance on the first learning and testing session and the generalization session, one for each condition. The children in the without prediction group did not show any evidence of generalization of learning to novel vocabulary after three learning and testing sessions. The mean difference between the first session and the generalization session for the without prediction group was 0.2 items out of 30 (*SD* = 1.14; range = -1 to 3). There was not a statistically significant difference between the sessions. The children in the with prediction group, however, did appear to show some evidence of generalization. The mean difference between the first session and the generalization session for the with prediction group was 4.7 items out of 30 (*SD* = 2.21; range = 1 to 8). The paired-samples *t*-tests comparing accuracy for the first learning and testing session to the generalization session revealed a statistically significant difference for the with prediction group, $t(9) = -6.714$, $p < .0001$.

During the free play context, the children in the without prediction condition used the Liberator™ an average of 0.9 times spontaneously (range = 0-4) and 0.7 times when prompted (range = 0-4), during 6 min of play. Even with prompting, 6 children (60%) did not use the system at all during free play. In contrast, the children in the with prediction group used the Liberator™ an average of 2.0 times spontaneously (range = 0-5) and 3.7 times when prompted (range = 1-7). Every child in this with prediction group used the system during free play.

Discussion

Effect of Iconic Prediction During Learning

The presence of iconic prediction did not significantly affect the children's performance in locating icon sequences for words during learning. For iconic prediction to be effective, at least two conditions need to be in place. First, iconic prediction should offer an advantage by limiting the response set of the display. Second, the children need to be able to make use of the visual cues. Each of these conditions will be considered regarding the current study.

To offer an advantage, iconic prediction should limit the response set as much as possible compared to iconic encoding without prediction. The fewer the available response options, the greater the probability that the child will select the correct icon. When iconic prediction was turned on, the probability of correct responding by chance for the first icon selection increased only minimally: from 2% for the without prediction condition (with 49 icons available as response options) to 3% for the with prediction condition (with 30 icons lit up as response options of the 49 icons available). Once the children selected the initial icon, the field of potential choices for the second icon was substantially narrowed to 2.6 icons on average (range of 1 to 6). This increased the probability of correct responding by chance to a mean of 39% for the second icon selection during the icon prediction condition (a mean of 2.6 icons lit up as response options out of the 49 icons on the display) compared to 2% for the without prediction condition (with 49 icons available within the display). This advantage was *only* helpful, however, if the first icon selected was correct. In fact, in both groups, the children made selections in which neither icon was correct the majority of the time, suggesting that there was little opportunity for the children to benefit in this way from iconic prediction.

Even if iconic prediction limits the response set thereby increasing the probability of a correct response, these benefits will only be realized *if* the children are able to understand and make use of the visual cues provided in iconic prediction to reduce the set of available icons (in this case, the use of red lights to designate icons available for selection). In the current study, the children showed an increasing use of the lights available in the with prediction condition over the 4 learning and testing sessions. During the first learning and testing session, the children in the with prediction condition made selections from the lit icons 53% of the time. They gradually increased use of the lights throughout learning; at the final learning and testing session, they were selecting lit icons 88% of the time. Interestingly, only one child used the lit icons 100% of the time by the last learning and testing session.

In discussing potential errors for children using iconic encoding on a voice output communication aid (VOCA), Oxley and Norris (2000) suggest that errors may arise "because of problems with attention at the time of memorization, insufficient practice, lack of motivation, or lack of understanding of the memorization task" (p.82). Presumably, these sources of error would be potential ones for children in both groups. An additional source of error for the children in the with prediction group may perhaps be a lack of understanding of the process (the role of the prediction lights). The gradual increase in the use of lit icons demonstrated by the children may have shown an increasing awareness of the role of the lights. Errors may be further minimized if the children by both groups were able to make use of specific strategies to remember the codes. However, memory strategies such as rehearsal, elaboration, and categorization are unlikely to be used by preschool children (Henry & Norman, 1996; Schneider & Sodian, 1997). Further, it is not until the age of 10 or 11 that children begin to spontaneously use semantic category organization to facilitate memory (Schneider & Sodian, 1997). Younger children are more likely to use a simple strategy, such as visually inspecting items or trial-and-error (Henry & Norman, 1996). Iconic prediction appears to be most similar to these simple strategies, but did not significantly reduce the number of errors for this group of children.

Generalization

There is some evidence that the children in the with prediction group were better able to generalize the use of the system to novel vocabulary. By the generalization session, the children had received approximately an hour and a half of instruction and had been reminded up to 90 times to use the lights. The children in the with prediction group selected icons that were lit 83% of the time during the generalization session. Without prediction, there was no evidence that the children were able to generalize their learning to novel vocabulary. This suggests that the availability of iconic prediction may provide some assistance to children in locating novel vocabulary by limiting the response set, if the children have some prior knowledge of iconic prediction. However, the advantage of iconic prediction during generalization is modest as the children in the current study were only able to locate an average of 7.0 vocabulary items (23% accuracy) during the generalization session. The children would still need to use other strategies to fully utilize the system.

The use of prediction may also have influenced the children to use the system more in the free-play situation. All of the children in the with prediction group used the system during the 6 min free-play, compared to 40% of the children in the without prediction group. The cognitive demands may have been too great for most of the children to use the iconic encoding system during the free play task; however, the iconic prediction may have alleviated some of these demands, allowing for increased use of the system by the children (cf. Oxley & Norris, 2000). Or, perhaps knowing that selecting icons that were lit would result in a vocabulary word – *any* vocabulary word – facilitated the children's willingness to use the system.

Limitations and Future Research

There are several limitations to the present research. First, only typically developing children were involved as participants, allowing for an initial investigation of the developmental issues of iconic encoding and iconic prediction. The results cannot be fully generalized to children with disabilities, however. The children in the study were using the system to assist the teddy bear with communication, but did not require the use of the system themselves. This may have increased the complexity for the children, requiring them to take the perspective of another (the teddy bear). It is also possible that the task of true communication and interaction may be even more complex than the current task, requiring the coordination of many elements, including the partner, the context, and the environment. It is also unclear if iconic prediction would help to alleviate some of the demands of communication in this complex situation, or if it would further add to the working memory demands.

Future research should investigate the use of iconic prediction with children who might already be using iconic encoding. Potentially, a different strategy used to teach the iconic codes or the iconic prediction to children would yield different results. Instructional procedures that address the sources of error identified by Oxley and Norris (2000) may facilitate the use of iconic encoding. For example, ensuring adequate attention, practice, motivation, and understanding of the memorization task may decrease the potential for errors in selecting vocabulary. Further, identifying strategies that make iconic prediction more salient or understandable should be investigated in the future. Also, future research should explore whether limiting the response set to a small number (e.g., 3) would have more of an impact on accuracy than limiting the response set to a more modest set (e.g., 15)?

Another limitation is the use of only 30 target vocabulary items and four learning and testing sessions. It is possible that the children only required more models of the system and that the learning curves would change over time if given more learning opportunities. However, developing a system that is transparent to young children who require AAC would allow for maximal time to be spent on the development of language, literacy, socialization, and other skills.

It is also unclear if more or fewer vocabulary items would have affected the outcome. Additional vocabulary might cause greater difficulties in learning the iconic codes. Additionally, all 30 target items were introduced at the same time. The children may have performed differently if they had been introduced in smaller sets. Future research is required to investigate these variables.

Lastly, a different design of the prediction cues may have yielded different results. The Liberator™ has a static display. As such, even with iconic prediction all of the icons are visually present. Although icons that are not currently available for use are not lit, they are still visible. Newer systems make use of a dynamic display, which allows for changes in the presentation of the icons. A dynamic display system using an iconic encoding strategy may only present those icons that are available for initial selection; other icons would not even be presented. It is impossible to determine, from the current investigation, whether narrowing the field of choices has a direct influence on accuracy. It is, however, reasonable to expect that outcome, given the higher probability of choosing a correct item by chance, particularly if those are the only items available (i.e., if the children did not have to make use of the light cues). The choices would then change depending on the input to the system. Once a selection is made for the first icon, only those that are used in combination with that selection are available and shown. Dynamic display technology would also allow the representations themselves to change. For example, the current system requires the child to first choose *TRUCK* to designate vehicles, and then *FAMILY* to select car (because a family rides in a car). Alternatively, upon choosing *TRUCK*, the system may then present a variety of vehicles that may look more like their referent (car, pickup truck, school bus, taxi, etc.) as the selection set for the second icon. Changing screens and selection sets, however, may introduce other demands on the children, which may influence performance. For example, understanding that symbols are available that are not currently visible may be difficult for young children and beginning communicators (Drager, et al., 2003). There is also an increase in navigational demands with dynamic display systems. In the previous example, if the child chose *TRUCK*, saw the vehicles that were available, and then determined that *TRUCK* was selected in error, he or she would need to understand how to "clear" the initial selection to begin again. The navigational demands for iconic encoding systems on a dynamic display platform are clearly different from those that use a more traditional "paging" paradigm. Future research is needed to determine these demands and identify appropriate instructional techniques for children.

The use of iconic prediction may offer some advantages during the learning process, particularly for generalization to novel vocabulary items, however it does not facilitate learning to a functional level after approximately 1.5 hours of instruction. To reduce the learning demands of AAC systems that use iconic encoding, other strategies need to be introduced to children. These might involve paying particular attention to the representations used for the icons, as well as to the associations that children might have for those icons. Specific memory strategies may help to use iconic encoding, although these strategies may be difficult for children to learn to use. Alternatively, prediction may be redesigned to provide appropriate cues for young children. Future research is necessary to further investigate the effects of iconic prediction, and how to improve outcomes for young children who require AAC, to unlock their potential to communicate and to learn.

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Department of Education. Additional information on the AAC-RERC is available at http://www.aac-rerc.org/.

The results of this study have been previously reported as a footnote in Light et al., 2004, and one of the participant groups from that study was also used in the current study. Portions of this article are based in part on a presentation at the Ninth International Conference of the International Society for Augmentative and Alternative Communication, Washington, DC, August, 2000.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Appendix A

Vocabulary during Learning and Generalization Sessions, with Iconic Encoding Sequences

Learning Vocabulary Items	**Learning Iconic Encoding Sequences**	**Generalization Vocabulary Items**	**Generalization Iconic Encoding Sequences**
Baby	*PEOPLE + LOVE*	Candles	*HOUSE + THINK*
Ball	*OPEN + SPACE*	Chair	*HOUSE + CHAIR*
Balloon	*OPEN + SUN*	Daddy	*FAMILY + FAMILY*
Blocks	*OPEN + DICE*	Donkey	*ZEBRA + OPEN*
Book	*BOOK + NOUN*	Eat	*APPLE + VERB*
Boy	*PEOPLE + BOY*	Friend	*PEOPLE + PEOPLE*
Cake	*THUMBS UP + WANTED*	Girl	*PEOPLE + GIRL*
Car	*TRUCK + FAMILY*	Give	*FLOWERS + VERB*
Come	*DOG + VERB*	Go	*FROG + VERB*
Dog	*DOG + DOG*	Good	*THUMBS UP + ADJ*
Door	*YORK + FLOWERS*	Grandma	*FAMILY + THINK*
Game	*DICE + NOUN*	Hat	*PREP + EXIT*
Grandpa	*FAMILY + TIME*	Help	*MEDICAL + VERB*
In	*PREP + OPEN*	Hi	*INTERJ + PEOPLE*
Like	*SUN + VERB*	Home	*HOUSE + NOUN*
Mommy	*FAMILY + LOVE*	Ice Cream	*THUMBS UP + MOUNTAIN*
More	*MUSIC + ADJ*	Juice	*JUICE + JUICE*
My	*I + POSS*	Little	*DICE + ADJ*
Neat	*INTERJ + SPACE*	Look	*EYE + VERB*
Not	*KNOT + KNOT*	Me	*I + OBJ*
On	*PREP + CHAIR*	Music	*MUSIC + COMPUTER*
Open	*OPEN + THUMBS UP*	Out	*PREP + EXIT*
Please	*INTERJ + WANT*	Play	*DICE + VERB*
Present	*WANTED + OPEN*	Prize	*DICE + OPEN*
Truck	*TRUCK + TRUCK*	Stop	*STOP + VERB*
Want	*WANT + VERB*	Table	*BED + JUICE*
What?	*WORD + TV*	Thank you	*INTERJ + FLOWERS*
Why?	*WORD + THINK*	Uh oh	*INTERJ + WRONG*
Win	*DICE + THUMBS UP*	Where?	*WORD + ISLAND*
Yummy	*INTERJ + APPLE*	You	*YOU + YOU*

Notes

Note 1. The BUILLD curriculum guide was used solely as an inspiration for an appropriate context (birthday party). The procedures described in this curriculum to teach iconic encoding were not used.

Note 2. Unity software is a Minspeak™-based application, consisting of a set of colored icons. Condensed Unity is an adaptation of the Unity program that uses one- or two-icon sequences to retrieve vocabulary. Unity is a registered trademark of Semantic Compaction Company. For further information, contact Prentke Romich Company, 1022 Heyl Road, Wooster, OH 44691, USA; (800) 262-1984; (330) 263-4829 (fax); www.prentrom.com.

Note 3. The Liberator is a dedicated, voice-output communication aid that supports Minspeak™ -based application programs, including Unity. The Liberator is manufactured by the Prentke Romich Company. For further information, contact Prentke Romich Company, 1022 Heyl Road, Wooster, OH 44691, USA; (800) 262-1984; (330) 263-4829 (fax); www.prentrom.com.

Figure 1

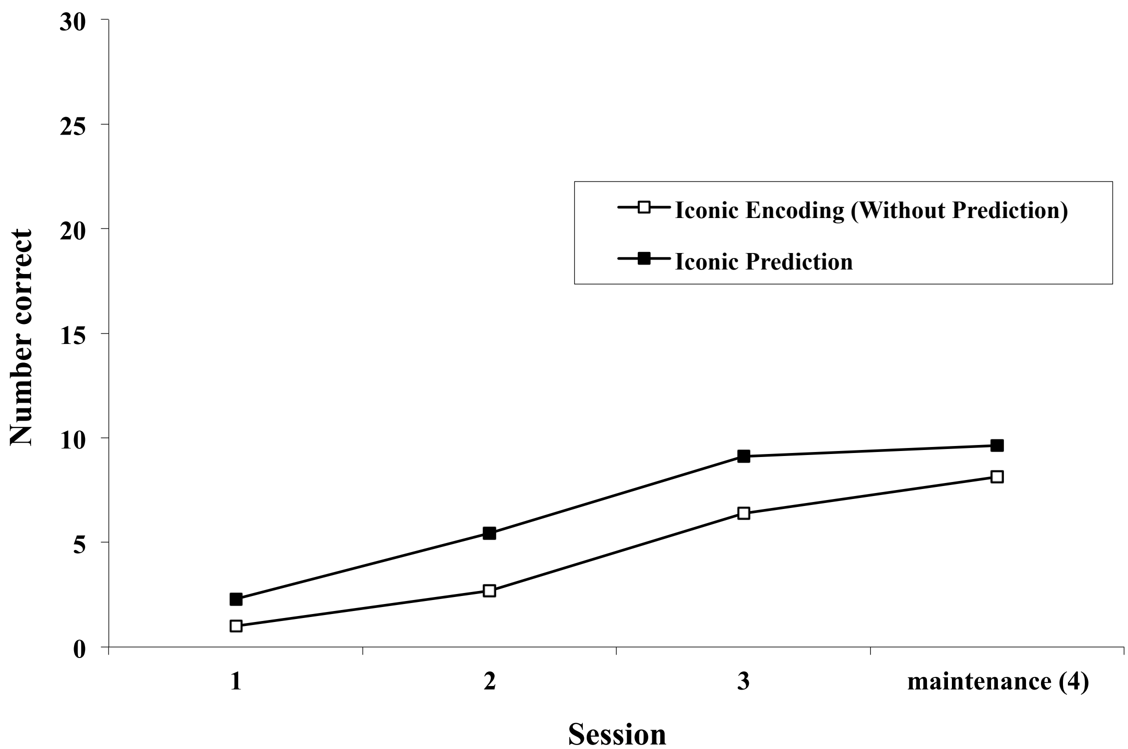

Figure 1. *Mean frequencies of correct responses (out of 30) across the four learning and testing sessions for the without prediction and the with prediction groups*

Figure 2

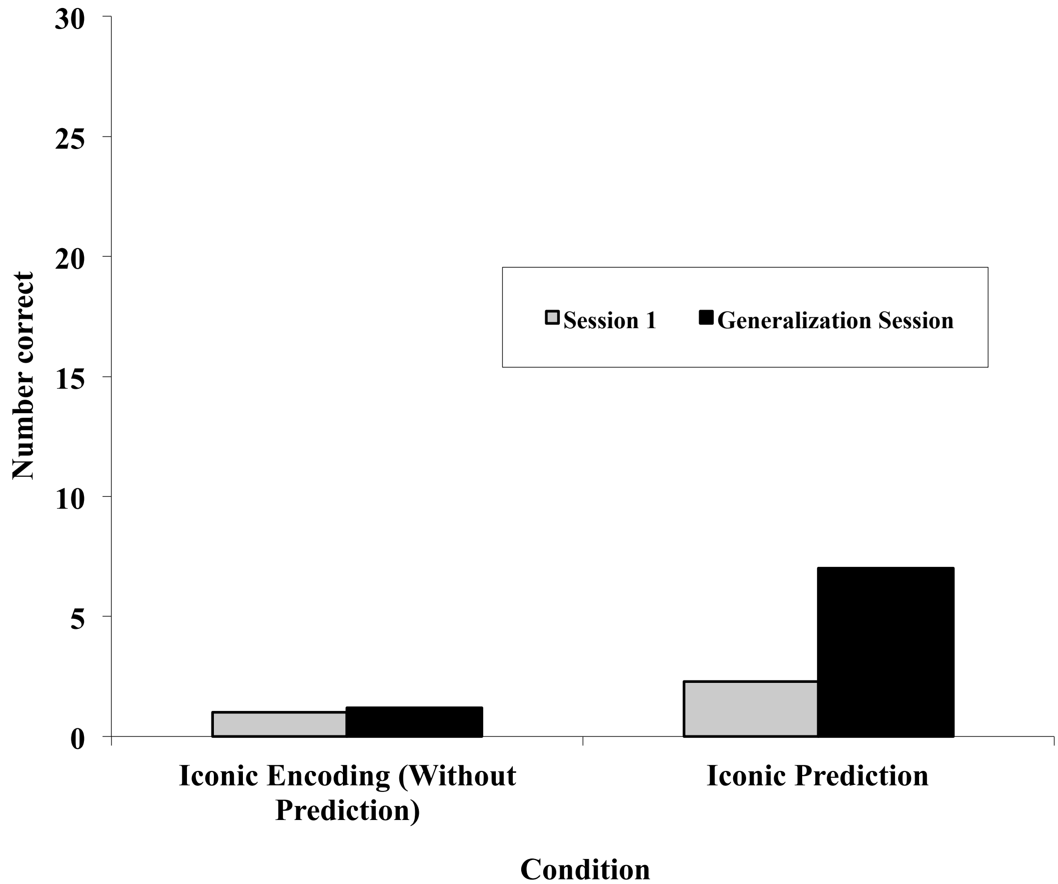

Figure 2. *Mean frequencies of correct responding (out of 30) for the first learning and testing session and the generalization session for the without prediction and with prediction groups*