Critical Review: Which is the best language organization strategy to promote effective and efficient communication and language learning in preschoolers who use augmentative and alternative communication (AAC) systems?

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This critical review examined the semantic knowledge and language organization patterns of young typically developing preschoolers in association with the learning demands of various system designs in dynamic display augmentative and alternative communication (AAC) technologies. Study designs reviewed included: mixed randomized block design (1) non-randomized between-groups design (2) and qualitative research studies (3). Overall, the studies demonstrated good validity and reliability. Evidence suggested that young typically developing preschoolers have a preference for schematic and context-based organization patterns over taxonomic organization patterns. Recommendations for future research and evidence-based practice are provided.

Introduction

For a child with severe speech and communication difficulties, Augmentative and Alternative Communication (AAC) systems can open the door to a whole new world of language, literacy, cognitive and social development. There are many factors that must be considered when designing AAC systems for children; one of these factors is deciding how vocabulary will be organized on the display to promote maximally effective and efficient communication and language learning (Beuklman & Mirenda 2005). Language organization strategies can be divided into two main categories: *grid displays* and *visual scene displays*.

In *grid display*, vocabulary items are usually individual symbols, text, or pictures that can be arranged in various ways, typically in rows and columns. In *semantic-syntactic grid displays*, items are organized according to parts of speech and their relationship within a syntactic framework. It is thought that arranging the symbols according to spoken usage facilitates language learning, although there has yet to be any empirical evidence supporting this idea. In *taxonomic grid displays*, items are organized according to super-ordinate categories (i.e., people, places, action words, things, feelings). A third type of grid display is the *activity grid* or *schematic grid display*, which organizes vocabulary according to event schemes and activities (i.e., birthday party, opening presents, playing games). In this type of grid display, vocabulary on one page is typically arranged into semantic categories (Beukleman & Mirenda 2005).
In contrast to grid displays, *visual scene displays* (also known as *integrated scene, contextual scene* or *schematic scene designs)* are a relatively new and thus far, a less popular means of organizing vocabulary in AAC systems. A visual scene display is a picture or virtual environment that shows and represents a place, situation or experience, and related elements are shown within the visual scene (i.e., people, places, actions, objects, etc.) Elements are depicted within a coherent, integrated visual image rather than a grid display that may include a selection of unrelated items. It has been suggested that visual scenes can support interactions for those who find traditional grid displays challenging (Beukelman & Mirenda 2005, Light & Drager, 2004).

Currently, AAC technologies often reflect the conceptual models and priorities of non-disabled adults, rather than of young children with complex communication needs. This often makes systems less appealing and more difficult for young children to learn to use, and leads to a high cost of learning as AAC instruction competes with other important opportunities for learning (Light & Drager, 2007). In terms of vocabulary selection and organization, it has been suggested that a developmental model based on the language abilities of typically developing children would provide a better framework for developing AAC systems for young children with complex communication needs (Bedrosian, 1997; Gerber & Kraat, 1992). It has also been suggested that such a framework could help in developing AAC systems that facilitate the natural transitions that occur in language development, by meeting the child at and guiding them through their "Zone of Proximal Development" as described in Vygotskian theory (Bedrosian, 1997; Paul, 1997, Fallon et al, 2003). Although it is questionable as to whether a developmental model is appropriate for the population of children who require AAC, it is generally understood that AAC systems must be designed specifically to meet and accommodate for the needs and skills of such children (Gerber and Kratt, 1992; Blackstone, Williams & Willkins, 2007 as cited in Light and Drager, 2007).

Objectives

The primary objective of this review is to critically evaluate the existing literature that examines the semantic organization patterns of preschoolers, and the associated learning demands of a variety of

dynamic display system layouts. A secondary objective of this paper is to propose future research considerations as well as evidence-based practice recommendations regarding improvements in AAC system designs to better reflect the learning capabilities of preschoolers using such systems.

Methods

Search Strategy: Computerized databases including Proquest, ScholarsPortal, and PubMed were searched using the following search strategy:

[(AAC) OR (alternative communication) OR (augmentative communication)] AND [(semantic organization) OR (language organization) OR (organization) OR (layout)] AND [(visual scene) OR (contextual scene) OR (visual)]

This search strategy only yielded a small number of articles. Therefore, additional relevant publications were found through a search of reference lists of articles identified through the database search.

Selection Criteria: To be included in this critical review paper, studies selected were required to have examined preferred semantic organization patterns of typically developing children including those exposed to alternative and augmentative technologies during the studies. No limits were set on the dates of articles, demographics of research participants, study designs, or outcome measures.

Data Collection: Literature search results found both qualitative and quantitative studies matching the previously mentioned selection criteria: mixed randomized block design (1) non-randomized between-groups design (2)
and qualitative research studies (3).

Results

<u>Mixed Randomized Block Design</u>

Drager, Light, Speltz, Fallon & Jeffries (2003) examined the learning demands of three different dynamic display system layout designs (taxonomic grid, schematic grid, integrated scene) for a group of 30 typically developing children between the ages of 2 years, 5 months and 2 years, 11 months (mean age =2 years, 8 months). Children were recruited from day-care centres, were primarily from middle class families, and 10-15% were from diverse ethnic and cultural backgrounds. Participants had no prior AAC experience and had no identified speech, language, cognitive or physical disabilities, and had parental consent to participate. Vision and auditory acuity were within normal limits. Auditory comprehension was informally screened through the child's ability to participate in the task. Ten children were randomly assigned to each of the three groups, with the constraints of five girls and five boys in each group and that the mean ages of each group were equal. The children were asked to locate 12 out of 61 available vocabulary items within a play context of a birthday party. The children participated in four individual learning and testing sessions and one individual generalization session. Results were analyzed using two separate analyses of variance (ANOVA) and independent t-tests for post hoc analyses. The first ANOVA used a three factor mixed design (system organization, session, vocabulary type) to examine the children's learning of vocabulary items. The second ANOVA used a two factor mixed design (system organization, session) to examine the children's ability to generalize their learning to novel vocabulary. The authors reported that, although children performed poorly in all three groups, there was statistically significant evidence that children were able to locate more vocabulary items in the integrated scene group than in either the taxonomic grid or schematic grid group. The authors also reported that children performed significantly better across sessions. Evidence failed to show generalization of vocabulary knowledge to facilitate learning of novel vocabulary items in all conditions.

Drager, Light, Carlson, D'Silva, Larsson, Pitkin & Stopper (2004) examined the learning demands of two different dynamic display system layout designs (schematic grid and contextual scene) for a group of 30 typically developing children between the ages of 3 years, 0 months and 3 years, 11 months (mean age= 3 years, 6 months). Inclusionary criteria and group assignment methods were maintained from the previously mentioned study. Procedure was also maintained, except that 36 out of 60 items were targeted. Results were analyzed using two separate analyses of variance (ANOVA) with independent samples t-test post hoc analyses. The first ANOVA used a two factor mixed design (system organization, session) to examine the children's learning of vocabulary items. The second ANOVA used a two factor mixed design (system organization, session) to examine the children's ability to generalize their learning to novel vocabulary. The authors found that the main effect for system organization was not statistically significant, but that there was a statistically significant Session x System interaction, in that after the initial learning session, the children in the contextual scene condition performed better than children in the schematic grid condition. There was no statistically significant difference in system organization during generalization.

Light, Drager, McCarthy, Mellott, Millar, Parrish, Parsons, Rhoads, Ward & Welliver (2004) examined the learning demands of four different dynamic display system layout designs (taxonomic grid, schematic grid, schematic scene, iconic encoding) for a group of 80 typically developing children; 40 children aged 4;0-4;11 and 40 children aged 5;0-5;11. (Ionic coding is a particular AAC strategy used on fixed displays, in which an individual activates

multiple symbols to specify a single target word or phrase.) Inclusionary criteria and group assignment methods were maintained from the previously mentioned study. Procedures were maintained, except that 48 out of 60 items were targeted for four-year olds, and 60 out of 60 items were targeted for five-year olds. Results were analyzed using separate ANOVAs with independent sample t-tests post hoc analysis. Each of the studies analyzed main effects and interaction effects for organization, session, and vocabulary type on the children's learning of target vocabulary. As well, separate ANOVAs were completed for both studies to test generalization according to organization and session. For study #1 (four-year olds) the authors reported a significant difference in organization technique, in that children performed better in taxonomic grid, schematic grid, and schematic scene conditions than in the ionic encoding condition. There were no significant differences found between the first three conditions. Although children performed better during the generalization session for all conditions, they performed significantly better in the first three conditions. Very similar and significant results were found for the five year old children in study #2. The researchers discussed their surprise in finding no significant differences between the three dynamic display systems, as previous research suggested an advantage for schematic organizations. They suggested that four- and five-year olds may be able to learn either organization with instruction, though they may tend to organize schematically on their own.

A mixed randomized block design (Evidence level 2b) was appropriate for the previously mentioned studies, as it allowed for randomization of participants into groups, while controlling for the possible language profile differences between girls and boys. The goals of these studies were clearly outlined and relevant to the field of study. Although participant selection was explained, the sample sizes were relatively small, and included typically developing children, who may not best represent the population of AAC users whose language development profiles may differ from those of typically developing children. Also to mention is the possible differences in motivation for a child requiring the system for his own communication, versus a child who was required to use the system for the particular study at hand. The number of sessions over which data was collected was also relatively small. A more in-depth and reliable analysis may have been possible if data had been collected over longer periods of time, particularly due to the nature of learning to use the AAC system. Statistical analyses were appropriate and in general, the studies were well-designed.

Non-randomized between-groups design

Lucariello, Kyratzis & Nelson (1992) examined taxonomic and schematic knowledge in a group of four and seven-year old children, and adults during three tasks (category production, word association, forced-picture choice). A total of 20 new participants of each age group participated in each of the three tasks, with equal numbers of males and females at all ages. The participants were native English speakers. Children were from public and private schools in a mixed socioeconomic population, and adults were introductory psychology students. Results were analyzed using t-tests to make comparisons between the groups on each of the three tasks. Throughout these tasks, the authors found that the four-year old children tended to rely primarily on schematic knowledge, but that they showed some understanding of horizontal-taxonomic categories in terms of slot-filler of 'event-related' categories. The seven-year olds demonstrated development of more conventional category use, which was evident in the adult group, indicating a developmental shift from schematic to taxonomic organization patterns.

A t-test comparison between groups (Evidence Level 2) was appropriate for the research questions posed as it allowed the researches to evaluate and describe differences between each of the groups. As in the previous study, a small sample size of typically developing children may not best represent the semantic knowledge of children with complex communication needs. However, the information from this study is suggestive as a framework for future research.

Qualitative Research: Retrospective Descriptive

Fallon, Light, & Achenbach (2003) examined the semantic organization patterns of a group of 20 typically developing children aged 4;0 to 5;11. Children were recruited through phone contact and direct mailings to teachers at two preschools, were English speakers from working class communities, and had no known cognitive, language or physical disabilities. Visual and hearing were within normal limits. The children were asked to organize 42 pictures depicting various familiar vocabulary items, and talk about their rationales for their arrangements. Two individual sessions were conducted, with two weeks in between. Results were analyzed with descriptive statistics and reported numbers and percentages only. The authors reported that 90% of the children made use of purposeful organizations, with 40% of the vocabulary. Of this vocabulary, 65% consisted of concrete vocabulary. Further, 68% were arranged in pairs rather than in larger groups. Of importance is to note that 93% of the items were organized according to a schematic organization system versus taxonomic, and 92% of rationales included descriptions of event scripts or scenes. It is also noteworthy that with the grid provided for vocabulary placement, seven out of 20 participants

used the grid page as an event setting or to create a story.

Although qualitative research (Evidence Level 3) may be considered a lower level of evidence, this type of approach was appropriate for the question at hand, as the researchers were interested in describing the semantic patterns of the group of children, rather than manipulating any variables. The high percentages described also help to strengthen the credibility of the evidence reported. This study had clear research aims that are important and relevant to exploring semantic knowledge of preschoolers and providing a framework for the development of AAC systems. The study had a high rate of reliability in both procedures and coding, and the researchers were unbiased in their question. One of the limitations of this study was that vocabulary was presented, but not specifically taught. It is therefore possible that the children may have been categorizing the vocabulary based on the picture more so than the concept, depending on their understanding of the graphic representation. Further, the sample size was very small (two preschools) and it is possible that the semantic knowledge could depend on the type of instruction that occurs at various schools. Finally, the patterns of typically developing participants may not best reflect the semantic organization patterns of children with complex communication needs. Therefore, although the findings of this study may be limited in generalization, it does provide a framework for understanding the semantic organization patterns of preschoolers, to guide future research in this area.

Conclusions

Currently, research and evidence is limited in terms of understanding which language organization strategies may lower learning demands and lead to more efficient and effective communication and language learning for preschoolers using AAC devices. Current evidence is limited to a small body of research that includes mixed randomized block designs, non-randomized between group designs, and qualitative research by a small group of researchers. The studies reviewed used designs that provided evidence of moderate strength; however the reliability of the evidence at hand is increased when different studies find similar results.

Although the research is limited, currently there is suggestive evidence indicating that preschoolers, particularly those under age four, tend to rely on schematic and context-based language organization patterns rather than taxonomic grid organization patterns. It has been suggested that typically developing children aged four and five may be able to learn either organization pattern through instruction, but tend to rely on schematic organization themselves (Light et al, 2004). Alternately, it has been suggested that a transition in categorical organization, from more schematic-based to more taxonomic-based typically occurs as children begin formal instruction in school, and that event schemas may in fact aid in the semantic development of preschoolers (Lucariello, Kyratzis & Nelson, 1992; Fallon et al, 2003).

Recommendations

Given the limitations of the current research available, it is recommended that clinicians remain cautious when implementing the results of these studies into clinical practice. However, given the relative strength of the few qualitative and quantitative research studies discussed, and the suggestive evidence provided, it is recommended that clinicians take these findings into consideration when developing AAC systems for preschoolers. In particular, it is important that clinicians consider the possibilities of using more schematic and contextual-based designs for younger children (ie., under the age of 4) or for those who experience difficulty using traditional grid displays.

It is noteworthy to mention that further research on AAC language organization designs for preschoolers requiring AAC systems, is currently underway by Janice Light and colleagues at Penn State University. This set of longitudinal, case study research will provide further evidence and implications for improving the designs of AAC systems for preschoolers with complex communication needs. Overall, as in any language therapy, it is important that clinicians consider the child's current language and communication skills, to set appropriate therapy goals and provide intervention that promotes continuing development of these skills.

Currently, the field of AAC does not include formal processes for making clinical decisions that reflect best practice. Future research would help promote the use of research-based practices to improve outcomes. As the field of AAC requires a strong and integrated multidisciplinary approach, it is suggested that future research on AAC system design take into consideration related fields. For example, Wilkinson and Jagaroo (2004) have proposed implications of visual cognitive science for AAC system display design, by discussing the differences in how a child may process grid versus visual scene displays. Through more in-depth and rigorous research, clinicians may gain further evidence for developing a more systematic and evidence-based method of making clinical decisions in the field of AAC. This would in turn allow AAC systems to be designed barrier-free, allow for transitions during language learning, and promote maximally efficient and effective communication.

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