AAC Intervention and Early Conceptual and Lexical Development

L'intervention en matière de CS et le développement conceptuel et lexical

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Abstract

This paper will illustrate how research on the typical course of early conceptual and lexical development can be relevent in planning AAC interventions. Four clinical challenges facing the clinician who is introducing a child to an AAC system using graphic symbols will be discussed: selecting a symbol system, selecting an initial vocabulary, organizing vocabulary displays, and using vocabulary encoding strategies. The clinical challenge will be described, selected literature from developmental psychology and psycholinguistics will be reviewed and possible clinical implications related to the clinical challenge will be discussed.

Abrégé

Cet article illustrera comment la recherche sur le déroulement caractéristique du début du développement conceptuel et lexical peut être pertinente à la planification des interventions en matière de CS. Une discussion portera sur les quatre défis à relever par le clinicien qui initie un enfant à un système de CS faisant appel à des symboles graphiques : choix d'un système de symboles, choix d'un vocabulaire initial, organisation de la représentation du vocabulaire et utilisation de stratégies de codage du vocabulaire. La description du défi clinique sera suivie d'un examen de la documentation sommaire en psychologie et en psycholinguistique du développement et d'une discussion sur les répercussions éventuellement liées au défi clinique.

Within the first 18 months of life, children acquire a staggering amount of knowledge in a very short time. Two of the many impressive feats of this period are the development of concepts and the beginning of the acquisition of a lexicon to describe and communicate these concepts to others. The past twenty years has seen an exciting growth in our understanding of normal conceptual and lexical development in this period. Much of the information generated in research has potential relevance to the field of augmentative and alternative communication (AAC), particularly around the introduction of AAC systems to individuals who are just learning to decode language and use symbols communicatively.

This paper will relate literature on typical conceptual and lexical development to four clinical challenges faced when introducing an aided AAC system to such an individual. The research discussed here describes typical development in these areas up to the age of 18 months. This developmental period was selected for two reasons. Firstly, because communication (and specifically language) is such a powerful cognitive and social tool there is a great press to provide the child who is unable to speak with access to this tool as early as possible, ideally within the same frame that an able-bodied child develops language. Secondly, this period in typical development is most similar (although not identical) to the cognitive and linguistic status of individuals with severe or profound mental retardation. These individuals comprise a large segment of the nonspeaking population and therefore may be considered for the introduction of aided AAC systems.

Before proceeding further however, the basic question of whether it is appropriate to examine normal development for guidelines on AAC intervention must be addressed. This approach has been somewhat contentious within the field of AAC, and therefore requires some discussion and defense.

Learning to use an AAC system and learning to speak - recognizing differences

Since Kraat's influential review of information on the communication interaction between aided and natural speakers (1985), there has been an emphasis in the AAC literature on the differences between communicating via an AAC system and communicating via spoken language. Significant differences have been identified which are introduced by characteristics of the AAC user, their partners in the interactive exchange, and the communication mode(s) employed. Kraat's conclusions, questioning of the use of a "normal conversational model" as the basis of viewing communication through an augmentative communication system, also reminded us to critically evaluate the appropriateness of using normal language development as a model for guiding the clinical introduction of augmentative communication (Gerber & Kraat, 1992).

Many authors (e.g., Light et al., 1988; Nelson, 1993) have also noted important differences in the situation facing the child learning to communicate via AAC, and the child learning to communicate via spoken language. The AAC learner is exposed to different and often more limited opportunities to acquire world knowledge. Proportionately more effort is required in the motor act of communication via an AAC system, and subsequently less attentional and cognitive resources are available for other activities such as monitoring the physical and social environment, planning the propositional content of communication, or processing linguistic input. There is a paucity of communication models via AAC in the natural environment. Preliterate AAC users have little control over the selection of potential productive vocabulary. A slower potential rate of communication leads to limited opportunities to initiate or lead communicative interactions. This list of differences is by no means exhaustive. It is clear that learning to communicate via an AAC system is not just like learning to speak.

Learning to use an AAC system and learning to speak: Recognizing similarities

Given the differences discussed above, what can we expect normal development to tell us about the process of learning to communicate via an AAC system? Insofar as human cognitive, social, and physiological architecture determines the array of possible instantiations or developmental outcomes, we would expect to see the influence of these factors in both the normal developmental case and in the situation where development is proceeding but with some atypical child-internal and external circumstances. Although it is certainly not the normal developmental case that a child should be faced with the necessity to learn to communicate via an AAC system, we can use what we know about predictors and influences on normal development in related areas to consider how learning might unfold in this situation. For example, if children below nine months have difficulty with tasks that require them to look in one direction while reaching in another direction (Millar & Schaffer, 1972), which affects their ability to solve standard Piagetian tasks of object permanence (Diamond, 1991), we might expect to see the same sort of difficulty when a very young child is expected to hit a switch while looking at an array on an augmentative communication device.

Furthermore, where there are differences of a given child-internal or external factor, our prediction of the impact of the difference will depend on the role that we suspect this factor to play given evidence from the normal developmental course. For example, if we propose that actual physical manipulation of objects is necessary (rather than facilitative) to the development of certain concepts, then we may expect to find that children who are not able to physically manipulate objects would have difficulty in acquiring these concepts.

Finally, there is much to be learned because of the functional similarity between the tasks. Communication via spoken language and communication via an AAC system share the same functional determination of success. The AAC user exists in and interacts with a speaking world, and many of the factors determining the functional success of a communication attempt by a speaking child will also operate when communication is attempted via an alternate means. For all of these reasons, and despite the differences, a thoughtful look at normal development can be useful, provided we are mindful of the complexity and multi-determinational nature of human development.

In this paper, four clinical challenges that must be addressed when first introducing an aided AAC system to a child will be presented. Each challenge will first be described, followed by a review of literature on related aspects of typical conceptual and/or lexical development in the first eighteen months of life. Then possible clinical implications will be derived by applying information from typical development to the clinical challenge under discussion. These implications may not apply to children who have more developed language and conceptual systems at the point when the AAC system is introduced (e.g., those children with age appropriate language skills but limited intelligibility who function adequately in conversations with family, but require an AAC system when they enter school).

Clinical challenge #1: What sort of graphic symbols should be used?

When the decision has been made to introduce an aided AAC system to a child, one of the first decision points in designing that system concerns the type of symbol that will be used to represent vocabulary. Research has suggested that, as a general rule, colour photographs are easier to learn than black and white photos, photos are easier than coloured pictures, and pictures are easier than line drawings (e.g., Mirenda & Locke, 1989). Objects have been suggested for use as "tangible symbols" with children with severe cognitive or visual impairments (Rowland & Schwiegert, 1989). Miniature objects have also been used, although caution is recommended because miniature objects have been shown to be more difficult for some individuals with cognitive impairments to recognize than pictures (Beukelman & Mirenda, 1992).

Various assessment probes including object-symbol matching and sorting paradigms have been suggested to assist the clinician in selecting symbols which the AAC user will find to be recognizable or easily learnable (Beukelman & Mirenda, 1992). To succeed at these types of symbol assessment tasks the child must have formed some sort of object or event category (e.g., "drinks" or "music"), and made a connection between items or events within that category and a graphic symbol (photo, picture, line drawing, blissymbol, etc.). Ideally, the child should recognize that the graphic symbol stands in a representational relationship to a concept, although this knowledge is not necessary in order to succeed at these assessment tasks.

Relevant developmental research

There are several lines of research on typical cognitive development which provide information pertinent to the clinical challenge of selecting the appropriate type of symbol for an AAC system. These include the typical development of perceptually and conceptually based categories, the development of picture recognition, and the development of the ability to use pictures as a symbolic representation.

Categorization can be perceptual or conceptual, and very early categorization is probably the former (Mandler, 1988, 1992, 1993). There is not general agreement on when infants can be said to show clear evidence of having acquired an actual concept, as opposed to a percept formed solely on the basis of sensory stimuli. The consensus view in the literature is that percepts are distinguished from concepts by the fact that the latter has theoretical (as opposed to strictly perceptual) content (e.g., Gelman & Markman, 1986; Medin & Wattenmaker, 1987; Piaget & Inhelder, 1969; Wellman & Gelman, 1988). The ability to form perceptual categories develops very early on. Infants as young as three and four months have been shown via habituation/dishabituation paradigms to form categorical representations for perceptually complex exemplars of natural kinds (e.g., cats) that exclude members of the other closely related, and perceptually similar category (e.g., dogs), (Quinn, Eimas, & Rosenkrantz, 1993). Infants reacted to outliers from a category with less perceptual variability (cats) at a younger age than they reacted to outliers from a category with more variability (dogs). But although they can perceptually categorize these animals, they probably do not recognize these categories as conceptually different (Mandler & McDonough, 1993).

How do young infants form these early categories? Younger and Gotlieb (1988) looked at infants' reactions to various patterns of dots, and found evidence that 3 month old infants form categories by computing summary prototypical representations from sets of exemplars. Although evidence of prototypical representation was present at 3 months, there were developmental changes between 3 and 7 months in the kinds of regularities that the infants detected. Whereas the three-month old infants' ability to form a prototypical representation was impaired if the patterns were made more visually complex, the seven-month old infants were able to abstract regularities from more complex and varied patterns.

In a study where the exemplars closely approximated the sort of natural kind distinctions made in the real world, Younger and Cohen (1986) also showed a developmental change from 4 to 10 months on what infants processed, as reflected in habituation-dishabituation patterns. The four-month old infants appeared to be attending only to independent features, dishabituating when a novel feature was introduced but failing to dishabituate when a previously established correlational relationship between familiar features was violated. The 10-month-olds did appear to be sensitive to correlational relationships within a category, dishabituating when presented with an exemplar where a familiar correlation between two features was violated by substitution of a different set of familiar features (i.e., in all previous pictures long-tailed animals had pointed ears and short-tailed animals had floppy ears, then a picture of a long-tailed animal with floppy ears is introduced). Thus, there is evidence from the "typical" child development literature that the very young infants compute perceptually based categories, and that there is a developmental course in terms of an infant's ability to compute categories from increasingly more perceptually complex exemplars, and categories based on correlational relationships between features as well as just the features themselves.

Conceptualizing involves going beyond recognition of an exemplar as a member of a category, to inferring that certain properties adhere to the exemplar based on its category membership (i.e., the child recognizes something as belonging to the category "cat", and infers that it drinks milk, since this is a characteristic of things in this category). Baldwin, Markman, and Melartin (1993) looked at this ability in infants by examining their exploratory play patterns with novel toys that had interesting but nonobvious properties. They found that infants in the 9 - 16 months age range showed evidence of making inferences about an underlying nonobvious property of a toy, based on its perceptual similarity to another previously introduced and briefly experienced toy. Thus by nine months of age, typically developing infants form concepts as well as percepts, giving clear indications of a rapid and versatile reasoning capability which allows them to quickly make inductive inferences about the properties of objects.

There is also a body of literature specifically about the development of the ability to associate objects to pictures. Bornstein (1984) calls the ability to see the relationship between objects and their identical pictures an example of referent equivalence categorization. As one would expect, the ability to form a single perceptual category which includes both objects and pictures develops very early in infancy. Babies as young as five-months old who have been habituated to a live face continue to show habituation to a photograph of that same face, but not to a photograph of an unfamiliar face (Dirks & Gibson, 1977). Similarly, five- to six-month old infants, habituated to 3-dimensional geometric shapes also showed habituation to two-dimensional colour and black and white representations of the shapes (Rose, 1977). At this same age, infants do respond differently to objects than to pictures. They are more likely to reach toward an object than a picture (Bower, 1972; DiFranco, Muir, & Dodwell, 1978), and when presented with both an object and a picture of the object will spend more time looking at the real object (DeLoache, Strauss, & Maynard, 1979). However, these differences in behaviour do not necessarily mean that the infants hold the picture in a representational relationship to the object. They could merely indicate that the three-dimensional cues provided by the object make it a more interesting candidate for visual and/or motor exploration than the two-dimensional picture. Early categorization of objects with pictures is likely to be perceptually based, with infants processing a picture as a two-dimensional object which shares enough salient perceptual features with the three-dimensional object to be included in the same category.

There is very limited information about the development of the recognition that a picture is a two-dimensional representation of an object (i.e., that the picture stands for something other than itself. There is some evidence, from studies of children's ability to use pictures for clues as to an object's location, that this "representational insight" may not occur until as late as age 24 to 30 months (DeLoache & Marzolf, 1992). It is interesting that this is also the age where nondisabled children are typically able to complete standard graphic symbol assessment protocols which require matching objects to pictures (P. Mirenda, personal communication, December 27, 1992).

DeLoache and Marzolf summarize research exploring the development of other aspects of symbol competence, including the development of an appreciation of "dual representation" - the ability to think of a single entity both as an object itself and as a representation of something else. In their research they have found that 2.5-year-olds are capable of responding to an entity such as a scale model or a picture either concretely, as an object itself, or abstractly, as a representation of something else. However, it is very difficult for them to do both at once. The ability to achieve dual representation develops for pictures before it develops for scale models, and DeLoache and Marzolf posit that the fact that scale models are also complex and highly salient objects makes it more difficult for the child to treat them as symbols.

Clinical implications

The literature on the development of categorization reminds us that success on assessment protocols such as an object-picture matching task or on a picture-picture matching task could be accomplished by perceptual categorization. Children could match object to symbol strictly on the basis of perceptual similarity, without having an adult-like concept of the object in question and/or without holding the graphic symbol to be a representation of that object. In this situation, error analysis may provide cues as to the underlying basis for the child's behaviour. To use an example drawn from personal clinical experience, a child who was matching objects to pictures based on perceptual similarity alone successfully matched several object-picture pairs, but made a consistent error of matching a blue hat with a coloured drawing of a boat on the water, rather than with a picture of a different sort of hat. Subsequent probes revealed that he was making this match on the basis of the perceptual cues of colour (the blue of the water) and a wavy line (the water in the "boat" picture, and the wavy outline of the top of the hat). This child did not recognize pictures as representations of objects; he treated pictures as two-dimensional objects and responded to their perceptual similarities to other two- and three-dimensional objects.

Perceptual categorization skills can certainly be exploited for simple AAC systems which provide individuals with opportunities to learn the power of intentional communication. In this instance, the knowledge that the individual is using perceptual categorization as a basis for analysis of graphic symbols can help the clinician predict, understand, and control errors in graphic symbol use. One would predict, for example, that such a child might be able to select a picture of a glass of juice when shown a glass of juice, on the basis of the perceptual similarities, but may be unable to "generalize" this response when shown a juice box. Given that conceptual categorization is logically required for more sophisticated cognitive and communicative functioning, intervention designed to give this individual opportunities to discover and explore nonobvious properties which unite perceptually dissimilar objects may be in order.

An individual may show evidence of conceptualizing but still be unable to grasp a representational relationship between a symbol and its referent. For example, a child may be able to match a picture of a glass of juice with a juice box, but still not understand that the picture is intended to represent the concept of juice. The literature on the development of the ability to use pictures symbolically reveals that this is neither as easy or straightforward as we might assume. In fact, a typical child has probably been talking for a year before developing this ability, and it may not be realistic for us to assume that the child with severe speech impairment will be able to use graphic symbols symbolically and communicatively at the same developmental stage that a typical child begins to speak. When children are able to point to graphic symbols on request but do not spontaneously use that symbol communicatively, this can be for many reasons. One reason may be that the child may not have grasped the symbol's referential function.

Work on the development of the ability to use scale models which suggests that children find these more difficult to interpret symbolically than pictures has clear clinical implications. If, as suggested by DeLoache and Marzolf, this is because children have difficulty with dual representation (considering an object as an object *and* as a symbol), it would explain why in the clinical literature miniature objects have been found to be more difficult than pictures. This also suggests caution in the use of tangible symbols with children with severe cognitive impairments, unless there is a severe visual impairment which precludes the use of graphic symbols. The concrete saliency of the tangible symbol may in fact make it more difficult for the child to appreciate that it is a symbol, standing in a representational relationship to some object, concept, or event.

Clinical Challenge #2: What vocabulary should be included in the child's first AAC system?

Having decided to introduce an aided AAC system to a child, another question which must be immediately faced concerns the selection of vocabulary to be displayed on that system. Current approaches to vocabulary selection focus quite appropriately on the functionality of the vocabulary in the child's communication environments. While functionality is indisputably a very important factor, a consideration of typical vocabulary development is also appropriate, particularly at the earliest stages of language development (Gerber & Kraat, 1992). Therefore it is of interest to know what sorts of words are in children's first lexicons, and fortunately, this is a topic about which there is a fair bit known.

Relevant developmental research

There is a predominance of nouns or object names in children's early vocabularies, although just how much of a preponderance depends on what you count; whether you include proper names, for example, (Nelson, Hampson, & Shaw, 1993). Nevertheless, the noun category (in syntactically based classification schemes) or object label category (in semantically based classification schemes) is almost always the largest category in studies which classify and describe early word types. Several proposals have been advanced as to why children learn so many nouns. These include proposals which implicate characteristics of language input (Goldfield, 1993), the perceptual saliency of objects (Nelson & Lucariello, 1985), conceptual density of object concepts (Gentner, 1978), and a variety of word-learning constraints which appear to support the acquisition of object names (Markman, 1992).

Several researchers (Bloom, 1993; Bloom, Tinker, & Margalis, 1994; Nelson, Hampson, & Shaw, 1993) claim that the preponderance of nouns in the early lexicon has been exaggerated. They point out that non-object words referencing locations, actions and events make up a significant proportion of early words. For example, words such as *allgone*, *up*, *no*, *uh-oh*, and *more* do not make reference to specific objects and are common in the vocabularies of children in the earliest stage of language development. These words, which refer to dynamic states rather than to entities, have been termed relational words (Lahey & Bloom, 1977; McCune-Nicolich, 1981).

As indicated by the work of Baldwin et al. (discussed above) and others, by the time infants begin to speak they are clearly capable of forming the conceptual structures associated with object names. The situation is more complicated for the conceptual information encoded by relational terms. McCune-Nicolich (1981) suggests that which specific nouns are seen in a child's productive vocabulary will depend largely on which objects are present in the environment. Relational words, on the other hand, not only capture information pertinent to many environments, but are also associated with more abstract concepts, not all of which may be mastered by the end of the first year. Therefore the timing of the emergence of relational words may be less directly predicted by environmental factors and more directly tied to changes in the child's cognitive organization. In other words, whether or not a child says "cat" will be related to the prevalence of cats in the environment, whereas whether or not a child says "more" will be tied to the child being able to conceptualize and recognize recurrence.

This suggestion is supported by Gopnik and Meltzoff (1986a), who provide information on the emergence of two types of relational words: words which encode disappearance (such as "gone"), and words which encode success or failure (such as "there" and "oh-oh"), between 13 and 19 months. Emergence of the former was associated with being able to solve a complex object-permanence task involving visual displacements, and success/failure words emerged at about the same time as the ability to solve a complex means-end task. These types of words were present in early lexicons, but not used to express relational meanings until around 18 months. Their emergence seemed to be associated with the attainment of specific cognitive abilities.

Although children's first lexicons do vary, there is a degree of commonality, particularly when children from the same culture communicate in the same sorts of situations. Bloom, Tinker and Margulis (1994) looked at the expressive lexicons of 14 children taken from language samples gathered in same play situation during the period from first words to the vocabulary spurt. These children used 316 different words, excluding person names. Of these, 47 words were said by seven or more of the children. There is even more commonality if one considers the semantic categories rather than the exact words used. Gopnik and Meltzoff (1986b) devised a classification scheme based on common early semantic categories such as recurrence, disappearance, and success. Using these categories they were able to classify 89% of the early words seen in a longitudinal sample of 12 children up to age 24 months. They noted that relational words in particular tended to occur in their language samples several times and over several months, whereas names were often recorded only once.

Clinical implications

If objects do hold some sort of perceptual and conceptual prominence which leads to a bias to learn object names, then perhaps the very first graphic symbols introduced should be representations of object labels in order to exploit this bias and maximize success. In fact, the first graphic symbols introduced often do represent objects, because these graphic symbols are typically highly iconic, and iconic symbols are known to be easier to learn.

However, object labels are not the only types of words represented in the very early vocabularies of speaking children, and they are also not the only types of words needed by AAC users. Composite data on the first 50-word lexicons of normally developing children may provide useful guidelines for the selection of a more diverse initial vocabulary for the AAC systems of young children, after an initial small set of graphic symbols for objects have been introduced. Composite lists of vocabulary frequently used by adults are routinely incorporated into the memories of AAC systems with lexical prediction, used by individuals who have the necessary literacy skills. Composite lists of preschoolers' output have also been compiled to assist in the selection of vocabulary on AAC systems for preschoolers (Fried-Oken & More, 1992). This same sort of tactic could be extended down to obtain a composite source list to be used for ideas during vocabulary selection for the AAC systems of even younger children in the earliest stages of language acquisition. As with the preschoolers, there will be some variability in terms of which specific words are used by different children, but the work of Bloom et al. cited above suggests that this variability may be much less pronounced than with the older children.

Alternatively, one could construct composite lists which organize data in terms of semantic categories, and use these to suggest vocabulary items to be included in AAC systems. Relational words would appear to be especially good candidates for inclusion on such a list for children whose cognitive development is similar to that of a 12- to 18-month old. Names or object labels are important to include of course, but the selection of appropriate names and object labels will be more dependent on methods such as environmental inventory or parent report. This would be particularly true for individuals who are chronologically much older than this cognitive-developmental level. The small manipulable objects in the life of a cognitively impaired adolescent will likely not be bibs, teddy bears, and bottles; rather they will be deodorant, baseball cards, and milk shakes.

Clinical Challenge #3: How to organize vocabulary on displays:

Once the size of the vocabulary has surpassed a handful of items, the challenge of how to organize multiple vocabulary displays often arises, especially if one elects not to use a vocabulary encoding scheme (see clinical challenge #4). Vocabulary must be organized and displayed on the pages in a communication book, overlays for a voice output communication aid, or screens in a portable computer, and various organizational strategies have been used. Individual pages or levels may be organized around variations of a Fitzgerald key, with symbols arrayed from left to right in columns or sections of people, actions, descriptors, objects, locations, time indicators (McDonald & Schultz, 1973). Pages can also be organized by superordinate category (e.g., all symbols for foods grouped on one page or in one area of a page as suggested by Mirenda and Schuler, 1986), topic specific displays (all symbols likely to be needed to talk about food grouped together) situation specific displays (all symbols likely to be needed during lunchtime grouped together as suggested by Goossens' and Crain, 1986), or some combination of these strategies can be used. One frequently recommended approach is to have a more permanent or central display of vocabulary which is useful in many situations, and to combine that with a changeable display of supplemental vocabulary that is likely to be needed only at a certain time or in a certain specific activity.

Relevant developmental research

Research on patterns of early word usage is relevant here. First words have often been described as situational or context bound (e.g., Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Dore, 1985; Nelson & Lucariello, 1985; Dromi, 1987; Smith & Sachs, 1990), with generalized referential use not emerging until later. Nelson (1985, 1991) suggests that early word use is context-bound because the prelinguistic conceptual space is organized largely in terms of events. The child gradually acquires the ability to carve up events into decontextualized concepts, and then is therefore able to use words in a contextually flexible manner. Nelson views the naming spurt and emergence of multiword utterances at around 18 months as evidence of this conceptual flexibility and ability to carve up events. At about this time she proposes that children move from using words as signs for familiar event-concepts to using words to represent conceptual categories or classes.

Recent research, motivated in large part by the search for innate linguistic and cognitive constraints on developmental phenomena, has called this view of early language into question (Huttenlocher & Smiley, 1987). For example, Harris, Barrett, Jones, and Brookes (1988) examined the first 10 words produced by four children, and found evidence that some of even these earliest of words were used referentially. The way the children used their first words was related to the most frequent use by mother, and typically mothers used these words in a flexible rather than context-bound way.

Dromi's careful longitudinal study (1987) of her daughter's early word acquisition and usage and her examination of other diary studies provides evidence supporting context-bound early word meanings, but for the very earliest appearing words only. From 10 to 14 months extension patterns in word usage indicated that words were associated with a situation rather than a conceptual category. By around age 15 months, and just before a productive vocabulary spurt, a more systematic pattern of extensions emerged, and Dromi suggested that this may indicate that her daughter had by that point hypothesized that words label a category. In the latter part of the one-word stage, Dromi did find evidence that some words were used in a decontextualized manner as names for classes of objects from the time of their first appearance.

Therefore, some very early words do appear to be context-bound and used only in a situation-specific manner, although the evidence would seem to be uncontroversial that decontextualization can occur earlier than Nelson suggested, at least for object names. Smith and Sachs' (1990) work on the early development of verbs however suggests that decontextualized, flexible usage for these types of relational words may develop somewhat later. These researchers traced the early development of verbs in a group of 12- to 19-month-old children. If used at all during this period, a verb was likely to occur only in a subset of specific situations. Although Smith and Sachs were looking for evidence of underlying cognitive/conceptual development to explain the emergence of verbs, they found this for the verb comprehension only. A surge in verb comprehension noted between 14 and 16 months was associated with the ability to consider others in the role of actor, and the ability to engage in symbolic action sequences on objects.

It appears that words for concrete objects, once acquired, are more likely to be applied by the child in any appropriate situation whereas relational words such as verbs may be more context bound. Gentner (1978) proposed that object concepts may be more easily recognized and abstracted from specific situations than relational concepts, which are fleetingly observed, more dynamic, and less tangible. In situations where a word is introduced that does not appear to refer to an object, the very young child may more frequently run into difficulty sorting out the conceptual referent and make the incorrect hypothesis that the word refers to a complexive cluster associated with an event. Perhaps this explains the apparent differences in patterns of early noun usage versus early verb usage.

Clinical implications

The emergence of many words in context-specific circumstances would strongly support a vocabulary organization strategy based on situations or activities for children who are just beginning to use language, as such an organization strategy will allow the children to take advantage of their developing understanding of the lexicon. This would be particularly advisable for vocabulary other than object labels. Paradoxically, relational vocabulary such as *more*, *allgone*, or *mine* would seem to be more potentially useful in many situations, and therefore would be likely to be considered for the central or core vocabulary display rather than a supplemental, situation specific display. Object-labels, on the other hand, are often most obviously situation-specific, (the child is likely to only need access to vocabulary labelling cutlery during meal-times for example) and would therefore be considered candidates for a supplemental vocabulary display. However, patterns of very early language use would suggest that initially all vocabulary, and especially relational words, should be organized by event. Situation-specific boards or overlays should contain both core and supplemental vocabulary in the same display, with duplicates of symbols on various displays for vocabulary that is potentially needed in multiple situations or activities.

Clinical Challenge #4: Vocabulary encoding issues

Two enduring challenges in AAC system design concern how best to give a preliterate individual access to a large vocabulary (see clinical challenge #3) and how to give the literate individual a faster way to produce a message than by spelling it out letter by letter. To this end, various strategies for vocabulary encoding have been used. One very innovative encoding technique was proposed by Baker (1982) and gained widespread popularity in the 1980s. Baker drew inspiration from systems of Egyptian and Mayan hieroglyphics to develop the encoding technique called semantic compaction, or Minspeak™. This approach calls for a set of pictures, which Baker calls icons, to be displayed on the keyboard of a computerized AAC device. Icons are selected on the basis of having many potential associations to various concepts. For example, a "sun" icon could be associated with the concepts of hot, yellow, round, weather, son, astronomy, day, etc. Word, phrase, or sentence length messages are stored under sequences of icons selected on the basis of some connection between the content of the message and associations to the icons in the sequence. The use of sequences allows for icons to be used in different combinations to represent different meanings. For example the "sun" icon may be combined with a "paintbrush" icon to represent the word "yellow", but when combined with the icon "teddy bear" (a toy) could represent the word "ball". Different meanings can be stored under the same subset of icons, sequenced in a different order. For example, the sequence "sun" plus "heart" may represent the word "angry" whereas the sequence "heart" plus "sun" may represent the phrase "I'm too hot." Thus a single icon is described as "multi-meaning", in that the specific meaning associated with the icon changes depending on the other icons in the sequence, and the order in which they were sequenced.

Semantic compaction was embraced by the clinical community as it appeared to have several advantages. This approach appeared to address both the problem of limited space for representing vocabulary and the need to increase speed of output, and it could be used with individuals who were not literate. Commercial products have been developed which use semantic compaction as the basis for encoding of vocabulary in AAC software, including products for preschool children (VanTatenhove, 1989) and for adolescents and adults with cognitive impairments (Jones, 1991). Case studies have appeared demonstrating the clinical viability of this approach (e.g., Bruno, 1989; Spiegel, Benjamin, & Spiegel, 1993).

Although semantic compaction is still a widely used vocabulary encoding technique, the initial enthusiasm for this vocabulary encoding scheme has been somewhat tempered. A significant amount of time is required to teach the semantic compaction codes. Furthermore, when given limited training, individuals with functional literacy were found to recall salient letter codes (e.g., "I'm too hot." stored under the letter sequence ITH) more accurately than semantic compaction codes employing icons (Light, Lindsay, Siegel, & Parnes, 1990). Finally, some literate individuals objected to the use of pictures on the device because they felt that the pictures (as opposed to an alphanumeric display) caused them to be perceived as less intelligent (Blockberger, 1987). On the other hand, competent adult Minspeak users are able to attain a very impressive fluency and speed in conversational exchanges.

Because of its perceived advantages, there has been considerable interest in the application of this approach for individuals with limited or no written literacy skills. However, clinical experience has revealed some difficulties with the use of semantic compaction encoding techniques with very young children and/or individuals with moderate to severe cognitive impairments.

Relevant developmental research

Research of interest includes factors that could impede or facilitate the learning of semantic compaction codes. In recent years, developmental psychologists have been interested in exploring the "hard-wired" biases or constraints that children bring to various developmental areas, including the area of conceptual and lexical development (Maratsos, 1992). In the area of conceptual development, recent work with infants has found that they appear to have much more early knowledge than previously thought. For example, a widely quoted study by Baillargeon (1987) has shown that when the motor response required by the task is simplified to looking, infants as young four months show evidence of an expectation that one solid object (a rotating screen) cannot pass through another solid object. Although this is not evidence for the sophisticated object concept that Piaget spoke of, it does call into question a view of the young infant as being largely unaware of object properties.

Spelke (1988, 1991) summarizes an extensive research program exploring what very young infants appear to know about objects. She claims that infants have a primitive theory of the physical world, guided by four properties of physical bodies: cohesion, boundedness, substance and spatiotemporal continuity. Infants as young as four-months-old appear to be aware of these properties of physical bodies: they expect that a hidden large ball will not be able to pass through a smaller opening; they expect objects to move independently of each other and in connected paths; they expect that a hidden ball, when dropped, will rest by the first surface in its path; and they expect that a hidden rolling ball will stop at the first barrier it encounters. Spelke suggests that the four principles listed above form an innately specified core of the infants' conceptual theory of objects, which is added to through a process of theory enrichment as infants gain experience in the world.

Mandler (1988, 1992) also suggests that conceptual development is evident in early infancy. She reviews the work of Spelke, Baillargeon, and others, pointing out that it provides evidence that very young infants must remember previous events in order to recognize whether the present event is consistent or inconsistent with previous experience. She also points out that infants are able to learn manual signs and communicative gestures very early and before they learn a spoken language. Arguing against a Piagetian framework of a pre-conceptual sensori-motor stage, she suggests that these abilities in infants would only be possible given some sort of primitive representational storage of event knowledge. Mandler proposes that children are born with the capacity to engage in perceptual analysis, which she describes as a process of conscious comparison. This leads to the formation of "image-schemas" such as self-motion, animate motion, and containment. Image-schemas are condensed redescriptions of sensori-motor processes which eliminate many details, and are an intermediate step between perception and language. Concepts are seen as being built from this accessible representational system.

Turning now to the area of lexical acquisition, some theorists have suggested that innate constraints are necessary to narrow down the hypothesis space for the child trying to learn word meanings (Markman, 1992). The three "word-learning" constraints thought to be available to child, at least by the time of the vocabulary spurt at about 18 months, are the whole object assumption, the taxonomic assumption, and the mutual exclusivity assumption. The whole object assumption is that words will refer to whole objects, not to a part or an attribute: The child assumes that "car" refers to the whole car, not just the seats, wheels, or radio. The taxonomic assumption is that words capture taxonomic relationships, not thematic ones: The child assumes that a label such as "dog" refers to the family pet and to other things of the same kind, but not to associated objects, events, or actions such as the dog's blanket, dog food, or a barking noise. The mutual exclusivity assumption is that each object will have only one label: a cup is assumed to be called only a cup, not a container, mug, or vessel. In Markman's view, word-learning constraints should be viewed as "default assumptions" or "probabilistic biases" rather than innate mechanisms that are immune to input. If these constraints are operating when the child is just entering into language prior to 18 months as Markman suggests, and if they represent the "default assumptions" that children bring to the task of deciphering the meaning of all words, then the presence of these constraints could partially explain the predominance of object names in early lexicons. Acquiring words that are not object names would be more difficult than acquiring object names because the former would require the effort and/or the ability to over-ride the default assumptions.

Clinical implications

Why is it that, having learned to associate an icon with one meaning, young individuals or individuals with significant cognitive impairments appear to have such difficulty in learning to associate that icon with a second meaning? Two of the word learning constraints described above may be operating to account for this observation, if in fact the learner is treating the icon sequences as equivalent to words. Possibly a variant of the mutual exclusivity assumption (objects have one label) is being applied, which suggests that icons too can only be associated with one meaning. Semantic compaction may also violate the taxonomic assumption (words capture taxonomic relations) if cues for the icon's reference are sought in the picture. Under these conditions, the meaning of an icon would be assumed to be the object depicted, rather than an associative meaning. The guesses that people typically provide for the meanings of graphic symbols suggests that this is a natural first assumption, and perhaps with very young children this taxonomic assumption is too strong to be over-ruled. Thus both the mutual exclusivity and taxonomic assumptions may operate against an encoding system like semantic compaction.

On the other hand, semantic compaction strategies for encoding vocabulary would seem to be naturally designed to exploit theoretical models where words and/or concepts are decomposed into conceptual constituents or primitives, such as those proposed by Mandler and Spelke. If conceptual primitives such as animacy, causality and containment form the basis of the infant's conceptual, and ultimately lexical development, these would be obvious candidates to be represented in a semantic compaction icon set. To date, theories positing lexical and/or conceptual primitives have not been systematically exploited in the design of semantic compaction vocabulary encoding schemes.

Conclusions

Relationships between the conceptual and lexical domains in normal development are both complex and controversial. The atypical circumstances associated with the graphic symbol learning task and with the life circumstances of the AAC user throw different factors into what is already a complicated and only partially understood equation. It appears likely that humans are wired to accomplish the same important outcomes via a number of different paths. This would suggest that "normal" development can be viewed as the most popular path, not the only path. Clinical intervention in AAC should not be focused on reproducing normal development; this is not only impossible (given the atypical circumstances mentioned above) but also unnecessary. Nevertheless, by identifying the relevant developmental factors affecting a typical child's performance in a given situation, and by considering how these may interact with factors in the unusual situation of the nonspeaking child, useful clinical hypotheses can be generated for further consideration and validation. The clinical implications for graphic symbol learning suggested by a selective review of the literature in conceptual and lexical development illustrate the value of this approach.

With regard to the four clinical challenges discussed here, obviously information on normal conceptual and lexical development is not the only body of information that must be considered when making clinical decisions. The literature on typical and atypical social development, motor development, and perceptual development will also provide useful information. So too will careful consideration of the social and physical environments of our clients, and the hopes, attitudes, fears, and expectations of parents and caregivers.

This paper began by pointing out that there are many differences between learning to communicate via an AAC system versus learning to communicate via spoken language. Yet, despite these differences, useful information and many provocative ideas can be derived from an consideration of clinical issues in light of the normal developmental course. Normal development does not provide a comprehensive blueprint for clinical goals, nor does it necessarily predict the course of development in atypical circumstances. Nevertheless in the absence of either contrary evidence or logical reasons which suggest differences, it is both useful and parsimonious to assume as a starting point that the normal developmental course will hold.

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