Applied Psycholinguistics **21** (2000), 473–486
Printed in the United States of America

Relative clause sentence production using augmentative and alternative communication systems

ANN SUTTON
Université de Montréal

TANYA GALLAGHER
University of Illinois

JILL MORFORD
University of New Mexico

NAVID SHAHNAZ
McGill University

ADDRESS FOR CORRESPONDENCE
Ann Sutton, École d'orthophonie et d'audiologie, Université de Montréal, C.P. 6128, Succursale Centre-ville, Montreal, Quebec H3C 3J7, Canada. Email: ann.sutton@umontreal.ca

ABSTRACT
Complex syntactic structures may be difficult to recognize when produced using augmentative and alternative communication (AAC) systems that do not contain grammatical markers. The present study investigated adult English speakers' production of Subject and Object relative clause sentences using a picture/symbol-based AAC system with speech output. Most participants avoided the potential ambiguity that resulted from the absence of grammatical markers. They followed spoken English word order when encoding Object relative clause sentences, but altered this order for Subject relative clause sentences. Most participants used constituent proximity to maintain the distinction between Subject and Object relative clause sentences. Results indicate the combined effects of underlying syntactic knowledge and pragmatic variables on the AAC constituent order patterns observed.

Communication using augmentative and alternative communication (AAC) systems such as picture/symbol displays and voice output devices differs significantly from spoken communication. This is recognized widely in the literature (Beukelman & Mirenda, 1998; Gerber & Kraat, 1992; Glennen & DeCoste, 1997; Kraat, 1985; Nelson, 1992), but our understanding of the underlying nature of these differences is less certain. Intrinsic variables, visual modality factors, and AAC system constraints all may influence utterance forms produced using AAC systems. Intrinsic variables include differences in underlying knowl-

© 2000 Cambridge University Press 0142-7164/00 $9.50

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

edge of vocabulary and grammar that may result from the language learning experiences of children with limited language production opportunities. Visual modality factors include the use of visual representations, such as picture sets, graphic symbols, or printed words, and the use of strategies that facilitate visual processing. Some strategies, such as selecting two symbols simultaneously, are only possible in the visual modality, whereas others are not exclusive to this modality. Constraints imposed by AAC system use include limited vocabulary and grammatical markers available on AAC displays, reduced communication rate, the need for message coconstruction, and the negotiation of message meaning (for a discussion of these issues, see Smith, 1996; Smith & Grove, 1999; Sutton, 1999; Sutton & Morford, 1998).

Some research has suggested that individuals with severe speech and physical impairment (SSPI) who use AAC systems may not achieve full English competence (Berninger & Gans, 1986; Kelford-Smith, Thurston, Light, Parnes, & O'Keefe, 1989; Soto & Toro-Zambrana, 1995; Sutton, 1989; Sutton & Gallagher, 1993; Udwin & Yule, 1990), and difficulties in language assessment within this population have been identified (Blackstone, 1986; Nelson, 1992, 1993; Sutton & Gallagher, 1995; Yoder & Kraat, 1983). It would appear that the relationships among these research findings and the constraints inherent in the use of AAC systems require closer examination. Reductions and variations in constituent orders produced using AAC systems are frequently noted (e.g., Bruno, 1989; Kelford-Smith et al., 1989; Kraat, 1991; Smith, 1996; Soto & Toro-Zambrana, 1995; Sutton, 1989; Udwin & Yule, 1990), but the relationships between spoken English syntax and the structures of utterances produced using AAC are often difficult to interpret. For example, grammatical markers and function words (e.g., articles, determiners, plurals, past tense, relative pronouns) tend to be eliminated from AAC displays, especially those based on graphic pictures/symbols, in order to include as many content words (nouns, verbs, adjectives, adverbs) as possible within the limited space available. Compared to spoken sentence structures, AAC utterances may appear reduced or different as a consequence of observers' difficulties in recognizing complex syntactic structures in AAC productions.

Previous research found that preschool-aged children (Smith, 1996) and school-aged children (Sutton & Morford, 1998) with normal speech and language development, who had no prior experience with AAC communication, sometimes used non-English constituent orders when asked to construct single-clause utterances by pointing to pictures on an AAC display. Grammatical morphemes were not included on the experimental AAC displays in these studies (Smith, 1996; Sutton & Morford, 1998), but their absence did not result in ambiguity with regard to the relationships among the major constituents because only single clauses were encoded. Grammatical distinctions were identified by the order in which pictures representing the constituents were selected on the displays. One study explicitly targeted single-clause events with nonreversible actions to investigate whether participants would use this strategy (Sutton & Morford, 1998). These studies suggest that, at a fairly young age, individuals who demonstrate consistent use of English constituent orders in their spoken

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

productions are sensitive to the role of word order in expressing grammatical relations even if they do not recruit specific English structures in their ACC productions.

Expressing basic constituent relations in single clauses is fairly straightforward since any consistently used word order can function as a grammatical device. In complex structures, in contrast, correct interpretation of the sentence structure may depend on the presence and placement of grammatical morphemes. For example, two types of relative clause sentences, Subject relatives and Object relatives, may have exactly the same order of major constituents, but may differ structurally due to grammatical morpheme placement. In relative clause structures, the relative pronoun (e.g., *who*) follows the head noun. The Subject relative "The girl who pushes the clown wears a hat" and the Object relative "The girl pushes the clown who wears a hat" have exactly the same sequence of major constituents. Without the grammatical marker *who*, these sentences would be ambiguous. AAC encoding of complex structures, such as relative clause sentences, provides a context in which to explore the potential influence of grammatical marker absence on AAC sentences. If English word order of the major constituents were followed, these two types of relative clause sentences would be identical, but would have two different underlying meanings. If the underlying difference in meaning were encoded (i.e., the role served by the relative clause marker), modification of the major constituent order would be required. This solution would be consistent with the use of non-English patterns observed in previous studies of single-clause utterances produced by young English speakers (Smith, 1996; Sutton & Morford, 1998).

Systematic research analyzing the relationships between AAC system features and the production and comprehension of language is needed so that principled decisions can be made to support AAC system designs that will maximally facilitate language growth. Examination of how grammatical structures are encoded using AAC systems would also address theoretical issues of language representation which cannot usually be discussed within the typical language learning situation. Under normal circumstances, children acquire grammatical knowledge through integrated language comprehension and production experiences. For children with severely restricted language production capabilities, such as those who require AAC, language comprehension experiences may play a more significant role. Theories vary in the relative importance they attribute to language production as a mechanism of language growth, and by implication they would predict different degrees of difficulty in acquiring grammatical knowledge for children with limited language production experiences. Theories that emphasize language comprehension opportunities within the language environment (e.g., Braine, 1988; Chomsky, 1986; Meisel, 1995) imply that grammatical acquisition would not be impeded by limited language production experiences. Theories that view language production experience as an important influence on the acquisition of grammar (e.g., Bruner, 1983; Ninio & Snow, 1988; Ochs & Schieffelin, 1995) imply that the limited language production experiences of children who need AAC would result in reduced or different grammatical knowledge (Sutton, 1999). A clearer understanding of the gram-

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

matical and syntactic features of sentence encoding using visual-graphic AAC systems should help identify and clarify the relationships among restrictions on language production and acquisition of grammatical knowledge.

The purpose of the present study was to investigate the production of a complex structure using a picture/symbol-based AAC system with speech output that does not contain grammatical markers. Adult English speakers with normal speech and language development and no physical impairment were selected for the initial study because some of the variables that may influence AAC utterance structures could be controlled. These include known English language competence and easy visual and motor access to vocabulary on the display. The potential influence of differences in English grammatical acquisition and in ease of access issues on AAC constituent orders was controlled. The results obtained with adult English speakers, therefore, would be more clearly interpretable relative to the issues under study.

The complex structure investigated was that of relative clause sentences. Subject and Object relatives were targeted because the English order of the major constituents is the same across the structures, and thus they would be ambiguous based on constituent order alone. Three research questions were addressed. First, do adult speakers of English maintain a structural distinction between Subject and Object relatives when encoding relative clause sentences using a picture-based AAC system that does not include conventional grammatical markers? Second, what constituent order patterns are used (a) when the distinction between Subject and Object relatives is maintained and (b) when it is not maintained? Third, is there an underlying principle that accounts for the patterns used?

METHOD

Participants

The participants were 43 adult speakers of English with no reported history of intellectual, linguistic, social, or motor impairment who had normal hearing and normal or corrected vision. They were recruited through notices posted around an urban university campus. There were 11 males and 33 females. The mean age of the participants was 25.33 ($SD = 7.47$). All participants had completed high school. Some participants had also completed junior college ($n = 9$, 20%), an undergraduate university degree ($n = 16$, 37%), or a graduate degree ($n = 3$, 7%).

AAC system

The AAC system used in the study was a nine-picture display comprised of Picture Communication Symbols (PCS) (Mayer-Johnson Co., 1993) and mounted on a MacawIII™ programmed to speak each word as the corresponding picture was selected. Eight pictures on the display represented the nouns and verbs used in the experimental task, the relative clause production task. A separate picture for "Start Over" was included so that participants could self-correct if

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

they wished to do so. A different random arrangement of the pictures on the display was used for each participant.

The spoken picture labels were recorded onto the MacawIII™. The location of each word in the Macaw was determined by the random display arrangement for that individual subject. Speaker characteristics, sound quality, prosody, and loudness were controlled. One male speaker made all the recordings in a sound booth. Each word was recorded one at a time onto high-quality audiotape and subsequently recorded onto the Macaw in the appropriate location. All occurrences of each word were therefore identical. Loudness of recording (live voice onto audiotape and taped words onto the Macaw) was controlled by passing the audio signal through a clinical audiometer (GSI-10) set at 55 db HL (normal conversational speech level).

Relative clause production task

Stimuli. The stimuli were spoken sentences accompanied by photographs. The spoken sentence stimuli were Subject and Object relative clause sentence pairs (SS and OS, respectively). The sentence pairs were constructed using the same vocabulary to designate the five major constituent roles within each sentence (N1, V1, N2, V2, and N3) and were distinguished only by the placement of the relative pronouns. For example, the SS relative "The girl who pushes the clown wears a hat" and the OS relative "The girl pushes the clown who wears a hat" have the same order of major constituents. Both sentences describe a girl pushing a clown, but in the SS relative the agent (girl) wears a hat and in the OS relative the patient (clown) wears a hat. When grammatical markers were absent, as in the case of picture-based AAC systems and the AAC device used in this study, the structure (SS or OS) would be ambiguous based on the order of the major constituents.

In each sentence, the five major constituents were arranged in the following order: N1 V1 N2 V2 N3. There were two animate nouns with one reversible action (i.e., either of the nouns named as agent or patient could plausibly perform the action: N1 V1 N2) and one inanimate noun with a nonreversible action (i.e., the noun named as the patient could not plausibly perform the action: V2 N3). As a result of these constraints, N1 and N2 were potential agents for V1 and V2, but N3 was not a potential agent.

Each sequence of N1 V1 N2 V2 N3 was used to make an SS/OS sentence pair. Sixteen sentence pairs were constructed by combining four agent–patient pairs (girl–clown, clown–girl, boy–clown, clown–boy) used as N1 and N2, two action verbs (push, pull) used as V1, and two descriptive verb + noun phrases (wears a hat, wears a scarf) used as V2 N3, yielding a total of 32 sentences.

Photographs were used to elicit AAC utterances. These were $4'' \times 6''$ color photographs of figurines positioned to correspond to the events described in the sentence stimuli. In each photograph, two additional figurines were included: a second token of each of the figurines representing the agent and the patient of the action. The photograph thus depicted a situation in which relative clause use would be appropriate (Hamburger & Crain, 1982).

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

Training. Participants received training on the vocabulary included in the AAC device, on sequencing using the device, and on using the vocabulary represented on the device to describe the photographs. During vocabulary training, participants were asked to point to each picture on the AAC device when it was named by the examiner. The "Start Over" key was identified, and participants were told that they could use this key to indicate that they made an error and would like to begin again. The pictures were named in a different random order for each subject. The criterion was 100% correct performance. All participants achieved this criterion on the first presentation.

The sequencing training provided an opportunity for participants to practice pointing to the pictures on the AAC display in a sequence. A row of five pictures (strip sequence), identical to those used on the display, was presented, and participants were asked to point to the pictures on the display in the same sequence as they appeared on the strip. Participants were instructed to touch the "Start Over" key if they made a mistake and wanted to begin the sequence again. The criterion for completing the sequencing training was eight consecutive strip sequences correctly encoded on the AAC device. Participants would be excused from the study if this criterion was not reached within 24 trials. All participants passed the sequencing training in 8 trials.

The purpose of the production practice training was to familiarize the participants with the task of encoding relative clause sentences using the AAC device. A set of four photographs was presented to participants. The set included a target and three foils, which differed from the target in only one feature. The experimenter described the target photograph using a relative clause sentence and pointed out how the photographs differed from each other. For example, the first set of photographs included the following:

Target: two girls, two clowns; one girl pushes one of the clowns and wears a hat
Foil One: two girls, two clowns; one girl pushes one of the clowns and wears a scarf; no one wears a hat
Foil Two: two girls, two clowns; one girl pushes one of the clowns; the second girl wears a hat; the girl pushing the clown does not wear a hat
Foil Three: two girls, two clowns; one girl pushes one of the clowns and the clown wears a hat; the girl does not wear a hat

Following this orientation, the experimenter repeated the relative clause sentence that described the target photograph and asked participants to construct the same sentence using the AAC device. Participants were encouraged, but not required, to use full sentences. If the participant pointed to a sequence of five pictures (i.e., the content words of the sentence), the next practice trial was presented. If the participant pointed to a sequence of less than five pictures, the experimenter asked whether the participant's response was equivalent to the spoken relative clause sentence. If the participant responded affirmatively, the next training trial was presented; if the participant responded negatively, the examiner repeated the spoken sentence and asked the participant again to produce that sentence using the AAC device. The next practice trial was then presented

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

regardless of the length of the response. There were 8 randomized practice trials, four examples of SS relatives and four examples of OS relatives.

Experimental procedure. All testing, including practice, was administered by a trained examiner. In each test trial, the examiner presented the stimulus photographs one at a time and produced the spoken stimulus sentence that described each photograph. Participants were asked to repeat the same sentence using the AAC device and to respond by pointing to a sequence of pictures on the device. There were a total of 32 trials (16 trials × 2 types of sentences). Each participant received a different random ordering of the sentence stimuli. Responses were videotaped to facilitate scoring.

Response coding

The constituent orders that each participant used for SS and OS sentence pairs were compared and scored as "same" if exactly the same order of constituents was used or as "different" if there were any differences in pointing orders across the two sentence types. Constituent order patterns were identified within the data, and their frequencies of use for SS and OS sentences were calculated for each participant.

Reliability

Reliability was assessed on 10% of all response recording, same/different scoring, and constituent order pattern assignment for each participant. A second trained examiner viewed a portion of each participant's videotape and independently recorded and scored responses (same/different) and coded constituent order patterns. Video segments for each participant were selected beginning with a randomly assigned trial number. Response recording, scoring, and coding were compared with those made by the first examiner. Interrater agreement was 100% for response recording and same/different scoring and 95% for constituent order pattern assignment.

RESULTS

The first research question – whether adult English speakers maintain a structural distinction between SS and OS relatives in AAC productions – was addressed by comparing the frequencies of response pairs that were scored as same with the frequencies of response pairs that were scored as different. This analysis indicated that participants had significantly more different than same responses for SS and OS sentence pairs ($M = 13.77$ and 2.23, respectively; $n = 16$), and that the difference was significant ($t = 6.075$, $df = 42$, $p < .001$). Thus, the group data indicated that adult English speakers maintained a distinction between most of the SS and OS relative clause sentences when using the AAC device.

Further examination of the data, however, indicated that the frequencies of same and different scores for individual participants clustered at the extremes

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

Table 1. *Frequencies of OS and SS constituent order patterns by +DEP and –DEP participants*

	+DEP participants		–DEP participants	
Patterns	OS	SS	OS	SS
N1 V1 N2 (V2) N3	446	19	112	109
N1(V2) N3 V1 N2	0	477	0	3
N1 V1 N2 N2 V2 N3	74	2	0	0
N1 V1 N2 N1 V2 N3	0	46	0	0
N1 V1 N3 (V2) N2	39	0	0	0
N3 N1 V1 N2	0	28	0	0
N2 V2 N3 N1 V1	14	0	0	0
N1 V2 N3 N1 V1 N2	0	4	0	0
N2 V2 N3 N1 V1 N2	3	0	0	0
Total	576	576	112	112

of the frequency distribution range. These scores were either less than 4 or greater than 12 of the sentence pairs presented ($n = 16$). These data suggest that participants fell into two groups. One group of participants, the distinctive encoding pattern (+DEP) participants, encoded the sentence pairs distinctively at a high frequency. The other group of participants, the nondistinctive encoding pattern (–DEP) participants, did not encode the sentence pairs distinctively. There were 36 participants (84%, $n = 43$) in the +DEP group: 32 participants encoded 100% of the SS and OS sentence pairs distinctively, 3 participants encoded 94% of the sentence pairs distinctively, and 1 participant encoded 81% of the sentence pairs distinctively. There were 7 participants in the –DEP group: 6 participants used the same pattern on 100% of the SS and OS sentence pairs, and 1 participant used the same pattern on 77% of the sentence pairs. The response patterns of the –DEP participants were not consistent with the overall group data trend.

The second research question – what constituent order patterns are used by participants who maintain a distinction between SS and OS sentences and by those who do not – was addressed by identifying the various pointing order patterns that occurred in the data. Comparison of the constituent order patterns with the original spoken sentences revealed that only one constituent was deleted: the verb *wear*, which was the V2 constituent. Overall, deletion occurred infrequently (14% of SS sentences and 16% of OS sentences). In all further analyses of constituent order patterns, therefore, patterns in which V2 was deleted were analyzed as an infrequent variant of those containing V2 and were scored as the same pattern. V2 is indicated in the text and tables as optional by enclosing it in parentheses.

Nine constituent order patterns were observed within the data. These order patterns are listed in Table 1 according to their frequencies of use. The first pattern, N1 V1 N2 (V2) N3, was used most frequently across all participants. OS sentences were encoded with this pattern by both +DEP and –DEP partici-

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

Table 2. *Number of +DEP and –DEP participants who used each constituent order pattern to encode OS and SS sentences on 75% or more trials*

	+DEP participants		–DEP participants	
Patterns	OS	SS	OS	SS
N1 V1 N2 (V2) N3	27	1	7	7
N1(V2) N3 V1 N2	0	29	0	0
N1 V1 N2 N2 V2 N3	4	0	0	0
N1 V1 N2 N1 V2 N3	0	4	0	0
N1 V1 N3 (V2) N2	2	0	0	0
N3 N1 V1 N2	0	2	0	0
N2 V2 N3 N1 V1	1	0	0	0
N1 V2 N3 N1 V2 N2	0	0	0	0
N2 V2 N3 N1 V2 N2	0	0	0	0
No predominant order	0	0	0	0
Total	36	36	7	7

pants (77% and 100%, respectively). +DEP participants used this pattern significantly more frequently than all other patterns combined ($t = 5.503$, $df = 35$, $p < .001$); its frequency of use was at ceiling for –DEP participants. In contrast, SS sentences were encoded differently by the two groups. +DEP participants encoded SS sentences with a different order pattern from the one they used on OS sentences. They used the pattern N1 (V2) N3 V1 N2 for SS sentences significantly more frequently than all other patterns combined ($t = 2.925$, $df = 35$, $p < .01$). However, –DEP participants encoded SS sentences with the same order pattern as the one they used on OS sentences: N1 V1 N2 (V2) N3. Their frequency of use of this pattern was at ceiling (97% of SS sentences), similar to their data for OS sentences.

Examination of individual participant data indicated that, whether or not they distinguished OS and SS sentences (+DEP and –DEP participants), all but two participants used particular constituent order patterns on 75% or more of the OS and SS sentences presented (see Table 2). These data were consistent with the frequency of occurrence data (see Table 1). When encoding OS sentences, 27 +DEP participants and all 7 –DEP participants used the pattern N1 V1 N2 (V2) N3. When encoding SS sentences, 29 +DEP participants consistently used the pattern N1 (V2) N3 V1 N2; 2 +DEP participants did not use a consistent pattern when encoding OS sentences, but were nonetheless consistent in their encoding of SS sentences. In contrast, all –DEP participants used the pattern N1 V1 N2 (V2) N3 for SS sentences, just as they did for OS sentences. The type of initial trial type presented (OS or SS sentence) was not related to participants' response patterns or to whether they distinguished between OS and SS sentences (+DEP vs. –DEP).

The third research question – whether an underlying principle accounts for the AAC encoding patterns observed – was then explored. Two possibilities were suggested by the data. One principle was to follow the order of mention

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

of the major constituents in the spoken sentences in constructing the AAC constituent orders. The constituent order pattern N1 V1 N2 V2 N3 corresponded exactly to the spoken order of mention in both SS and OS sentences. This principle could account for the data for –DEP participants because they used the pattern N1 V1 N2 (V2) N3 frequently and consistently for both OS and SS sentences (see Tables 1 and 2). It could also account for +DEP participants' constituent order patterns for OS sentences but not for SS sentences. They encoded SS sentences using order patterns that differed from the spoken order of mention (see Tables 1 and 2).

A second principle – constituent proximity – was explored. The potential ambiguity between OS and SS sentences that resulted from the absence of relative pronouns could be resolved by altering the order of the constituents from the one presented in the spoken sentences. The principle of constituent proximity could account for +DEP participants' data for SS sentences. Nearly every +DEP participant consistently used a pattern that altered the spoken order of mention of the constituents in order to place the attribute, N3 (*hat* or *scarf*), closer to N1 than to N2: 29 participants used the pattern N1 (V2) N3 V1 N2, in which the constituents (V2) N3 were moved forward so that they directly followed N1 in the AAC encoded sentence; 4 participants used the pattern N1 V1 N2 N1 V2 N3, in which N1 was repeated and intervened between N2 and N3; and 2 participants used the pattern N3 N1 V1 N2, in which N3 was placed before N1. Only 1 +DEP participant did not follow this constituent proximity principle when encoding SS sentences. This participant followed the order of mention for SS sentences, but maintained a distinction between OS and SS sentences by using a different constituent order for OS sentences.

DISCUSSION

The results of the study indicated that most adult speakers of English distinguished SS and OS relative clause sentences when encoding them using a picture-based AAC system that did not include relative pronoun grammatical markers. Of 43 participants, 36 (i.e., +DEP participants) maintained this distinction; 32 did so on 100% of trials. These findings, as well as the observation that participants' response patterns did not differ based on the type of initial trial (SS or OS), suggest that +DEP participants adopted a strategy to encode SS and OS sentences distinctly from the very first trial. They were highly sensitive to the potential ambiguity that would result from the absence of relative pronouns in encoding the sentences.

Most +DEP participants (97%) readily employed an alternative encoding option that was available – constituent proximity. These participants used constituent order patterns for SS sentences in which the attribute (V2) N3 was more closely linked with N1 than with N2 because of its proximity to N1. Given this finding for SS sentences, the constituent order pattern that most (72%) +DEP participants used for OS sentences, N1 V1 N2 (V2) N3, could also be considered an example of constituent proximity. The attribute (V2) N3 was more closely linked with N2 than with N1 because of its proximity to N2. Similarly, the constituent order patterns N1 V1 N2 N2 V2 N3 and N1 V1 N3 (V2) N2 used

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

by +DEP participants for OS relatives maintained the proximity of N2 and (V2) N3. The observation that most participants freely modified the order of constituents they heard in SS sentences in order to maintain constituent proximity suggests that proximity may have played a role in the constituent orders used for OS sentences as well.

Although English syntactic relationships between the spoken clauses could not be demonstrated in the same way using the AAC device, some participants explicitly marked the grammatical roles of the nouns and verbs by repeating the noun represented in the spoken sentence by the relative pronoun *who*: for example, constituent order patterns N1 V1 N2 N1 V2 N3 for SS and N1 V1 N2 N2 V2 N3 for OS. These patterns were used infrequently (46 and 74, respectively, $n = 576$), but their occurrence indicated that a more explicit syntactic solution was available to, but not preferred by, most participants. This finding strengthens the proximity interpretation of the data.

Proximity is recognized as one of the primary historical factors influencing grammatical structure in spoken languages. Haiman (1985) credited Behaghel (1932) as the first scholar to identify proximity as an organizing principle in languages. He noted that the linear order of words in a sentence is not arbitrary; it is determined in part by the conceptual relationship between the words. Over time, words that once occurred in consecutive order may become conjoined, creating bound morphology. Indeed, in a study of 50 unrelated languages, Bybee (1985) confirmed the prediction that bound morphemes with meanings more relevant to the verb (e.g., aspect) will be more proximal to the verb stem, whereas bound morphemes with meanings more relevant to the verb's arguments (e.g., mood, person, number) will be more distal to the verb stem. Moreover, relevance influenced the degree of phonological fusion between bound morphology and the verb stem. Thus, the use of proximity by participants in this experiment has considerable historical precedence. Humans around the world are sensitive (at least implicitly) to the potential of proximity to express the presence of semantic relations.

Overall, the findings of the study suggest that +DEP participants responded to the task using a pragmatic strategy to resolve the potential ambiguity of the sentences presented when grammatical markers were not available. These participants responded on this task as though they were sensitive to the fact that the primary source of any potential ambiguity between the sentences, when presented with the photographs, related to the attribution of the hat or scarf. All photographs contained two animate nouns that served as agent and patient of an action verb (V1). The agent and patient roles were unambiguous (N1 = agent; N2 = patient), but either the agent (N1) or patient (N2) could be wearing a hat or scarf.

These data trends did not represent all participants. A small group (7 –DEP participants) used a single constituent order pattern, which corresponded to the order of mention of the constituents in the spoken sentences. One cannot determine from this study whether these participants ignored the potential ambiguity, did not recognize it, or concluded that English constituent order could not be modified. Although –DEP participants were the minority, their performance suggested that English grammatical distinctions, even if acquired by individuals

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

who use AAC for daily communication, may not be apparent to interlocutors when grammatical markers are not available on the AAC system in use.

The results of this study highlight the fact that clause structures corresponding to those of spoken sentences may not be directly evident in utterances produced using a graphic-based AAC system. The participants, who were mature, native speakers of English, freely altered the order of the constituents they heard to suit their communicative purposes and to accommodate the constraints of the AAC system. Some of the constituent orders differed from conventional English word orders (e.g., "GIRL HAT PUSH CLOWN"; "GIRL PUSH CLOWN HAT"). The findings suggest that, when using such an AAC system, caution is needed in interpreting pointing orders as examples of specific syntactic structures, particularly complex syntactic structures for which there are multiple relationships of elements within and across clauses. This does not necessarily mean that complex structures cannot be encoded using these systems. In the absence of grammatical markers, participants conveyed the distinction between two English complex syntactic structures by using pointing orders that did not correspond directly to conventional English word order.

When these results are combined with those of Smith's (1996) study of preschool-aged children and Sutton and Morford's (1998) study of school-aged children, there is a strong basis on which to conclude that English speakers of all ages consider a variety of strategies for communicating with AAC displays and do not limit themselves to their knowledge of spoken syntactic structures. Moreover, evidence from the current study is helpful in evaluating the developmental trend observed by Sutton and Morford, whereby older children follow English syntax more closely than do younger children. Contrary to what could be expected, adults are not so firmly entrenched in the use of spoken syntax that they would never abandon it if the situational constraints made it advantageous to do so. It may be the case that adults systematically follow SVO constituent order when encoding simple clauses, but interestingly several participants' response patterns in the present task did violate SVO order. Specifically, the response patterns N1 V1 N3 (V2) N2, N3 N1 V1 N2, and N2 V2 N3 N1 V1, accounting for 14% ($n = 576$) of +DEP responses, all violate SVO order by exchanging the position of the object and the subject, moving the object to the front of the clause or moving the object and its modifying constituents to the front of the clause.

These results suggest that the relationships among AAC production patterns and language representation are not straightforward. The participants in this study had fully mastered English syntax, and yet this knowledge was not the only factor that influenced their AAC encoding. Pragmatic pressure to communicate encouraged participants to employ an available solution in order to avoid the ambiguity that resulted from the absence of grammatical markers. Thus, the constituent order patterns we observed were the combined product of underlying syntactic knowledge and pragmatic variables.

Speaking individuals produced the observed constituent order patterns with the intention that they would be interpreted as relative clause sentences. The possibility of discovering standard ways to convey English structures using picture-based AAC systems, even though they may not directly mirror English

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

syntax, would have important implications for clinical practice. Once identified, such encoding patterns could serve as models for sentence production by individuals who use AAC for daily communication and for sentence interpretation by conversation partners. These patterns could also provide the basis for sentence structure prediction in AAC devices that support sentence programming. From a theoretical point of view, discovering how potential ambiguities are resolved when constituent proximity is not available would provide valuable information regarding the limits of constituent order as a means of encoding complex sentences. As has been frequently noted in the literature (e.g., Bedrosian, 1995; Higginbotham, 1995a, 1995b), however, particular caution must be used in extending research findings involving participants without disabilities to individuals with disabilities who use AAC systems for daily communication. The preceding inferences regarding the relationships among English grammatical structures and AAC encoding are therefore drawn with caution. Research to explore AAC encoding of English sentence structures by individuals who use AAC systems for daily communication is needed to explore further the relationships among restrictions on language production and acquisition of grammatical knowledge.

ACKNOWLEDGMENTS

This research was supported by a standard research grant to the second author from the Social Sciences and Humanities Research Council of Canada and by a postdoctoral fellowship to the first author from the Cusson Foundation. The work was conducted while the first and second authors were at McGill University and the first author was affiliated with the Mackay Center, Montreal, Canada.

REFERENCES

Bedrosian, J. (1995). Limitations in the use of nondisabled subjects in AAC research. *Augmentative and Alternative Communication, 11*, 6–10.

Behaghel, O. (1932). *Deutsche Syntax, Band IV*. Heidelberg: Carl Winter.

Berninger, V., & Gans, B. (1986). Language profiles in nonspeaking individuals of normal intelligence with cerebral palsy. *Augmentative and Alternative Communication, 2*, 45–50.

Beukelman, D., & Mirenda, P. (1998). *Augmentative and alternative communication: Management of severe communication disorders in children and adults* (2nd ed.). Baltimore: Brookes.

Blackstone, S. (Ed.). (1986). *Augmentative communication: An introduction*. Rockville, MD: American Speech-Language-Hearing Association.

Braine, M. (1988). Modelling the acquisition of linguistic structure. In Y. Levy, I. Schlesinger, & M. Braine (Eds.), *Categories and processes in language acquisition*. Hillsdale, NJ: Erlbaum.

Bruner, J. (1983). *Child's talk: Learning to use language*. New York: Norton.

Bruno, J. (1989). Customizing a Minspeak™ system for a preliterate child: A case example. *Augmentative and Alternative Communication, 5*, 89–100.

Bybee, J. (1985). Diagrammatic iconicity in stem-inflection relations. In J. Haiman (Ed.), *Iconicity in syntax*. Amsterdam: John Benjamins.

Chomsky, N. (1986). *Knowledge of language*. New York: Praeger.

Gerber, S., & Kraat, A. (1992). Use of a developmental model of language acquisition: Applications to children using AAC systems. *Augmentative and Alternative Communication, 8*, 19–32.

Glennen, S., & DeCoste, D. (Eds.). (1997). *Handbook of augmentative and alternative communication*. San Diego: Singular Press.

Haiman, J. (1985). Introduction. In J. Haiman (Ed.), *Iconicity in syntax*. Amsterdam: John Benjamins.

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press

Hamburger, H., & Crain, S. (1982). Relative acquisition. In S. Kuczaj II (Ed.), *Language development: Volume 1. Syntax and semantics*. Hillsdale, NJ: Erlbaum.

Higginbotham, D. J. (1995a). Subject selection in AAC research: Decision points. *Augmentative and Alternative Communication, 11*, 11–13.

(1995b). Use of nondisabled subjects in AAC research: Confessions of a research infidel. *Augmentative and Alternative Communication, 11*, 2–5.

Kelford-Smith, A., Thurston, S., Light, J., Parnes, P., & O'Keefe, B. (1989). The form and use of written communication produced by physically disabled individuals using microcomputers. *Augmentative and Alternative Communication, 5*, 115–124.

Kraat, A. (1985). *Communication interaction between aided and natural speakers: A state of the art report*. Toronto: Canadian Rehabilitation Council for the Disabled.

(1991). Methodological issues in the study of language development for children using AAC systems (Reactant Paper No. 1). In J. Brodin & E. Bjorck-Akesson (Eds.), *Methodological issues in research in augmentative and alternative communication*. Stockholm: Swedish Handicap Institute.

Mayer-Johnson Co. (1993). *Boardmaker 3.0 for the Macintosh: User's guide and manual*. Solana Beach, CA: Mayer-Johnson Co.

Meisel, J. (1995). Parameters in acquisition. In P. Fletcher & B. MacWhinney (Eds.), *Handbook of child language*. Cambridge: Blackwell.

Nelson, N. (1992). Performance is the prize: Language competence and performance among AAC users. *Augmentative and Alternative Communication, 8*, 3–18.

(1993). *Childhood language disorders in context*. Toronto: Merrill.

Ninio, A., & Snow, C. (1988). Language acquisition through language use: The functional sources of children's early utterances. In I. Schlesinger & M. Braine (Eds.), *Categories and processes in language acquisition*. Hillsdale, NJ: Erlbaum.

Ochs, E., & Schieffelin, B. (1995). The impact of language socialization on grammatical development. In P. Fletcher & B. MacWhinney (Eds.), *Handbook of child language*. Cambridge: Blackwell.

Smith, M. (1996). The medium or the message: A study of speaking children using communication boards. In S. von Tetzchner & M. Jensen (Eds.), *Augmentative and alternative communication: European perspectives*. London: Whurr.

Smith, M., & Grove, N. (1999). The bimodal situation of children learning language using AAC. In F. T. Loncke, J. Clibbens, L. L. Lloyd, & H. H. Arvidson (Eds.), *Augmentative and alternative communication: New directions in research and practice*. London: Whurr.

Soto, G., & Toro-Zambrana, W. (1995). Investigation of Blissymbol use from a language research paradigm. *Augmentative and Alternative Communication, 11*, 118–129.

Sutton, A. (1989). The social-verbal competence of AAC users. *Augmentative and Alternative Communication, 5*, 150–164.

(1999). Linking language learning experiences and grammatical acquisition. In F. T. Loncke, J. Clibbens, L. L. Lloyd, & H. H. Arvidson (Eds.), *Augmentative and alternative communication: New directions in research and practice*. London: Whurr.

Sutton, A., & Gallagher, T. (1993). Verb class distinctions and AAC language encoding limitations. *Journal of Speech and Hearing Research, 36*, 1216–1226.

(1995). Comprehension assessment of a child using an AAC system: A comparison of two techniques. *American Journal of Speech-Language Pathology, 4*, 60–67.

Sutton, A., & Morford, J. (1998). Constituent order in picture pointing sequences produced by speaking children using AAC. *Applied Psycholinguistics, 19*, 525–536.

Udwin, O., & Yule, W. (1990). Augmentative communication systems taught to cerebral palsied children – A longitudinal study: I. The acquisition of signs and symbols, and syntactic aspects of their use over time. *British Journal of Disorders of Communication, 25*, 295–309.

Yoder, D., & Kraat, A. (1983). Intervention issues in nonspeech communication. In J. Miller, D. Yoder, & R. Schiefelbusch (Eds.), *Contemporary issues in language intervention* (ASHA Report No. 12). Rockville, MD: American Speech-Language-Hearing Association.

https://doi.org/10.1017/S0142716400004033 Published online by Cambridge University Press