Conversation-Based Intervention for Adolescents Using Augmentative and Alternative Communication

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Abstract

This study evaluated the effects of a conversation-based intervention on the use of verbs, personal pronouns, bound morphemes and spontaneous clauses in adolescents with cerebral palsy who use augmentative and alternative communication (AAC). Four teenage girls aged from 14 to 18 years participated in the study. After a baseline period, a conversation-based intervention was provided for each participant in the context of a personal collage building activity. The conversations were videotaped, transcribed, and analyzed using the Systematic Analysis of Language Samples (SALT™; Miller & Iglesias, 2012). While the results are mixed, all 4 participants increased their use of at least one linguistic target, 3 increased their use of verbs and grammatically correct spontaneous clauses, 2 increased their use of personal pronouns, and one produced more bound morphemes during intervention than in baseline. These findings, and future research needs, are discussed.

Keywords: Adolescents; Augmentative and alternative communication; Cerebral palsy; Conversation-based intervention; Language intervention

Conversation-based Intervention for Adolescents Using AAC

Adolescents' language skills grow in both scope and sophistication during the teenage years. Their knowledge of vocabulary, morphology, and syntax expands, and conversational interaction with peers becomes an increasingly common focus of language use (e.g., Paul & Norbury, 2012; Raffaelli & Duckett, 1989). Adolescent peer interactions involve particular language demands and also offer rich opportunities for language learning and personal development. For example, through the use of increasingly complex narratives about themselves and others, including the use of vernacular, adolescents learn new language skills and build, maintain, and develop social relations (Nippold, 2007; Nippold et al., 2014).

Adolescents who use augmentative and alternative communication (AAC) are reported to see themselves as typical teenagers with the same interests and challenges as their neurotypical peers (Wickenden, 2011 a, b, c). Yet, much research indicates that adolescents who use aided AAC have few communication partners that understand their systems and limited opportunities to interact in peer groups and develop conversational skills (Biggs, Carter, & Gustafson, 2017; Lilienfeld & Alant, 2005; Smith, 2005). For example, Raghavendra, Olsson, Sampson, Mcinerney, & Connell (2012) compared the social participation of a group of 14 adolescents with typical development, 11 with physical disabilities but no communication difficulties, and 14 with physical disabilities who used aided AAC. They report that a combination of physical and communication difficulties were particularly disabling in terms of peer interactions. While typically developing adolescents and adolescents with physical disabilities but no communication disabilities interacted and socialized widely with peers and school staff (albeit less frequently in the group of adolescents with physical disabilities), the young people using AAC experienced limited opportunities for interaction, had fewer acquaintances and friends, and

rarely used their AAC devices for peer directed social interaction (Raghavendra et al., 2012). Similar findings have been reported by Chung and colleagues (Chung, Carter, & Sisco, 2012) in a study that explored the social interactions of 16 students who used AAC in general education classrooms. Participants in that study primarily interacted with adults, and infrequently conversed with peers although they were often in close proximity with each other.

Despite years of intervention and advances in language and communication skills, many adolescents who use aided AAC continue to struggle to communicate effectively (McNaughton & Bryen, 2007; Smith, 2005). It is well documented that individuals who use AAC have limited expressive language abilities and experience difficulties building and using novel vocabulary and forming appropriate and grammatically complete utterances. The expressive language of individuals who use AAC is often characterized by the predominant use of single word utterances (commonly nouns), or brief utterances that are morphologically and syntactically incorrect or immature (Binger & Light, 2008; Soto & Hartmann, 2006; Sutton, Soto, & Blockberger, 2002). Equally, their communication systems are often insufficient to meet the increasing demands for peer socialization and conversation associated with adolescence (Smith, 2005).

Given the importance of conversational interaction during adolescence, and the fact that this population is under-represented in AAC intervention research (e.g., Turkstra, Ciccia, & Seaton, 2003; Holyfield, Drager, Kremkow, & Light, 2017), it is critical to design studies that investigate specific intervention approaches that support language development in teenagers who use AAC (see Holyfield, Drager, Kremkow, & Light, 2017; Therrien, Light, & Pope, 2016; Wong et al., 2015). Evidence shows that through explicit instruction and systematic language intervention, children who use AAC can improve their expressive vocabulary and learn to

generate grammatically correct utterances (e.g., Binger, Maguire-Marshall, & Kent-Walsh, 2011; Binger, Kent-Walsh, King, Webb, & Buenviaje, 2016; Kent-Walsh, Murza, Malani, & Binger, 2015). Similarly, Soto and Clarke (2017) used a conversation-based intervention to teach eight children aged 8 to 13 with motor speech disorders who used speech-generating devices (SGDs) to form more complex and grammatically correct utterances. Improvements seen in intervention were generalized to conversations with familiar adults.

Conversation-based interventions implement verbal scaffolding procedures (e.g., clarifications, reformulations, explicit corrections) during child-centered conversations where the adult presents the child with implicit or explicit corrective feedback immediately following a child's incomplete, immature or ungrammatical utterance (Eisenberg, 2013, 2014). The adult uses verbal scaffolding, within the context of personally motivating conversations for the child, to make linguistic targets more salient at the specific moment at which the child has something to say, and with minimal disruption to the flow of the conversation. Such techniques afford the child opportunities to hear the target form being used in a meaningful way, and to contrast his or her own utterance with a more complex or grammatically correct one.

Such interventions have been shown to be effective with children with autism spectrum disorder (Scherer & Olswang, 1989), specific language impairments (Camarata & Nelson, 2006; Nelson, Camarata, Welsh, Butkovsky, & Camarata, 1996), language learning disabilities (Stiegler & Hoffman, 2001), language delay (Ruston & Schwanenflugel, 2010), and motor speech disorders who use aided AAC (Soto & Clarke, 2017). In the Soto and Clarke study, clinicians used recasting of participants' AAC-mediated utterances and direct prompting for the repair of incomplete or ungrammatical utterances in conversations around personal events. .

While evidence exists for the facilitative effect of conversation-based interventions for

children with a range of language learning disabilities, including those who use aided AAC, this approach has not been systematically investigated with adolescents who use AAC. The purpose of the current study, therefore, was to investigate the impact of a conversation-based intervention on the expressive language skills of adolescents with cerebral palsy who use AAC, specifically on their use of verbs, pronouns, bound morphemes and grammatically complete utterances. The current study is a systematic replication of the intervention procedures reported by Soto and Clarke (2017).

Method

Experimental Design

The study used a variation of a multiple-baseline design across participants (Gast & Ledford, 2010) to examine the effect of a conversation-based intervention on the expressive vocabulary and grammatical skills of four adolescents who used AAC. In a multiple probe design, baseline data are probed at different points in time rather than monitored continuously. After baseline, the participants received a period of intervention in a randomly assigned order. Following the start of intervention for the first participant, the start of intervention for the second was triggered by evidence of an increase from baseline in the first participant's use of spontaneous clauses (control variable) of at least 25% over three successive intervention sessions (see description that follows) (Gast & Ledford, 2010). Evidence of the same improvement in the control variable in the second participant prompted the start of intervention with the third participant, and so on.

Participants

Four adolescents with cerebral palsy between the ages of 14- and 18-years participated in the study (see Table 1 for participant characteristics). Nadia, Maddie, and Jenna had a clinical

description of spastic quadriplegia and used wheelchairs for mobility, while Anna had a clinical description of ataxia and was ambulatory. They each used a speech-generating device (SGD) with English speech output in which vocabulary was organized on a main core vocabulary page, with multiple pages of vocabulary organized taxonomically within subfolders, so access to vocabulary required extensive navigation. All of the SGDs included pronouns, verbs, and verb inflexions and other linguistic structures that would afford the generation of grammatically correct utterances. The participants also met the following inclusion criteria in that they (a) displayed operational competence at Level III on the Augmentative and Alternative Communication Profile[1] (AACP) (Kovach, 2009); (b) used direct selection techniques to formulate their messages (e.g., pressing the SGD screen, rather than accessing the device indirectly via switches); (c) had English as the primary language; (d) communicated mostly through single word utterances in typical daily conversational interaction, as indicated by their speech language pathologists and confirmed through language sampling; (e) had functional vision and hearing (with or without correction), suitable for SGD use and conversational interaction; and (f) had a speech intelligibility score of less than 50% on the Index of Augmented Speech Comprehensibility in Children (Dowden, 1997), representing little or no intelligible speech.

Insert Table About Here

A number of tests and subtests were used to establish the participants' receptive single word vocabulary and their understanding of grammatical morphemes (see Table 1). Language assessments were conducted in English, the dominant language for all. Participant age-equivalent scores for single word receptive vocabulary were much lower than for chronological age, and performance in relation to comprehension of grammatical morphemes was extremely limited for

three out of four of the participants. In typical language development, children with equivalent single-word receptive vocabulary scores would be expected to be using full sentences. Yet, school records (e.g., Individualized Education Program) reported that the participants communicated mostly through device-generated single word utterances consisting mostly of nouns, via unaided means of communication (e.g., facial expressions, vocalizations, looking behaviors, and pointing). Maddie and Anna were reported to experience some developmental delays yet there was no formal measure of intellectual functioning in their IEPs, and their parents declined requests for permission to assess cognition. The participants attended mainstream high schools and were members of classrooms designed for students with physical and speech impairments who used AAC, where English was the only language of instruction. All participants used their own SGDs during the study.

Procedures

Setting. Language assessment and experimental sessions were carried out at the participants' schools in a quiet room (e.g., therapy room or empty classroom). Baseline and intervention sessions were conducted by four graduate student clinicians (all female) who were pursuing a master degree in speech and language pathology with a concentration in AAC. Each participant worked with a single clinician. All clinicians had considerable experience working with children who used some form of AAC prior to entering their degree program, as either instructional assistants, behavior specialists, or private care provider/tutors. As part of their graduate training, all had completed two graduate courses in AAC, two campus clinics, and a school-based practicum in AAC. Throughout their coursework and field-based experience, the clinicians had received extensive information regarding general conversation techniques designed to foster vocabulary development in children and youth who use aided AAC. They had

learned to (a) allow their clients to lead the topics of conversation, (b) provide adequate time, (c) display active listening, (d) encourage turn taking, (f) introduce novel vocabulary naturalistically through expansions and vocabulary recasting, (g) use prompts to elicit and support their client's reformulation of grammatically incomplete utterances, and (h) avoid being overly didactic within a conversation. The student clinicians did not receive extra academic credit for their participation in the research study.

Baseline assessment. Baseline sessions were carried out prior to clinicians' intervention training, and were designed to establish a profile of the participants' expressive language skills during natural conversational interaction. Each clinician had a 40- to 50-min conversation with a participant about a topic relevant to the participant's life (e.g., family, school, friends and community). Before each session, the clinician reviewed a procedural checklist that included baseline steps and strategies to facilitate the conversation. They were permitted to use active listening techniques and other strategies to support the progression of the conversation, such as open-ended questions (e.g., "What do you like best about xx?"), contingent queries (e.g., "What about xx?"), verbal encouragement (e.g., "Can you tell me more about xx?"), and expectant waiting; however, during baseline, clinicians did not use any corrective feedback or any type of prompt to shape the participants' utterances. Four baseline sessions were carried out to establish the stability/variability of the participants' language use in conversation. Limits for acceptable baseline variability were calculated by dividing the mean frequency of each target language measure (e.g., mean number of pronouns used across four data points) by 2. The resulting figure was then added to and subtracted from the mean for that language target in baseline. A baseline was considered stable if, during the final three baseline probes, the frequency of the target measure (e.g., pronoun use) fell within this range ($M/2$ + or - M) (Gast & Ledford, 2010).

Peer conversation generalization probes. Generalization probes were conducted for each participant on at least one occasion before intervention and following every sixth intervention session (Schlosser & Lee, 2000). Each generalization probe consisted of a single conversation between each participant and a peer. The peers were schoolmates who used natural speech and did not have intellectual disabilities who volunteered to participate in the study as conversation partners, as part of either a reverse mainstreaming period (i.e., when typical peers are brought into special education classrooms) or an extra-curricular service-learning club that supported social interaction between students with disabilities and peers without disabilities. They did not receive extra credit or any monetary incentive for their participation in the study. Prior to their involvement in the study, the peer partners had engaged with students with disabilities in general, but not with the study participants, and not in conversations involving AAC. Neither the participants nor their peers received any guidance on what to talk about or how to manage the conversation. Peers were also blind to the purpose and the procedures of the intervention. The conversations commonly ran for 30-40 min and often included topics such as school and social activities, other students in the class, and commonly shared interests (e.g., pets, singers, TV programs and so on).

Training of clinicians. Following completion of the baseline phase and before the intervention began, the student clinicians underwent training on the specific intervention procedures. The training was delivered by the first author in a 4-hr group session, 2 hr of which centered on direct instruction on general conversational techniques already familiar to the clinicians and designed to elicit language production in users of SGDs (e.g., allowing enough wait time, following the child's lead, using contingent questions and comments to stimulate the conversation, using active listening strategies). A further 2 hr were dedicated to the specific

scaffolding strategies to be delivered during intervention. Clinicians received instruction on how to introduce missing novel vocabulary in conversation through expansions and reformulations of the participants' grammatically incomplete or incorrect utterances, and how to use verbal and gestural prompts to encourage the participants to repair their utterances. Clinicians were also instructed to use open-ended questions to continue the flow of the conversation (e.g., "Can you tell me more about that?" and "Why do you think that?"). The clinicians were informed that in order to be effective, these strategies needed to be used intensively and frequently during the intervention sessions, at a minimum rate of at least 10 exchanges that included question, recast, and prompts for repair. Clinicians viewed videos of the specific techniques being used with other clients, and practiced these techniques with each other. At the training they received copies of a procedural checklist that included step-by-step instructions on session intervention procedures, and they used this checklist to remind themselves of the procedures before each intervention session, and to self-rate their adherence to use of these techniques (see also Gillam, Hartzheim, Studenka, Simonsmeier, & Gillam, 2015).

Finally, the clinicians received a checklist of approximately 300 core vocabulary words including pronouns, copulas, frequently occurring verbs and verb inflections, prepositions and other words that are essential to the formation of grammatically correct sentences (Boenisch & Soto, 2015). The list also highlighted words that their client had not used during baseline sessions, and served as a reminder for words to target during intervention phase. The clinicians were not told the specific targets to introduce at each session, but to introduce novel vocabulary naturalistically, in the context of the conversation by recasting the participants' single word or incomplete utterances into more complex ones. They were also told to target a minimum of five verbs and pronouns and two bound morphemes per session from the list of words that had not

been observed at baseline, and to use the word checklist to keep track of the targets during the session.

Intervention. Each intervention session consisted of a conversation between the clinician and the participant while they constructed a personal collage. Personal collage building is a well-established technique for facilitating conversation with adolescents, both with and without disabilities (e.g., Cowley, 2013; Wickenden, 2011a) and was a critical component of the intervention. The format gives the adolescent a motivating opportunity to talk about his or her life, home, community and school, and provides a visual representation of what is important in their life, as identified by the young person.

At the beginning of each session, the participant and the clinician jointly reviewed teen magazines, websites, personal photographs, and other artifacts (e.g., concert tickets, wedding invitations). Once the participant selected an item to be posted on her personal collage, the clinician asked the participant to describe why she had selected that image or artifact. Following the response, the clinician used open-ended questions to elicit further information about the meaning of that particular item in the young person's life. Once the clinician had enough information about the participant's communicative intention, she used recasts to reformulate the participant's ungrammatical or incomplete utterances (Clarke, Soto, & Nelson, 2017), and used explicit instruction and verbal prompts to encourage the participant to formulate a grammatically correct version of her original utterance (i.e., to repair). When the participant was not able to find a vocabulary item on her device, the clinician added a gestural prompt (e.g., pointing to the target on the young person's device without activating it) to support navigation. The following excerpt illustrates a sequence of turns that was typical of intervention sessions:

Clinician: *What would you like to say about this photograph?*

Youth: "*Flowers*"

Clinician: *What about the flowers?* (question)

Youth: "*Girl"*

Clinician: *Oh, you were a flower girl*! (recast)

Youth: "*Yes"*

Clinician: *So that the message is a bit more clear, you can say it in a full sentence. Because it happened in the past you can say. I was a flower girl. Can you say, I was a flower girl?* (verbal prompt)

Youth: "*I was a flower girl."*

Clinician: *Good!!! Whose wedding was it?*

Youth: "*Sister"*

Clinician: *Remember we are making full sentences, ok? You can say, it was my sister's wedding. You can start with it was* (while pointing to *IT* and *WAS* on the SGD).

During each intervention session, each clinician used the sequence: question + recast + prompt for repair at least 10 times in the course of the conversation to bring about participants' repair of their AAC-mediated utterances. Given the relatively slow pace of AAC-mediated productions, clinicians were able to use the vocabulary and procedural checklists to keep track of the targets and the teaching episodes (question + recast + prompt) as the session progressed. Because many of the vocabulary targets were frequently used words (e.g., personal pronouns, copula, frequently used verbs), some of those words (e.g., I, my, was, go, went, like, get) were practiced across multiple sessions.

Intervention sessions were carried out twice a week and lasted between 40- and 50-min each, for up to 12 weeks (i.e., up to 24 sessions). This treatment intensity mimics a typical

dosage of intensive language-based intervention programs in the USA (cf. McGregor, 2000; Ruston & Schwanenflugel, 2010). Typically at each session, the participant chose a different item to add to the collage and discuss, although there were times when an item was discussed in more than one session.

Treatment Fidelity

The lead author monitored procedural integrity through observation of every fourth session. This included a comparison of clinicians' actions in relation to the procedural checklists. A threshold of 90% compliance was set. On nine occasions, this threshold was not met, and for those sessions the clinicians were provided with written feedback highlighting deviation from procedures. When written feedback failed to improve procedural integrity, the lead author and clinician met to review the video recording of the relevant session. Two clinicians met with the first author once, and one met twice. To ensure treatment fidelity, two observers independently assessed 20% of randomly selected video recordings of baseline and intervention sessions per participant, and rated clinicians' performance against the procedural checklist. Clinician compliance with session procedures ranged from 86%-100%. Cohen's Kappa was calculated to determine the level agreement between observers, K= 0.96 (p <05). A kappa over 0.75 indicates an excellent level of agreement (Fleiss, 1981).

Transcription and Coding

Video recordings of all baseline, intervention sessions and generalization probes were transcribed in full by research assistants trained in transcription of multimodal AAC-mediated interactions and conventions of the Systematic Analysis of Language Transcripts (SALT) program™ (Miller & Iglesias, 2012). These research assistants were blind to the motivation and procedures for the study, and the phases of interaction they were asked to transcribe. Only

participants' device-generated utterances were included in the transcriptions. Pre-recorded utterances, and clearly unintentional repetitions and errors in SGD use were not included (see Savaldi-Harussi & Soto, 2016).

Dependent measures. The dependent variables were productions of verbs, pronouns, bound morphemes, and spontaneous clauses. These represent a variety of linguistic structures that are essential to the formation of grammatically correct sentences, and they increase in use as language develops (see Manhardt & Rescorla, 2002; Scott & Stokes, 1995; Thordardottir, Chapman, & Wagner, 2002). The total number of prompted and unprompted verbs, pronouns, and bound morphemes used by each participant per session was calculated using SALT. The number of spontaneous clauses was calculated by hand by the research assistants who created the transcriptions. A spontaneous clause was operationalized as a simple sentence containing a subject, verb, and predicate that could function in isolation and was generated by the participants autonomously. Spontaneous clauses were responses to questions, initiations (i.e., not as a response to a clinician's prior turn), or contingent comments that did not follow a clinician's recast or direct prompt. Because session times varied slightly between participants and across phases, we calculated the rate of use of verbs, pronouns, bound morphemes, and spontaneous clauses per 60 min (Gast, 2010) as our dependent measures.

Reliability. Reliability of transcription was evaluated by an additional research assistant who viewed and independently transcribed 25% of randomly selected video recordings. Where differences were observed between the transcribers, these were resolved through discussion and shared viewing of the relevant episode of interaction until inter-transcriber consensus was reached for all discrepancies, and a single agreed transcript was analyzed with SALT (Kovacs & Hill, 2015). This research assistant also coded and counted the number of spontaneous clauses in

the sample of transcripts she transcribed. Inter-rater agreement for the number of spontaneous clauses was calculated by dividing the total number of agreements by the total number of agreements and disagreements. The percentage agreement was 98%.

Visual and statistical analysis. Data analysis involved both visual and statistical examination of participant performance in the baseline probes, intervention sessions, and generalization probes. Visual analysis was conducted by observing within and between-phase data patterns across six factors: (a) level, that is, mean scores for data within each phase; (b) trend across baseline and intervention phases, including stability of change; (c) variability within each phase; (d) overlap between baseline and intervention phases; (e) immediacy of effect; and (f) consistency of data patterns across phases and participants (see Gast, 2010; Kennedy, 2005).

To complement the visual analysis, the Tau-U (Parker, Vannest, Davis, & Sauber, 2011), and calculation of robust improvement rate difference (R-IRD; Parker, Vannest & Brown, 2009; Parker, Vannest & Davis, 2011) were used to estimate effect sizes in relation to performance in intervention. These non-parametric procedures are deemed highly suitable to AB designs, can produce confidence intervals, and have benchmarks against which the size of an intervention effect can be determined (Rakap, Snyder, & Pasia, 2014). The Tau-U quantifies the degree of non-overlap between phases, by examining pairwise comparisons of data points within and between baseline and intervention phases. Scores for Tau-U can range from 0 to 1.0, and benchmarks for the interpretation of intervention effect have been suggested as follows (Rakap, 2015): questionable <0.65, effective 0.66-0.92, very effective >0.92. An improvement rate difference is the difference between improvement rates (IRs) in baseline and intervention (Parker et al., 2009). To calculate an IR, the number of improved data points in a phase is divided by the total number of data points in that phase. In the baseline phase an improved data point is

identified when it is equal to or greater than any data point in intervention. Improved data points in intervention are those that exceed all data points in baseline. To derive R-IRD, the number of overlapping data points (minimum number of data points that need to be removed to avoid any overlap), are also included and split evenly between baseline and intervention phases (for worked example see Parker et al., 2011). The difference between the baseline IR and the intervention IR provides the R-IRD. IRD scores range between 0 and 1, and thresholds for interpreting IRD have been cautiously proposed as: questionable <0.5, moderate change 0.5-0.7, large change 0.7-0.75, and very large change >0.75 (Vannest & Ninci, 2015). An online calculator (www.singlecaseresearch.org) was used to obtain the Tau-U and R-IRD for each participant, for each dependent measure. Confidence intervals (set at 85%) were calculated using the two proportions test (with bootstrapping) with NCSS software (Parker et al., 2009). We note that caution is warranted in the interpretation of Tau-U and R-IRD figures where confidence intervals are wide. This may be a consequence of analysis based on a relatively small number of data points.

Results

The rate of production of linguistic targets at each probe across phases; as well as trend, variability, immediacy of effect, and consistency across dependent variables and participants, are shown in Figures 1-4. In these figures, baseline and intervention data are represented by black diamond markers, and generalization data by white squares. Levels of performance for each participant (i.e., mean rate of production of verbs, pronouns, bound morphemes, and spontaneous clauses) during baseline and intervention sessions are presented in Table 2. Table 3 includes levels of performance for each participant during generalization probes.

Insert Figures 1 to 4 and Tables 2 and 3 About Here

Tau-U and R-IRD data are presented in Table 4. Because the Tau-U and IRD measures align closely (see Table 4), and Tau-U benchmarks for evaluation of intervention effect are more conservative than those suggested for R-IRD, Tau-U only is presented to exemplify individual performance across the dependent variables. Tau-U and R-IRD data are not available for generalization due to the few data points available. Visual inspection of the figures and Table 2 suggests that the results are mixed and that there is no single dependent measure in which a clear functional relationship with intervention is evident across all four participants. What follows is a brief summary of changes in levels and overlap (Tau-U and visual inspection of overlap in the case of generalization data) for each participant.

Nadia. Figures 1-4 indicate that Nadia's use of all four linguistic targets increased during intervention as indicated by a positive change in performance across conditions. Tau-U indicates that the intervention was very effective in relation to changes in the use of verbs, pronouns and bound morphemes (Tau-U: verbs=0.95, pronouns=0.92, bound morphemes=0.85), and questionable in relation to Nadia's use of spontaneous clauses (Tau-U spontaneous clauses=0.6), although the Tau-U derived for use of spontaneous clauses was close to the threshold of 0.65, which suggests moderate change. The generalization data show considerable overlap for all linguistic targets between pre-intervention probes and probes carried out during the intervention phase, and no clear evidence of improving trend.

Maddie. Figures 1-4 show an increase in the use of verbs, pronouns, and spontaneous clauses during intervention, with Tau-U scores indicating that the intervention was very effective (Tau-U: verbs=0.95, pronouns=1.0, spontaneous clauses=1.0). The intervention did not bring about a marked change in the use of bound morphemes (Tau-U: bound morphemes=0.26). Maddie's production of all target measures during generalization probes was very low and

inconsistent, as indicated by low levels of performance and high degrees of overlap across all dependent variables.

Jenna. Jenna's production of spontaneous clauses increased in level between baseline and intervention as illustrated in Figures 1-4, with Tau-U scores indicating that the intervention was very effective in relation to this linguistic target (Tau-U=1.0). Tau-U scores for use of verbs and pronouns fell slightly below the threshold of 0.66, which is indicative of an effective intervention (Tau-U: verbs=0.61; pronouns=0.57). The intervention did not appear to be effective in supporting Jenna's use of bound morphemes (Tau-U: bound morphemes=0.33). Jenna's production of the target measures during generalization probes shows much overlap between those probes conducted prior to intervention and those carried out during intervention.

Anna. Visual analysis of Figures 1-4 indicates that Anna's level of production of all dependent measures was low during baseline, but during intervention, increases were observed in her use of verbs and bound morphemes but less so for pronouns and spontaneous clauses. Tau-U measures confirm that the intervention was effective in developing her use of verbs (Tau-U=0.75) and bound morphemes (Tau-U=0.83) but questionable in relation to pronouns (Tau-U=0.21) and spontaneous clauses (Tau-U=0.5). Anna participated in only two generalization probes, one prior to and one during intervention. Her production of linguistic targets was higher during the second probe.

Discussion

This study was designed to explore the use of a conversation-based intervention to improve the formation of grammatically complete utterances in adolescents who use AAC. While there is no specific linguistic target that shows consistent change across all the participants, all four increased their use of at least one linguistic target during intervention

sessions, three participants increased their use of verbs and spontaneous clauses, two increased their use of personal pronouns, and one produced more bound morphemes during intervention than in baseline. Overall, participants increased their use of some linguistic targets in generalization probes after the intervention had started; however, a functional relationship between the intervention and generalization cannot be fully established from the current data, due primarily to the low number of generalization probes and the overlap in performance between phases.

Differences between participants' performance during intervention and generalization sessions may be attributed to a number of individual and SGD-related factors, including differences in participants' language competence prior to intervention and language organization and navigation demands. For example, participants with greater language comprehension scores made the greatest gains during intervention. Receptive language ability in this group may be indicative of more general language and cognitive skills that support retention of the modeled targets across sessions and the creation of new internal hypotheses about how language is constructed (Clarke et al., 2017). It is possible, also, that the naturalistic, conversation-based nature of the intervention allowed each participant to orient to features of adult input that were developmentally appropriate for them, ignoring or filtering out those aspects that were developmentally less salient. Variation in adolescents' expressive language capabilities, which is linked to differences in vocabulary organization and access demands, may have influenced the frequency with which they received corrective feedback. The dialogic nature of this intervention implied that participants who produced more language per session may have received more corrective feedback than those who produced fewer utterances. This may have influenced the total number of models received, the total number of opportunities for utterance reformulation,

and the total number of opportunities for spontaneous use.

The findings from the current study are consistent with previous research that shows that recasting delivered in the context of naturally occurring conversations can be an effective language facilitation strategy for both typical and atypical populations (e.g., Baker & Nelson, 1984; Camarata, Nelson, & Camarata, 1994; Nelson et.al, 1996). As in Soto and Clarke (2017), the current intervention combined enhanced adult input in the form of recasts, with an expectation for participants to reformulate limited or erroneous utterances using their SGDs. Prior research indicates that users of AAC benefit from interventions that include an expectation for output (Romski et al., 2010). Arguably, if people who use AAC do not routinely perform the physical operations required for producing SGD- mediated spoken output, they risk failing to develop familiarity with the vocabulary organization of their device, and may not fully develop the motor plan to accelerate, and ultimately automatize, language retrieval and thus expressive language output (Soto & Clarke, 2017; Clarke et al., 2017).

Limitations and Future Directions

The outcomes of this study should be interpreted with respect to its mixed findings and limitations. The intervention included multiple elements that converged to support learning, including developmentally appropriate and yet challenging linguistic targets, emotional attunement between clinician and client, client's developmental readiness, use of a personally meaningful and motivating activity (i.e., personal collage), clinician's provision of linguistic contrast through recasting, and the provision of explicit prompts for participants' reformulation of original utterances. Further research is required to assess the relative effectiveness of each of these factors.

The dependent measures in this study combined total counts of prompted and unprompted targets. Future studies should differentiate between participants' spontaneous use of targets from those that follow prompts, allowing for exploration of relations between class of prompt (e.g., type of recast), participant reformulation, and spontaneous use over time. Likewise, future studies could incorporate dynamic assessment procedures within conversation-based interventions to determine the most appropriate linguistic targets for a given learner. Dynamic assessment has been used successfully by Binger and colleagues to establish targets for structured language intervention with children who use aided AAC (e.g., Binger, Kent-Walsh, & King, 2017; Binger, Kent-Walsh, King, & Mansfield, 2017).

The peers that participated in the generalization probes were not familiar with the participants and had not been trained in communicating with people who use AAC. While it could be argued that the use of untrained peers provides a more robust and socially valid context for generalization, further research is needed to examine whether concurrent peer training would result in greater increases in the participants' production of linguistic targets. Recent studies indicate that peer training can result in substantial increases in communication opportunities and social interaction (Biggs et al., 2017).

With the current design, it is possible that increases in participant output may have been attributed to increased familiarity with the clinician after the fourth baseline session. While the immediacy of effect and consistency of data patterns across phases and participants adds to the internal validity of this research and minimizes this possibility, further research controlling for this variable is needed. Additionally, the current study did not include an analysis of maintenance following completion of intervention. Future studies should include maintenance evaluation to establish the long-term effectiveness of the intervention.

While there was a high level of implementation fidelity, it is possible that the mixed findings reflect an uneven level of support required by the clinicians after receiving training. While most clinicians needed minimal support to sustain implementation fidelity during intervention, one clinician needed two additional follow up sessions. Future research studies should ensure that clinicians are trained to criterion prior to intervention.

Finally, although high levels of inter-rater reliability for treatment fidelity were obtained, the raters were not masked to the phases they were observing, which could have affected their rating. Future studies should include raters that are blinded to both the purposes of the study and to the type of session they are observing.

Conclusion

In closing, the results of this study indicate that the use of conversation-based interventions, which are personally meaningful, interactive, and carry with them an expectation for comprehensible output, can lead to the acquisition of certain linguistic forms by adolescents who use SGDs. Adolescents are in a dynamic state of change, and therefore it is still possible to influence positively their course of development and to improve their ability to use language more effectively (Nipold, 2016).

References

Baker, N. D., & Nelson, K. E. (1984). Recasting and related conversational techniques for triggering syntactic advances by young children. *First Language, 5*, 3-21.

Biggs, E. E., Carter, E. W., & Gustafson, J. (2017). Efficacy of peer support arrangements to increase peer interaction and AAC use. *American Journal on Intellectual and Developmental Disabilities, 122,* 25-48.

Binger, C., & Light, J. (2008). The morphology and syntax of individuals who use AAC: Research review and implications for effective practice. *Augmentative and Alternative Communication, 24,* 123-138.

Binger, C., Kent-Walsh, J., & King, M. (2017). Dynamic assessment for 3-and 4-year-old children who use augmentative and alternative communication: Evaluating expressive syntax. *Journal of Speech, Language, and Hearing Research, 60,* 1946-1958.

Binger, C., Kent-Walsh, J., King, M., & Mansfield, L. (2017). Early sentence productions of 3- and 4-year-old children who use augmentative and alternative communication. *Journal of Speech, Language, and Hearing Research, 60,* 1930-1945.

Binger, C., Kent-Walsh, J., King, M., Webb, E., & Buenviaje, E. (2017). Early sentence productions of 5-year-old children who use augmentative and alternative communication. *Communication Disorders Quarterly, 38*(3), 131-142.

Binger, C., Maguire-Marshall, M., & Kent-Walsh, J. (2011). Using aided AAC models, recasts, and contrastive targets to teach grammatical morphemes to children who use AAC. *Journal of Speech, Language, and Hearing Research, 54*(1), 160-176.

Boenisch, J., & Soto, G. (2015). The oral core vocabulary of typically developing English-speaking school-aged children: Implications for AAC practice. *Augmentative and Alternative Communication*, *31*(1), 77-84.

Camarata, S. M., Nelson, K. E., & Camarata, M. N. (1994). Comparison of conversational-recasting and imitative procedures for training grammatical structures in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *37*, 1414-1423.

Chung, Y. C., Carter, E. W., & Sisco, L. G. (2012). Social interactions of students with disabilities who use augmentative and alternative communication in inclusive classrooms. *American Journal on Intellectual and Developmental Disabilities*, *117*, 349-367.

Clarke, M. T., Soto, G., & Nelson, K. (2017). Language learning, recasts, and interaction involving AAC: Background and potential for intervention. *Augmentative and Alternative Communication*, *33*, 42-50.

Cowley, D. M. (2013). *" Being grown": How adolescent girls with disabilities narrate self-determination and transitions* (Doctoral dissertation, Syracuse University).

Dowden, P. (1997). Augmentative and alternative communication decision making for children with severely unintelligible speech. *Augmentative and Alternative Communication*, *13*, 48-59.

Dunn, L.M., & Dunn, D.M. (2007). *PPVT-4: Peabody picture vocabulary test*. Minneapolis, MN: Pearson Tests.

Eisenberg, S. L. (2013). Grammar intervention: Content and procedures for facilitating children's language development. *Topics in Language Disorders*, *33*(2), 165-178.

Eisenberg, S. (2014). What works in therapy: Further thoughts on improving clinical practice for children with language disorders. *Language, Speech, and Hearing Services in Schools*, *45*(2), 117-126.

Fleiss, J. L. (1981). Balanced incomplete block designs for inter-rater reliability studies. *Applied Psychological Measurement, 5*, 105-112.

Gast, D. L. (Ed.). (2010). Single subject research methodology in behavioral sciences (pp. 129-165). New York: Routledge.

Gast, D.L., & Ledford, J. (2010). Multiple baseline and multiple probe designs. In D. L. Gast (Ed.), *Single subject research methodology in behavioral sciences* (pp. 129-165). New York: Routledge.

Gillam, S. L., Hartzheim, D., Studenka, B., Simonsmeier, V., & Gillam, R. (2015). Narrative intervention for children with autism spectrum disorder (ASD). *Journal of Speech, Language, and Hearing Research, 58*, 920-933.

Hammill, D.D., & Newcomer, P.L. (2008). *TOLD-I:4. Test of Language Development-Intermediate: 4th Edition*. Austin, TX: Pro-Ed.

Holyfield, C., Drager, K.D.R., Kremkow, J.M.D., & Light, J. (2017). Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder. *Augmentative and Alternative Communication*, 33, 201-212. https://doi.org/10.1080/07434618.2017.1370495

Kennedy, C. H. (2005). *Single-case designs for educational research*. Prentice Hall.

Kent-Walsh, J., Murza, K. A., Malani, M. D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. *Augmentative and Alternative Communication*, *31*(4), 271-284.

Kovach, T. M. (2009). *Augmentative & alternative communication profile: A continuum of learning*. East Moline, IL: Linguisystems.

Kovacs, T., & Hill, K. (2015). A tutorial on reliability testing in AAC language sample transcription and analysis. *Augmentative and Alternative Communication, 31*, 148-158.

Lilienfeld, M., & Alant, E. (2005). The social interaction of an adolescent who uses AAC: The evaluation of a peer-training program. *Augmentative and Alternative Communication, 21*, 278-294.

Manhardt, J., & Rescorla, L. (2002). Oral narrative skills of late talkers at ages 8 and 9. *Applied Psycholinguistics, 23*, 1-21.

McGregor, K. K. (2000). The development and enhancement of narrative skills in a preschool classroom: Towards a solution to clinician-client mismatch. *American Journal of Speech-Language Pathology, 9*, 55-71.

McNaughton, D., & Bryen, D. N. (2007). AAC technologies to enhance participation and access to meaningful societal roles for adolescents and adults with developmental disabilities who require AAC. *Augmentative and Alternative Communication, 23*, 217-229.

Miller, J., & Iglesias, A. (2012). Systematic analysis of language transcripts (SALT ™), Research version 2012 [Computer Software]. Middleton, WI: SALT Software, LLC.

Nelson, K. E., Camarata, S. M., Welsh, J., Butkovsky, L., & Camarata, M. (1996). Effects of imitative and conversational recasting treatment on the acquisition of grammar in children with specific language impairment and younger language-normal children. *Journal of Speech, Language, and Hearing Research, 39*, 850-859.

Nippold, M. A. (2007). *Later language development: School-age children, adolescents, and young adults*. Austin, TX: Pro-ed.

Nippold, M. A., Frantz-Kaspar, M. W., Cramond, P. M., Kirk, C., Hayward-Mayhew, C. & MacKinnon, M. (2014). Conversational and narrative speaking in adolescents: Examining the use of complex syntax. *Journal of Speech, Language, and Hearing Research, 57*, 876-886.

Parker, R., Vannest, K. & Davis, L. (2011) Effect size in single-case research: A review of nine nonoverlap techniques. *Behaviour Modification*, *35*, 303 – 322

Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011). Combining nonoverlap and trend for single-case research: Tau-U. *Behavior Therapy, 42*(2), 284-299.

Parker, R. I., Vannest, K. J., & Brown, L. (2009). The improvement rate difference for single-case research. *Exceptional Children, 75*, 135-150

Paul, R., & Norbury, C. (2012). *Language disorders from infancy through adolescence: Listening, speaking, reading, writing, and communicating*. Philadelphia, PA: Elsevier Health Sciences.

Raffaelli, M., & Duckett, E. (1989). "We were just talking...": Conversations in early adolescence. *Journal of Youth and Adolescence, 18*, 567-582.

Rakap, S. (2015). Effect sizes as result interpretation aids in single- subject experimental research: description and application of four nonoverlap methods. *British Journal of Special Education*, *42*, 11-33.

Rakap, S., Snyder, P., & Pasia, C. (2014). Comparison of nonoverlap methods for identifying treatment effect in single-subject experimental research. *Behavioral Disorders*, 39, 128-145.

Raghavendra, P., Olsson, C., Sampson, J., Mcinerney, R., & Connell, T. (2012). School participation and social networks of children with complex communication needs, physical disabilities, and typically developing peers. *Augmentative and Alternative Communication, 28,* 33-43.

Romski, M., Sevcik, R., Adamson, L., Cheslock, M., Smith, A., Barker, R., & Bakeman, R. (2010). Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. *Journal of Speech, Language, and Hearing Research,* 53, 350-364.

Ruston, H. P., & Schwanenflugel, P. J. (2010). Effects of a conversation intervention on the expressive vocabulary development of prekindergarten children. *Language, speech, and hearing services in schools, 41*, 303-313.

Savaldi-Harussi, G., & Soto, G. (2016). Using SALT: Considerations for the analysis of language transcripts of children who use SGDs. *Perspectives of the ASHA Special Interest Groups, Volume 1* (SIG 12), 110-124.

Scherer, N. J., & Olswang, L. B. (1989). Using structured discourse as a language intervention technique with autistic children. *Journal of Speech and Hearing Disorders*, *54*(3), 383-394.

Schlosser, R., & Lee, D. (2000). Promoting generalization and maintenance in augmentative and alternative communication: A meta-analysis of 20 years of effectiveness research. *Augmentative and alternative communication*, *16*, 208-226.

Scott, C. M., & Stokes, S. L. (1995). Measures of syntax in school-age children and adolescents. *Language, Speech, and Hearing Services in Schools*, *26*, 309-319.

Smith, M. (2005). The dual challenges of aided communication and adolescence. *Augmentative and Alternative Communication, 21,* 67-69.

Soto, G., & Clarke, M. (2017). Effects of a conversation-based intervention on the linguistic skills of children with motor speech disorders who use augmentative and alternative communication. *Journal of Speech, Language, and Hearing Research, 60,* 1980-1998.

Soto, G., & Hartmann, E. (2006). Analysis of narratives produced by four children who use augmentative and alternative communication. *Journal of Communication Disorders, 39,* 456-480.

Stiegler, L. N., & Hoffman, P. R. (2001). Discourse-based intervention for word finding in children. *Journal of Communication Disorders, 34*(4), 277-303.

Sutton, A., Soto, G., & Blockberger, S. (2002). Grammatical issues in graphic symbol communication. *Augmentative and Alternative Communication, 18,* 192-204.

Therrien, M. C., Light, J., & Pope, L. (2016). Systematic review of the effects of interventions to promote peer interactions for children who use aided AAC. *Augmentative and Alternative Communication, 32,* 81-93.

Thordardottir, T., Chapman, R. S., & Wagner, L. (2002). Complex sentence production by adolescents with Down syndrome. *Applied psycholinguistics, 23,* 163.

Turkstra, L., Ciccia, A., & Seaton, C. (2003). Interactive behaviors in adolescent conversation dyads. *Language, Speech, and Hearing Services in Schools, 34,* 117-127.

Vannest, K. J., & Ninci, J. (2015). Evaluating intervention effects in single- case research designs. *Journal of Counseling & Development, 93,* 403-411.

Wickenden, M. (2011a). Talking to teenagers: Using anthropological methods to explore identity and the life-worlds of young people who use AAC. *Communication Disorders Quarterly, 32*, 151-163.

Wickenden, M. (2011b). Whose voice is that?: Issues of identity, voice and representation arising in an ethnographic study of the lives of disabled teenagers who use augmentative and alternative communication (AAC). *Disability Studies Quarterly, 31,* 1-19.

Wickenden, M. (2011c). Talk to me as a teenager: Experiences of friendship for disabled teenagers who have little or no speech. *Childhoods Today, 5*, 1-35.

Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., ... & Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of Autism and Developmental Disorders*, *45*(7), 1951-1966.

Endnotes

[1] A person using AAC at Level III (a) purposefully selects targeted symbols with few prompts (operational), (b) is beginning to engage in dialogue and combines words to create simple phrases (linguistic), (c) is using AAC for social interaction purposes such as making comments and greeting friends, (d) is familiar with and can retrieve vocabulary and messages on the AAC device to communicate more effectively, and (e) may use telegraphic messages but understands the importance of selecting correct vocabulary to be an effective communicator and is actively learning vocabulary (strategic).

[2]iPad is a registered trademark of Apple Inc., Cupertino, CA. www.apple.com

[3] LAMP Words For Life and Unity are products of Semantic Compaction Systems, Inc.

[4] Vantage Lite is a registered trademark by Prentke Romich Corporation. https://www.prentrom.com

[5] Nova Chat is a registered trademark of Saltillo Corporation.

Table 1

Participants' Demographic Characteristics

Participants	Age	Speech Disorder	Mobility	Speech Generating Device	SGD Access	Languages Spoken at Home	Receptive Vocabulary Age Equivalent	Operational Competence-AAC Profile	Morphological Comprehension Percentile[c]	Speech Intelligibility Rating
Nadia	14:2	Dysarthria secondary to spastic cerebral palsy	Wheelchair user	iPad with LAMP Words for Life app	Finger pointing	English	7:3[a]	Level 3	87	0% (non-verbal)
Maddie	18:2	Dysarthria secondary to spastic cerebral palsy	Wheelchair user	Vantage Lite with Unity	Finger pointing	English	4:11[a]	Level 3	<12	0% (non-verbal)
Jenna	15:1	Dysarthria secondary to spastic cerebral palsy	Wheelchair user	Vantage Lite with Unity	Finger pointing	English Spanish	4:8 [b]	Level 3	<12	0% (non-verbal)
Anna	15:8	Dysarthria secondary to ataxic cerebral palsy	Ambulatory	Nova Chat app	Finger pointing	English	4:3 [b]	Level 3	<12	0% (non verbal)

Note. [a]Peabody Picture Vocabulary Test-4 (Dunn & Dunn, 2007). [b]Receptive One-Word Picture Vocabulary Test (Martin & Brownell, 2010).
[c]Test of Language Development-Intermediate: Fourth Edition (Hammil & Newcomer, 2008)

Table 2

Results for Baseline and Intervention Sessions

Participant	Number of sessions		Mean rate of verb use		Mean rate of pronoun use		Mean rate of bound morpheme use		Mean rate of spontaneous clause use	
	Base	Inter	Base	Inter	Base	Inter	Base	Inter	Base	Inter
Nadia	4	19	18	61	19	60	4	19	9	20
Maddie	4	20	4	17	2	16	0.5	1	0	7
Jenna	4	14	23	36	17	29	12	10	2	11
Anna	4	6	8	19	2	5	0	6	4	6

Note. Base= Baseline; Inter = Intervention

Table 3

Results for Pre-Intervention and During Intervention Generalization Probes

	Number of sessions		Mean rate of verb use		Mean rate of pronoun use		Mean rate of bound morpheme use		Mean rate of spontaneous clause use	
Participant	Pre	During	Pre	During	Pre	During	Pre	During	Pre	During
Nadia	1	3	25	45	14	39	16	16	17	12
Maddie	1	3	14	9	10	9	1	3	0	5
Jenna	1	2	14	19	10	16	3	9	4	8
Anna	1	1	1	60	1	16	0	34	0	18

Note: Pre= Pre-intervention; During= During intervention

Table 4

Tau-U and R-IRD

Participants	Dependent measure	Tau-U[a]	*P*	CI (85%)	R-IRD [b]	CI (85%)
Nadia	Verbs	0.95	0.004	0.48<>1.0	0.94	0.88<>1.0
	Pronouns	0.92	0.005	0.45<>1.0	0.95	0.89<>1.0
	Bound morphemes	0.89	0.006	0.43<>1.0	0.84	0.95<>0.74
	Spontaneous clauses	0.60	0.06	0.14<>1.0	0.43	0.079<>0.79
Maddie	Verbs	0.95	0.0005	0.56<>1.0	0.75	0.5<>1.0
	Pronouns	1.0	0.002	0.54<>1.0	1.0	1.0<>1.0
	Bound morphemes	0.26	0.39	-0.19<>0.74	0.35	0.2<>0.5
	Spontaneous clauses	1.0	0.002	0.55<>1.0	1.0	1.0<>1.0
Jenna	Verbs	0.61	0.07	0.13<>1.0	0.64	0.43<>.086
	Pronouns	0.57	0.09	0.09<>1.0	0.61	0.29<>0.96
	Bound morphemes	0.33	0.92	0.041<>0.62	0.36	0.034<>0.75
	Spontaneous clauses	1.0	0.003	0.52<>1.0	1.0	1.0<>1.0
Anna	Verbs	0.75	0.06	0.19<>1.0	0.67	0.33<>1.0
	Pronouns	0.21	0.59	-0.36<>0.77	0.50	0.17<>0.83
	Bound morphemes	0.83	0.03	0.27<>1.0	0.83	0.67<>1.0
	Spontaneous clauses	0.50	0.20	-0.06<>1.0	0.58	0.17<>1.0

Note. [a] Benchmarks for interpretation of effectiveness: questionable <0.65; effective 0.66-0.92; very effective >0.92. [b] Benchmarks for interpretation of effectiveness: questionable <0.5; moderate change 0.5-0.7; large change 0.7-0.75; very large change >0.75

Figure 1. Rate of Verb use per 60 Minutes

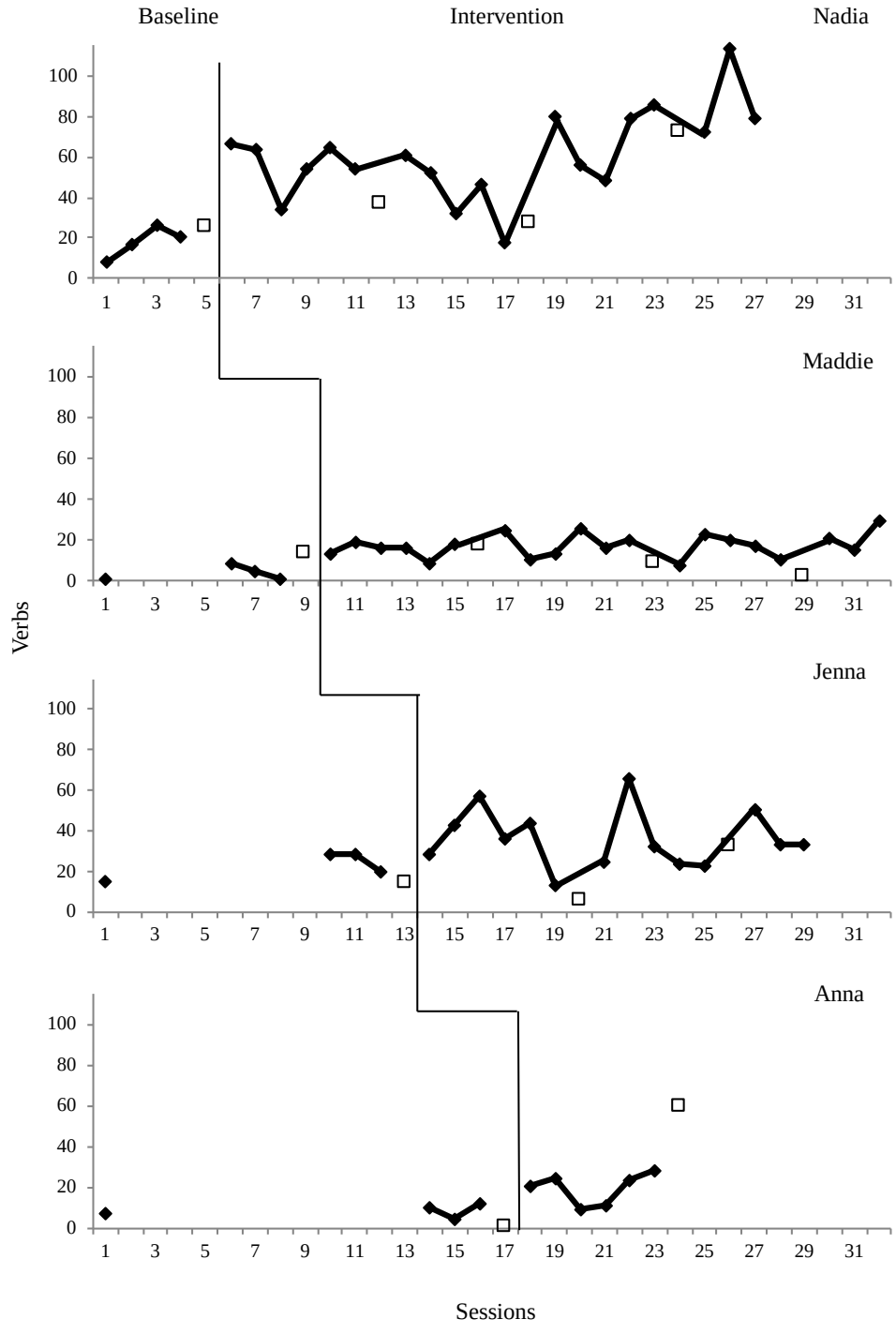

Figure 2. Rate of Pronoun use per 60 mins

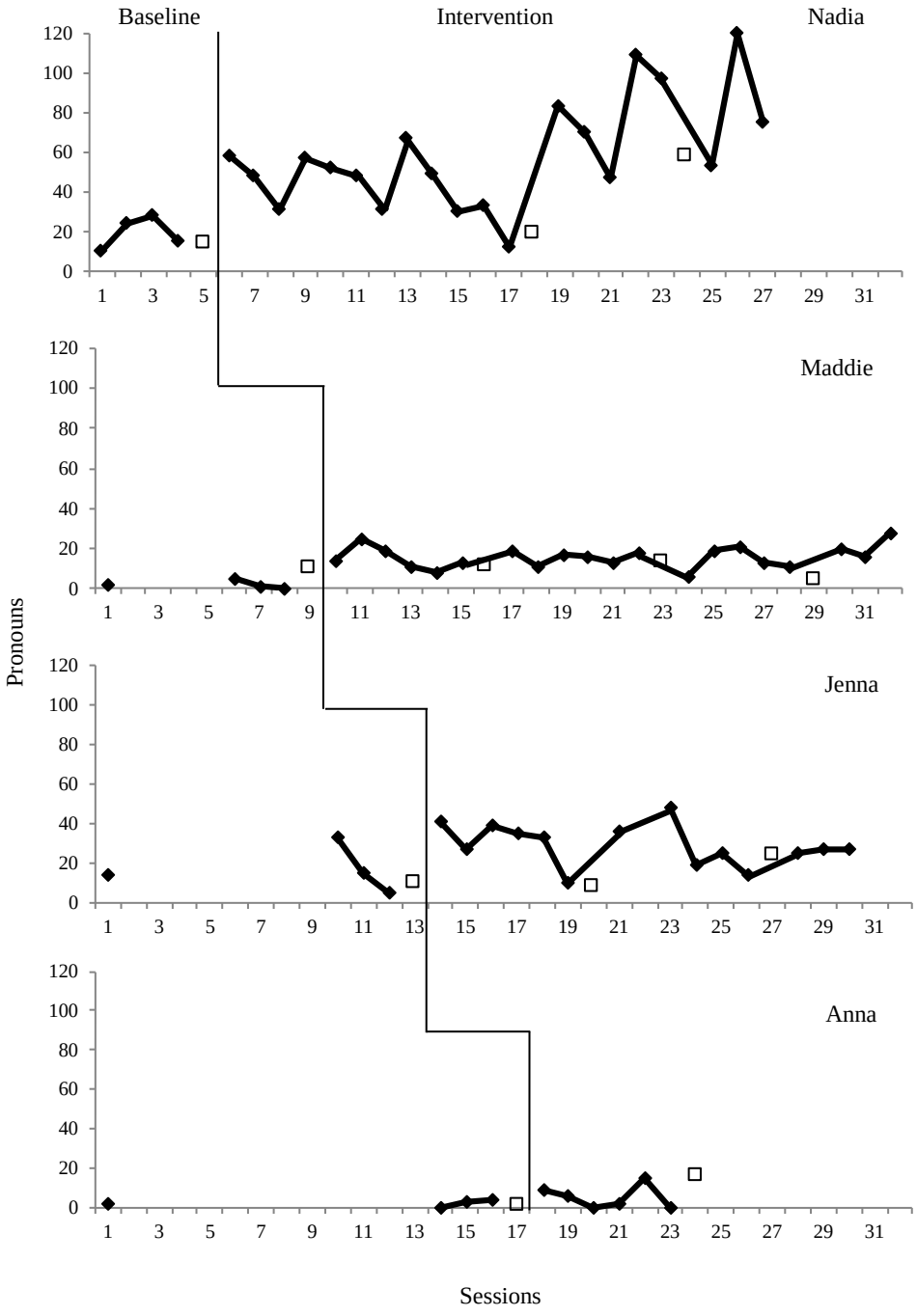

Figure 3. Rate of Use of Bound Morphemes per 60 mins

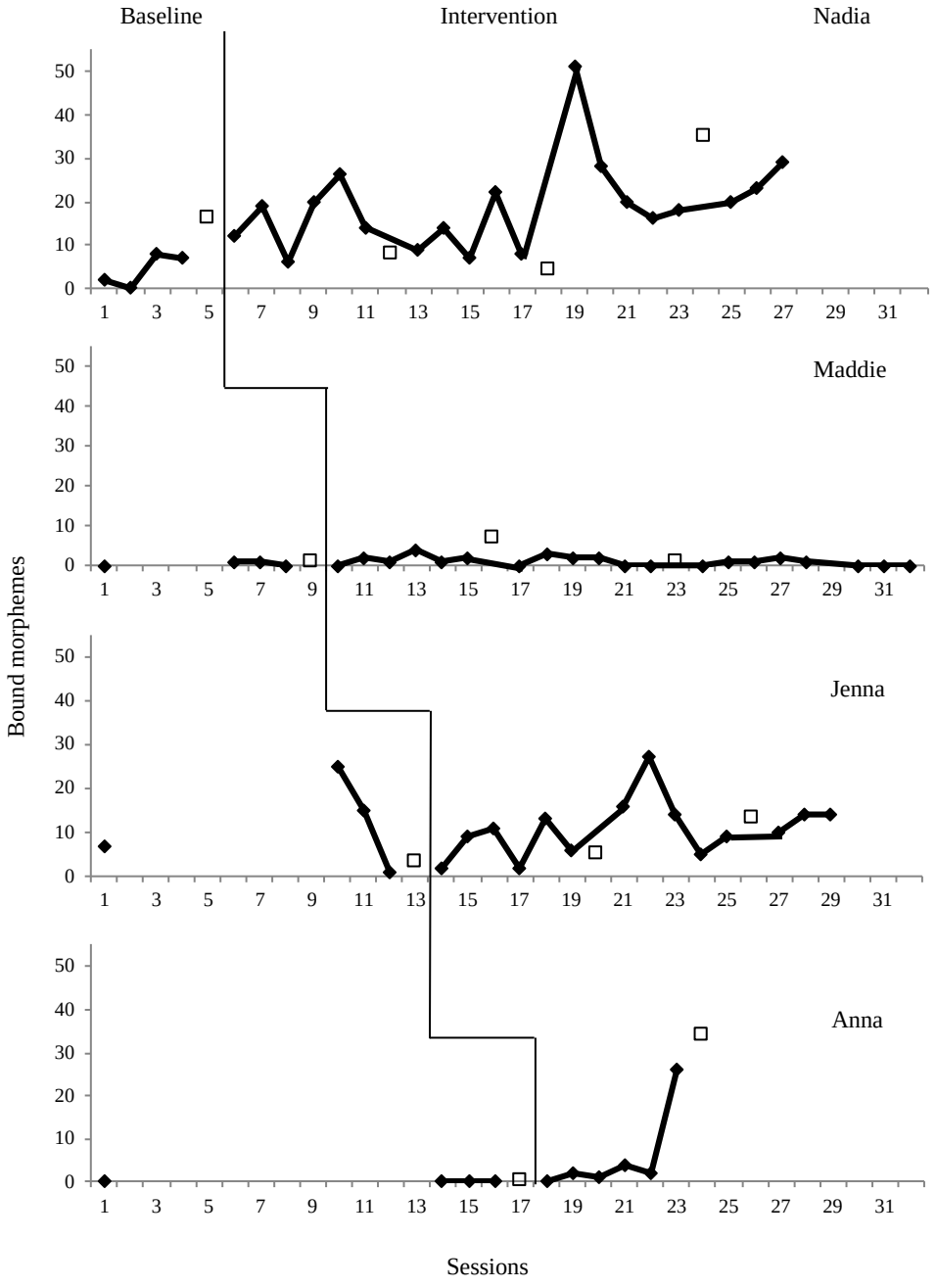

Figure 4. Rate of use of Spontaneous Clauses per 60 mins