Can conversation-based intervention using speech generating devices improve language

in children with partially intelligible speech?

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Abstract

Background: Children with partially intelligible speech and language difficulties are often provided with speech generating devices (SGDs) to support their spoken communication. However, little is known about how SGDs can be used best to facilitate language development.

Aims: This study evaluated the effects of a conversation-based intervention using SGDs, on the rate of expressive clause production in children with speech that is partially intelligible (SPI).

Methods and Procedures: A multiple probe across participants design was used to evaluate intervention with four children aged 8 to 10 years. Following baseline monitoring, the children received language focussed intervention involving adult recasting, SGD modelling and prompting to repair.

Outcomes and Results: All participants showed increases in their rate, complexity and length of clause use. Gains were sustained and generalised.

Conclusions: Intervention using conversation, recasting and SGD-modelling can increase clause production and grammaticality of children with SPI.

**Background**

Augmentative and alternative communication (AAC) is a term used to describe any mode of communication used to support and/or replace, natural speech such as the use of signing, communication books and electronic speech-generating devices (SGDs) (Griffiths, Price, Bloch & Clarke, 2018). The last decade has seen significant growth in the availability of specialist speech-generating software made available on mainstream mobile technologies such as tablet computers. Falling costs and growing recognition of SGD potential to support language development and communication has led to such SGDs being provided to children with an increasingly diverse range of neurodevelopmental disabilities (e.g., Ganz, 2015).

For children with minimal or no intelligible speech, and for whom use of gesture and signing is severely restricted by significant physical limitations, high dependence on the use of aided AAC systems, particularly SGDs provides clear theoretical and clinical rationale for intervention. For these children, SGD use supports linguistic development, and provides a bridge between language understanding and their capacity for expression (Griffiths, Price, Bloch & Clarke, 2018). SGDs are also provided to children with motor speech disorders who have speech that is partially intelligible (SPI), in the absence of severe whole-body physical impairment. This heterogenous group includes children with a range of conditions such as dysarthria, for example associated with Worster Drought Syndrome (WDS; Clark, Harris, Jolleff, Price & Neville, 2010), childhood apraxia of speech (CAS) (Murray, McCabe & Ballard, 2014), and developmental speech and language disorders related to genetic conditions (Newbury & Monaco, 2010). Such children commonly receive intervention focusing on speech intelligibility as a primary mode of communication in addition to the use of manual signs and gestures. For these

children, SGDs are typically used to provide an 'intelligible' alternative when speech is not understood, and where signs are unknown to the listener and gestures lack required linguistic sophistication (Binger, 2007; Murray, et al., 2014). However, the ways in which SGD provision can support language development for these children is less clearly defined. We propose that while the focus of SGD intervention support and use is on in-the-moment repair of unintelligible speech, child self-repair can also serve as an important language learning mechanism (Clarke, Soto & Nelson 2017), and there is strong potential for interventions to exploit the repair function of SGD use for enhancing language.

A key element of adult scaffolding of child language that offers naturally occurring opportunities for child repair of a prior utterance, and which is understood to be particularly effective in facilitating language acquisition, is the recasting of child utterances. In essence, recasts are adult turns that occur straight after the child's utterance and include features of the child's turn, including its basic meaning, while also correcting and/or expanding the turn (e.g. Baker & Nelson, 1984). Following an adult recast, the child may repair their prior utterance incorporating part or all of the adult recast. Such interventions reflect social-interactive theories of language development which propose that children learn language through conversational interaction with adults who, consciously or not, scaffold child language learning by aligning to, and responding 'in sync' with, the child's focus of language use and interaction (Clark, 2014).

A large body of intervention research has demonstrated the effectiveness of recasts in facilitating language acquisition in children developing typically and those with difficulties learning language (e.g., Camarata, Nelson, & Camarata, 1994). The use of recasts along with prompting for SGD use in child directed conversation have also proved positive in supporting enhanced language use by children and adolescents with little or no intelligible speech using

SGDs (Soto & Clarke 2017; 2018). For example, in a conversation-based intervention conducted by Soto and Clarke (2017) the participants chose from photographs of themselves in activities (e.g. trips or holidays) as the basis for a conversation with the interventionist. During these conversations, the children were exposed to adult recasts and explicit prompts to repair their prior turns, using their SGD. The children showed gains in grammaticalisation and use of clauses that were broadly maintained outside the intervention sessions. Soto & Clarke (2017) propose that the children using SGDs benefited from recasts delivered during motivating conversations, and from promoting of SGD use primarily because it assisted children to learn and retain the critical operational requirements (see also Clarke, Soto & Nelson, 2017).

Adult modelling of AAC use has also formed a critical element of interventions supporting language learning by children with complex needs (Sennott, Light & McNaughton, 2016; O'Niell, Light & Pope, 2018). For example, the impact of modelling as a primary element of intervention for children was examined by Sennott, Light and McNaughton (2016) in a systematic review of research between 1989 and 2013. Sennott et al. argue that during early childhood typically developing children are involved in rich language interactions with numerous speech models. In contrast, children who are learning to use AAC rarely see adults modelling the use of their AAC system. Sennott and colleagues identified that the modelling interventions led to consistently positive and meaningful improvements in language in areas of morphology, syntax, semantics and pragmatics. They concluded that using AAC models alongside techniques such as recasting, in naturalistic interactions, enabled children using AAC to improve receptive and expressive language.

In summary, research indicates that using recasts, prompting for child repair and modelling within motivating conversations can prove successful in facilitating language

development in children with severe speech and physical disabilities. Children with SPI are often supported to use SGDs to repair their unintelligible speech during conversation to enhance communicative intelligibility. Child self-repair can also be a powerful language learning mechanism. Therefore, the purpose of this study was to examine the effects of a conversation-based intervention involving SGDs, and using recasting, repair and modelling, on the expressive language of young children with speech that is partially intelligible (SPI).

## Method

### Participants

**Child Participants.** Four children (three boys and one girl) participated in the study. Table 1 gives information for language skills, speech intelligibility and characteristics, and communication modes for each participant. The children were assessed for receptive vocabulary and speech intelligibility by the first author, prior to commencement of the study, and evidence of receptive and expressive language abilities were taken from the children's Speech and Language Therapy records. All of the children attended the same school, where admission criteria included a Standard Score of 7 or above on non verbal subtests of standardised cognitive assessment batteries. The children in this study met the following criteria; they were: a) aged between 8;08 and 10;01 years; b) presented with a severe speech delay/disorder; c) presented with a severe receptive and expressive language delay/disorder ; d) had been provided with an SGD which had software allowing for marking of grammar; e) accessed their SGD directly, using touch-screen and/or keyboard; f) showed functional communicative competence at Levels II - III on the Augmentative and Alternative Communication Profile (Kovach, 2009); f) had English as their dominant language; and g) had hearing and vision within normal functional limits.

All of the children used manual signs and gestures in addition to their speech and SGD. Three children used speech as their primary means of communication, and one child used manual signs as the primary mode of expression, as reported by each child's class SLT. All children were ambulant and physically active. Pseudonyms have been used for all of the children.

*Aaron.* Aaron was diagnosed with Childhood Apraxia of Speech (CAS) and severe dysarthria of unknown etiology. He also had a profile of poor attention with extreme distractibility. Aaron's speech was characterised by reduplication and repetitive syllables. His expressive language consisted of single words, with some two word phrases.

*Ben.* Ben was diagnosed with the genetic condition 1p micro duplication and a severe speech and language delay. He had a severe speech sound disorder and his expressive language predominantly consisted of nouns, with some verbs and some adjectives. He was able to produce some simple clauses but this was very inconsistent, and he more typically used two word phrases.

*Claire.* Claire was diagnosed with an unspecified genetic condition which presented similarly to Worster-Drought syndrome, and a severe expressive and receptive language disorder. She had a limited range of speech sounds which she supplemented with finger spelling, and Cued Articulation (Passy, 2010) for speech sounds. She expressed herself mainly through signing of single words and two-word phrases.

*Dilshad.* Dilshad had a clinical description of Worster-Drought syndrome and severe speech and language delay. Speech characteristics included devoicing errors, omissions and inconsistencies. Prior to the intervention he was reported to have demonstrated an ability to

produce clauses containing subject-verb-object and auxiliary verbs in specific therapy settings. He had severe word finding difficulties.

**Adult Participants**. Baseline and intervention sessions were conducted by each child's class speech and language therapist (SLT), who were all experienced in working with complex paediatric speech, language and communication needs. Two children were in the same class and received baseline and intervention from the same SLT. The SLTs were blind to the intervention strategy whilst conducting the baseline sessions. Generalisation sessions were conducted with class learning support assistants (LSAs) and a class support volunteer, each familiar to the child with whom they worked. The generalisation partners were blind to the intervention.

## Experimental Design

A multiple probe across participants design was used, which allows progress made by a number of individuals to be attributed to the strategies used in the intervention (Gast, Lloyd & Ledford, 2014). The threshold to establish a stable baseline was a rate of variation of no more than three productions of clauses, defined as Subject + Verb + Object / Complement / Adverbial, between all baseline sessions. After the intervention was introduced to the first child, the criterion for beginning intervention with the second, and subsequent children, was production, by the participant currently receiving the intervention, of four clauses more than his or her own highest baseline level, for three consecutive sessions. The order of intervention for the children was randomly assigned.

## Procedures

**Materials.** Baseline, intervention and generalisation probes each centred on conversation between the child participant and an adult partner. For each conversation probe the children's parents supplied 2 pictures of their child taking part in an event such as an outing, club or home

activity, along with specific vocabulary relevant to the event (e.g. names of people at a family party).  The events were ones in which the children's conversation partners had not been involved.  To ensure that relevant vocabulary was available to the children on their SGDs, the first author created new vocabulary pages before the commencement of the study. These new pages used the same organisation across participants, whilst the number of cells varied slightly depending on the participant's language level. The new pages were accessible via the SGD home page and were designed to reflect the child's current language organisation strategy (e.g. graphic symbol type, use of colour coding). Access to, and use of, these pages was modelled during intervention. An example of the SGD page layout is shown in Figure 1.

**Baseline.** Baseline sessions consisted of a 20-30 minute conversation. The child was asked to choose a picture that they had not talked about previously, and then asked: "Tell me what happened". Their SGD was available to them throughout the conversation.  The SLTs could ask further questions to promote conversation and use expectant pauses and repeat back to the child what they had understood him/her to say, but they were not permitted to use any other therapeutic techniques to support the child's communication, and were blind to the intervention techniques.

**Training of SLTs.** Individual SLTs received information about the intervention procedures once they had completed baseline sessions with all children with whom they were working, so that no SLT was conducting baseline and intervention simultaneously with different children. Since SLTs conducting the intervention were experienced in complex paediatrics a 30 minute session was sufficient to complete initial training. Training consisted of verbal instruction from the first author, some role-play of the child-therapist interaction, and provision of a

checklist covering the intervention steps which clinicians reviewed at the beginning of each session.

**Intervention.** Intervention sessions were conducted at each child's regular allocated individual speech and language therapy session in school.  Each child received 12 sessions of intervention, designed to represent an individual speech and language therapy input package for a school half-term period.  The experimental design criteria for staggering the commencement of intervention for each child, intervening school holidays and participant illness meant that for all children the provision of the total 12 sessions varied between once or twice a week and the intervention period for the children ranged from 6 to 12 weeks.

During intervention, each child continued to attend their usual two to three weekly group speech and language therapy sessions within their class, focussing on different objectives to those of the study, such as topic word learning and reading comprehension skills.

Intervention sessions typically lasted 25-30 minutes and consisted of a conversation between the child and SLT.  At the start of the session, the child was asked to choose a picture of from a choice of two not talked about previously. The intervention strategy involved a six step procedure, here referred to as ARAMPR:

1.  <u>A</u>sk – ask the child about the picture, for instance: "can you tell me what happened". This may lead to an exchange whereby the SLT and child engage in establishing the intended meaning of the child's contribution;

2.  <u>R</u>ecast – recast the child's contribution to correct and expand their prior utterance into a target clause incorporating subject + verb + object/complement/adverbial, plus additional elements such as pronouns, determiners, tense markers, prepositions and conjunctions depending on the expressive language structures already used by the child;

3. Ask – ask if that is what the child meant and amend if necessary;

4. Model – model the target clause on the SGD;

5. Prompt – prompt the child to repair their prior turn including using the SGD, for example

   saying: "You have a go" with further explicit instructions as required;

6. Respond – make a positive conversational response to the child's repaired utterance.

For Example:

| | | |
|---|---|---|
| Ask | SLT | "what else do you want to tell me about this picture" |
| | Child | "*unintelligible speech*… show…*unintelligible speech*" |
| | SLT | "show?" |
| | Child | "no, u*nintelligible speech,* no, friends" |
| | SLT | "did you show a friend last night, or are you talking about today?" |
| | Child | "no, class, everybody" |
| Recast + Ask | SLT | "you showed everybody in class", is that right? |
| | Child | "ye" |
| Model | SLT | models sentence on the SGD which speaks: 'I showed everybody in class' |
| Prompt | SLT | "your turn", and prompts child to find and combine symbols on the SGD |
| | Child | uses SGD to speak: 'I showed everybody class' |
| Respond | SLT | "well done" |

During each intervention session the SLTs delivered a minimum of 4 'ARAMPR'

intervention episodes.  This minimum number of episodes was frequently exceeded later in the

intervention, as the children's skills developed. The respective levels of recasting, modelling and

prompting for each intervention episode also developed during the intervention in line with the

child's developing skills, and following discussion between the investigator and individual SLTs

for each child.

**Generalisation.** Four generalisation sessions of between 20-30 minutes each were conducted: one during baseline, one during intervention, one at two weeks post intervention and a final session at four weeks post intervention. All the pictures used in the study sessions preceding that generalisation session were available to the child, and new pictures of recent events were added with corresponding vocabulary on the SGD for the post-intervention sessions. Children were also free to talk on a topic of their choice if they did not want to use the pictures.

The adults conducting the generalisation sessions were blind to the procedures of the intervention. Adult conversation scaffolding techniques mirrored those of baseline sessions: i.e. the adults were instructed that they could ask open questions, and use expectant pauses and follow-up questions, and repetition of child contributions in order to check understanding. They were not to use any other therapeutic techniques to support the child.

**Data Analysis**

**Fidelity.** SLTs and Learning Support Assistants (LSAs) read a procedural checklist before each session to ensure compliance with the procedures. The first author reviewed video-taped recordings of baseline, intervention and generalisation sessions every week to assess for correct implementation. No deviations from the protocol were observed and SLTs followed procedures for baseline and intervention without difficulty. Intervention adaptation was discussed with SLTs concerning the respective levels of recasting, modelling and prompting used in response to children's developing skills. LSAs complied correctly with generalisation session procedures throughout.

**Transcription.** All baseline, intervention and generalisation sessions were video-recorded, and were transcribed by the lead author.  All child output was orthographically

transcribed and annotated for mode of communication. Adult output was annotated for type of utterance.

**Dependent Measures.** The transcriptions of the children's output, made using the SGD, speech, signed, or a mixture of these modes, were analysed by the lead author for the following measures of grammaticality:

1. Rate of self-initiated clause use, by any communication mode. Clauses were defined as basic sentences containing at least three elements: subject, verb, and either object, complement or adverbial, but which did not have to be in correct grammatical order. Self-initiated clauses were those that were produced spontaneously or were self-repaired by the child. Spontaneous clauses were defined as either initiated by the child or following an adult comment, question, or verbatim repetition for clarification of the child's utterance. Self-repaired clauses where those in which the child reformulated at least 50% of their original utterance following adult recast. A measure of rate use was used because session length varied. Rate was calculated for each dependant variable, by multiplying the number of occurrences by 30 and dividing that total by the length of the session in minutes.

2. Rate of clause use following prompt to repair, produced by any communication mode. These were defined as utterances containing at least three elements: subject, verb, and either object, complement or adverbial, not necessarily in grammatical order, that followed an adult prompt for their production.

3. Rate of fully grammatical clause use (by any mode) i.e. any clauses, either self-initiated or repaired following a prompt, that were completely grammatically correct.

4. Length of longest utterance (using any mode) i.e. the total number of words in all the clauses in the longest conversation turn/utterance (Scott and Stokes, 1995, found that phrase structure

expands and clauses contain an increasing number of adverbials as syntax in school-aged children develops).

5. Rate of use of different modes of communication. The mode(s) of communication used by the participants to produce each clause were recorded i.e. SGD, speech, sign, or mixed modes (a combination of two or all of the modes). Rate of use was then calculated for each mode.

**Reliability.** To determine reliability of the transcriptions the second transcriber, who was a qualified speech and language therapist preparing to return to the profession, independently viewed and transcribed 10% of the videos. This second transcriber reviewed videos from all stages and children. She was masked to the stages of the study and did not know the children or adults involved.  Transcription of all words and word attempts by the child (by whatever communication mode), plus the coding of every adult utterance preceding a child utterance, were compared. Agreement between the transcribers for each transcript was calculated by dividing the number of agreements by the total number of agreements, omissions and differences. The mean reliability score for the child words and word attempts was 86% (range 77 – 93%); the mean reliability score for coding of the adult utterances was 86% (range 77 – 92%). Transcript differences and omissions which affected utterances meeting the criteria for analysis were re-examined and discussed by the two transcribers until consensus was reached. Each transcript was then altered in line with these decisions.

To determine reliability of the analyses a second analyst, who was a university research assistant working in the field of neurodisability, independently examined 25% of the transcripts across all stages and participants, in randomised order and masked to the stages of the study. Inter-analyst agreement was calculated by dividing the number of agreements for each dependant variable across the transcript sample by the total number of agreements, disagreements and

omissions for that feature. Mean reliability across the sample was 85% for identification of

qualifying clauses, 97% for coding of clauses as self-initiated versus prompted to repair, 86% for

the number of words in the clause, and 94% for identification of fully grammatical clauses. The

overall mean reliability score across dependent variables was 92% (range 78% - 100%).

**Visual and Statistical Analysis.** Analysis of the data for the baseline, intervention and

generalisation probes was carried out visually and statistically.  Single Case Design (SCD)

standards produced for the US Department of Education's What Works Clearinghouse, detail six

features to employ in visual analysis: trend, variability, immediacy of effect, overlap, consistency

of data patterns and level of performance (Kratochvill, Hitchcock, Horner, Levin, Odom,

Rindskopf & Shadish., 2010).  The data were examined for these features.

Statistical estimates of the effectiveness of the intervention were calculated for all

dependent measures for each of the participants, using nonoverlap procedures.  Tau-U and

Improvement Rate Difference were used in combination and were calculated using an online

calculator (www.singlecaseresearch.org).  Tau-U is an index designed for single-case research,

which uses a combination of trend measures for the intervention, and nonoverlap measures

between study phases.  IRD is the improvement rate in baseline subtracted from the

improvement rate in intervention (Parker, Vannest, Davis & Sauber, 2011)

**Social Validation.** The social validity of the intervention and outcomes was explored by

seeking the perceptions of the clinicians taking part in the study (Schlosser, 1999).  Semi-

structured interviews were conducted by the investigator with the SLTs, within six weeks of each

SLT completing the intervention.  The SLTs' views about any aspect of the intervention were

sought including whether, and how, the intervention and components of the intervention affected

the child. The interviews were audio-recorded, reviewed and a written record made.  These data

were then analysed qualitatively following the principles of Thematic Analysis (Braun & Clarke, 2006) by coding features across the data, collating the coded data into themes, and refining and naming these themes.

## Results

Figures 2, 3 and 4 present the results for the use of self-initiated clauses, clauses following a prompt to repair, fully grammatical clauses, and the length of the longest utterance. These provide visual representation of trend, variability, immediacy of effect, and consistency. Visual inspection of Figures 2-4 suggests that experimental control was maintained for all dependent variables across all participants. For all participants, the use of self-initiated clauses, clause use following prompt to repair, and the use of fully grammatical clauses increased during intervention and was generalised above pre-intervention levels once the intervention ended, with the exception of generalisation of fully grammatical clauses for two of the children. The length of the longest utterance increased during intervention and was generalised and maintained above pre-intervention levels for three of the children.

The mean rate of use of self-initiated clauses versus clauses following prompt to repair in intervention is shown as part of Table S1 (supplementary materials). All children increased their mean rate of use of self-initiated clauses in both intervention and generalisation sessions when compared to baseline levels.

The communication modes used to produce clauses in each phase are presented in Figure 5. All participants increased the mean rate of clauses produced using their SGD during intervention to above baseline levels. All of the children also increased the mean rate of clauses they produced by speech or mixed modes of communication in these sessions.

**Statistical Non-overlap Measures of Effect**

The Tau-U and IRD scores (see Table S2 supplementary materials) show highly comparable results. Intervention effect for Tau-U and IRD scores can be interpreted in relation to benchmarks as follows, Tau-U: questionable <0.65, effective 0.66-0.92, very effective >0.92; IRD: >0.7 very effective, 0.5 – 0.7 effective, <0.5 questionable. All measures indicate that the intervention was very effective apart from the measures of longest utterance for Ben and fully grammatical utterances for Claire and Aaron. A summary of the results for each child is presented below.

**Participants**

**Aaron**. Aaron did not produce any self-initiated clauses in baseline. In intervention his level of use of the target measures was: 2 (range of 0 to 5) for self-initiated clause use and 5 (range of 3 to 7) for prompted clause use. His level for use of fully grammatical clauses was 1 (range 0 to 5), and his level for the number of words in his longest utterance was 8 (range of 5 to 12). Aaron generalised use of self-initiated clauses, producing a level of 2 (range 1 to 3) in generalisation probes compared to 0 at baseline. The length of his longest utterance in generalisation sessions was also above baseline at a level of 5 (range 3 to 6) compared to 0 at baseline. Aaron did not produce fully grammatical clauses during generalisation sessions.

Aaron used a variety of means to produce clauses during intervention and generalisation, in comparison to no use of clauses at baseline (see Figure 5). His rate of clause production using his SGD was 0 at baseline, 5 in the intervention sessions and 1 in the generalisation sessions. He used mixed modes to produce 0 clauses at baseline but a level of 1 clause during both intervention and generalisation sessions. He used speech to produce 0 clauses at baseline and generalisation but a level of 1 clause during the intervention sessions.

**Ben.** Ben's use of all the target measures increased during intervention as indicated by the change in levels between baseline and intervention sessions. Level of self-initiated clause use was 5 (range 4 to 7) at baseline, and 9 (range 1 to 13) in intervention. Level of clause production following prompt for repair in intervention was 5 (range 1 to 8). Levels for rate of fully grammatical clause use were 0 at baseline, and 2 during intervention (range 0 to 6). Levels for the number of words in his longest utterance were 8 at baseline (range 5 to 11), and 10 in intervention (range 7 to 20). Ben generalised use of self-initiated clauses, with a level of 14 (range 10 to 19) compared to 5 (range 4 to 7) at baseline. His level of use of fully grammatical clauses was 1 (range 0 to 3) in generalisation probes compared to the 0 at baseline. Level for number of words in Ben's longest utterance, however, did not increase in the generalisation sessions, with a level of 7 (range 6 to 9) compared to the 8 (range 5 to 11) at baseline.

Ben increased his use of clauses using speech and mixed modes in intervention and generalisation sessions when compared to baseline sessions as follows: level of clause use by speech was 4 at baseline, 7 during intervention and 9 in generalisation; levels of use of mixed modes was 1 at baseline, 2 during intervention, and 5 during generalisation. Ben increased his rate of production of clauses using the SGD between baseline and intervention where levels increased from 1 to 5, he did not use his SGD in generalisation sessions.

**Claire.** Claire's use of all grammatical measures also showed increases. Her level of self-initiated clause use was 2 (range 2 to 3) at baseline, and 3 (range 0 to 6) in intervention, with a level of 7 (range 3 to 11) for prompted clause use. Claire's level for rate of fully grammatical clause use was 0 at baseline and 1 (range 0 to 5) during intervention, while the level for the number of words in her longest utterance was 3 (range 3 to 4) at baseline and 8 (range 6 to 11) during intervention. She generalised the use of self-initiated clauses, producing a level of 4

(range 4 to 5) in generalisation probes, compared to 2 (range 2 to 3) at baseline. The length of longest utterance showed some improvement from a level of 3 (range 3 to 4) at baseline to 4 (range 0 to 6) in generalisation. Claire's did not use fully grammatical clauses in baseline or generalisation.

Claire increased her rate of production of clauses using her SGD and mixed modes in intervention and generalisation sessions when compared to baseline sessions (see Figure 45). Levels for rate of clause use produced via her SGD were 0 at baseline, 8 during intervention, and 2 in generalisation, and for mixed modes were 0 at baseline, 1 during intervention and 2 during generalisation. Claire's rate of production of clauses using signing decreased, with levels of 2 at baseline, 1 during intervention sessions and 0 in generalisation sessions.

**Dilshad.** Dilshad was able to produce more self-initiated clauses that the other participants at the start of the study (in baseline) though none of his clauses were fully grammatical. He made large increases in his rate of production of all the grammatical measures. His levels for rate of self-initiated clause use were 18 (range 16 to 19) at baseline, and 19 (range 7 to 30) during intervention. His level of clause use following prompt to repair was 8 (range 4 to 14). Dilshad's levels of fully grammatical clauses increased from 0 at baseline to 12 (range 1 to 17) during intervention. The level for number of words in his longest utterance was 11 (range of 10 to 14) at baseline and 19 (range of 13 to 30) during intervention. Dilshad was also able to generalise these increases, producing a level of 26 (range of 18 to 38) self-initiated clauses in generalisation probes compared to 18 (range 16 to 19) at baseline. Fully grammatical clauses also increased from a level of 0 at baseline to 8 (range 1 to 15) in generalisation. A particularly large increase was observed in the length of his longest utterance from a level of 11 (range 10 to

14) at baseline to 26 (range 12 to 48) in generalisation. Dilshad's gains continued to grow

strongly for all targets after the intervention ended (see Figures 2-4).

Dilshad increased in his rate of production of clauses using the SGD and speech in

intervention and generalisation sessions when compared to baseline sessions (see Figure 5).

Levels for rate of clauses produced using the SGD were 2 at baseline, 12 during intervention and

10 in generalisation, and levels for clauses produced using speech were 9 at baseline, 12 during

intervention and 12 during generalisation. Using mixed modes, Dilshad produced levels of 7

clauses at baseline, 3 during intervention and 4 during generalisation.

**Social Validation**

One central theme concerned observed improvements in children's use of grammar, with

the SLTs commenting positively on improvements during intervention and after completion of

the study measures.  For instance, Aaron had a "much better understanding of word-order" and

was "now beginning his sentences with a person".  A second theme concerned features of the

intervention itself.  For example, one SLT reported that "recasting enabled the child to see how

to put the words into a grammatically correct sentence". However, difficulties arose for children

when the SGD did not contain vocabulary items which the child wanted to use.  SLTs

commented also that the intervention had highlighted new areas of strength and hitherto

unrecognised areas of difficulty, for example, for Ben this related to difficulties with topic

maintenance. A third highlighted theme was that the children had begun to demonstrate

increased 'ownership' of their SGDs and confidence in communication as a consequence of

experiencing the benefits of its use. For instance, Ben was reported to use his SGD "frequently"

and "proudly", despite sometimes struggling with its functionality, and Claire was reported to

have started using her SGD spontaneously to communicate, rather than in response to prompting.

Dilshad's SLT reported that since participating in the intervention he "took a breath" to think and formulate his language before he spoke, and that he appeared "empowered" by his increased intelligibility through using his SGD. SLTs also commented that feedback received from parents was very positive. For instance, Dilshad's parents said he could now: "add in the details of his life" and he was "so much happier and more confident".

## Discussion

The purpose of this study was to examine the effects of a conversation-based intervention using child language scaffolding including speech generating devices (SGDs) on the expressive language of children with speech that is partially intelligible (SPI). The children had receptive and expressive language delay/disorder and communicated using combinations of communication modes, including speech, signing and SGDs.

The intervention was effective in increasing the rate of production of self-initiated clauses by all the children, and three of the four children also showed increases in the number of words used within the clauses they produced, although fewer gains were recorded in the use of fully grammatical clauses. When compared with baseline, increases shown during intervention were generalised to conversations with familiar adults who were blind to the intervention strategy. Many of the generalised gains were greatest at 2 and 4 weeks post intervention (figures 1 - 3).

The findings from the current study contribute to a growing body of research examining the effects of conversation-based interventions using adult scaffolding techniques on expressive language in children provided with SGDs (Soto & Clarke, 2017; 2018). In the current study involving children with partially intelligible speech, SGDs represent one modality of expression that may or may not be used interchangeably with children's speech. As previously reported in the AAC literature (e.g., Soto & Clarke 2017), adult recasts provide children with opportunities

to directly compare their utterance with one that is grammatically improved. In the current study, since only corrective recasts were used (i.e. when the child produced an incomplete or erroneous utterance), the capacity for recasts to stimulate child 'noticing' and contrasting their utterance with the adult reformulation was enhanced (Clarke et.al. 2017). Adult modelling of the target utterance on the SGDs also provided the children with a template to imitate when producing their own utterances (Sennott et al., 2016). Explicit prompting for the child to repair their prior utterance using the SGD offered focused experiential learning opportunities for language construction and familiarisation with the language infrastructure of the SGD, for example, using the grammatical colour coding system. These episodes of clause building invariably slowed the pace of the conversation. This, together with the children's active language work, may have further enhanced opportunities for embedding and retaining new language structures. Conducting the intervention through conversations about the children's own experiences, as chosen by the children, further stimulated the children's commitment to the activity, reflecting research evidence for the benefits of this approach in language intervention (Khan, Nelson & Whyte, 2014), and the views expressed by the SLTs who carried out the intervention, who felt strongly that conversation on topics important to the children and previously unknown to the SLTs was extremely motivating and engaging for the children.

The conversational approach, and the facility for the SLTs to work collaboratively with the first author in reviewing the intervention sessions, gave occasion to amend the respective levels of recasting, modelling and prompting in the intervention as appropriate to changes in child performance (Light & McNaughton, 2015). For example, complete recasts and models used early in the intervention for Claire were often scaled down by the end of the intervention to a simple prompt: 'can you say that altogether on your SGD' alongside some support for

accessing word categories on her SGD.  Similarly, in later sessions Dilshad often required less adult scaffolding as he began to reformulate his own utterances spontaneously and then produced them on the SGD.  In contrast, for Aaron, full recasts, models and prompts were maintained throughout the intervention, whilst Ben's difficulties with sequencing meant he continued to need scaffolding support to use the SGD throughout intervention.

The intervention was less effective at stimulating the children's production of fully grammatical clauses, however qualitative improvements were noted, not only in using the subject-verb-object/adverbial/complement clause structure, but also in children's use of a wide range of grammatical items including pronouns, tense and plural markers, adverbials, determiners and prepositions. This is exemplified by clauses such as "Nadia sign her name in books" from Claire, and "I wear France a helmet" from Aaron.

It is proposed that conversations that involve child self-repair, in the context of scaffolding techniques including adult recasting, can also facilitate language development in children using SGDs (Clarke, Soto & Nelson 2017). While the primary aim of the intervention examined in this paper was to facilitate improvement in language, increased use of SGDs, either in isolation or combined with speech, gesture and signing, has clear potential to improve the overall communicative intelligibility of children with SPI.  In a review of the effects of the use of low-tech communication aids (e.g. charts and books) and signing in intervention on speech production by children with autism and learning disabilities Millar, Light and Schlosser (2006) reported that natural speech and AAC should both increase in frequency if they are used together in the intervention alongside child reinforcement. The impact of conversation-based SGD mediated intervention on the speech production and overall communicative intelligibility of children with SPI is a promising area for further research. Notably also, qualitative

improvements in the use of clause formations delivered using speech and/or sign are indicative of improvements in these children's core language representations, rather than representing improved competence in their use of the SGDs.

**Limitations**

An important consideration for this study was the concern that extended baseline conditions, when children were not receiving support or reinforcement, can result in "aversive experiences for learners" (Gast et al., 2014, p.259). Consequently, the baseline period for the study was limited to three sessions. While this meets established requirements to demonstrate effect (Kratochwill et al, 2010), a greater number of baseline and generalisation sessions would have enhanced the standard of evidence. We note also that the semi-structured interviews used for assessing social validity were conducted by the first author, which may have influenced the views provided by SLTs conducting the intervention.

**Conclusions**

SGDs are increasingly offered to children with SPI who have language difficulties, however there is a dearth of research evidence about how SGDs may best be used to support these children's language learning. This study provides positive evidence for the use of conversation-based intervention employing both child chosen topics of personal events and structured scaffolding of child language including modelling of SGD use and child self-repair, on the language skills of children with partially intelligible speech.

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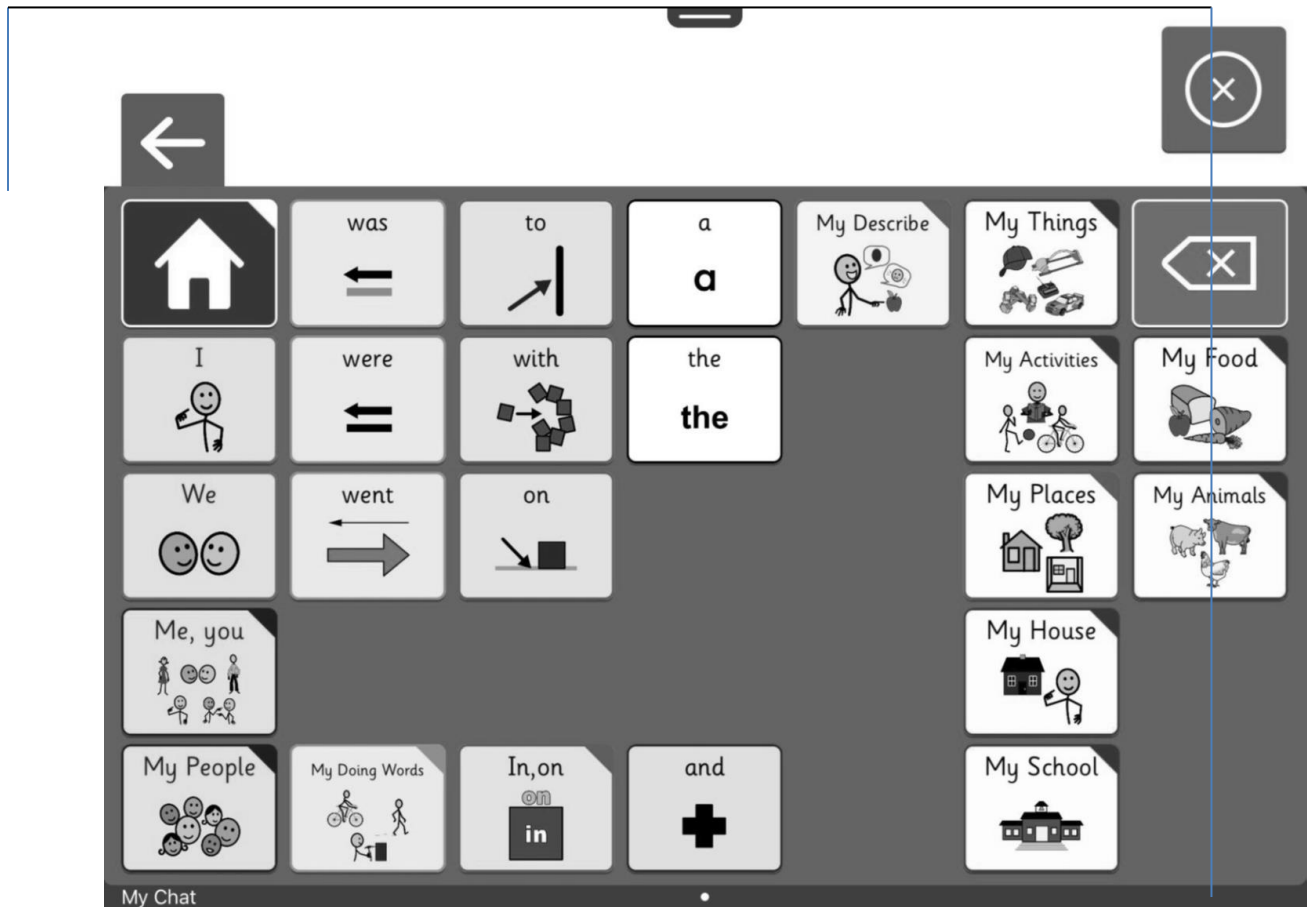*Communication*, *34(3)* 180-193 doi:10.1080/07434618.2018.1490926

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Table 1: *Participant Characteristics*

| Child | Age | Diagnosis | Receptive Vocabulary[b] | Receptive Grammar[c] | Expressive Grammar[d] | Speech Intelligibility[e] | Communication Modes |
|---|---|---|---|---|---|---|---|
| Aaron | 9;02 | Childhood Apraxia of Speech (CAS) | 5;05 | 5;01 | <3;06 | 10% | Speech, manual signs, gestures, Clicker[TM] iPad[f] |
| Ben | 8;08 | Genetic condition | 5;06 | <5;00 | < 3;06 | 50% | Speech, manual signs, gestures, Grid 2[TM] GridPad[f] |
| Claire | 10;01 | Genetic condition | 6;00 | 5;08 | <3;06. | 3% | Verbalisations, manual signs, gestures, Grid 2[TM] on GridPad[f] |
| Dilshad | 9;05 | Worster-Drought syndrome | 5;04 | 5;01 | <3;06 | 35% | Speech, manual signs, gestures, Clicker[TM] App on iPad[f] |

Note: [b] The British Picture Vocabulary Scales: Third edition (Dunn & Dunn 2009). [c] Concepts & Following Directions Subtest of Clinical Evaluation of Language Fundamentals-Fourth UK Edition (Semel, Wiig & Secord, 2006). [d] The Renfrew Action Picture Test; Revised Edition (Renfrew, 2010). [e] The Beginner's Intelligibility Test (Osberger, Robbins, Todd & Riley, 1994). [f]Clicker Communicator App[TM] for iPad and The Grid 2[TM] are two symbol and word vocabulary set systems for SGDs which use core vocabulary words, but also allow vocabulary personalisation, and creation of spontaneous and novel utterances with grammaticalization.
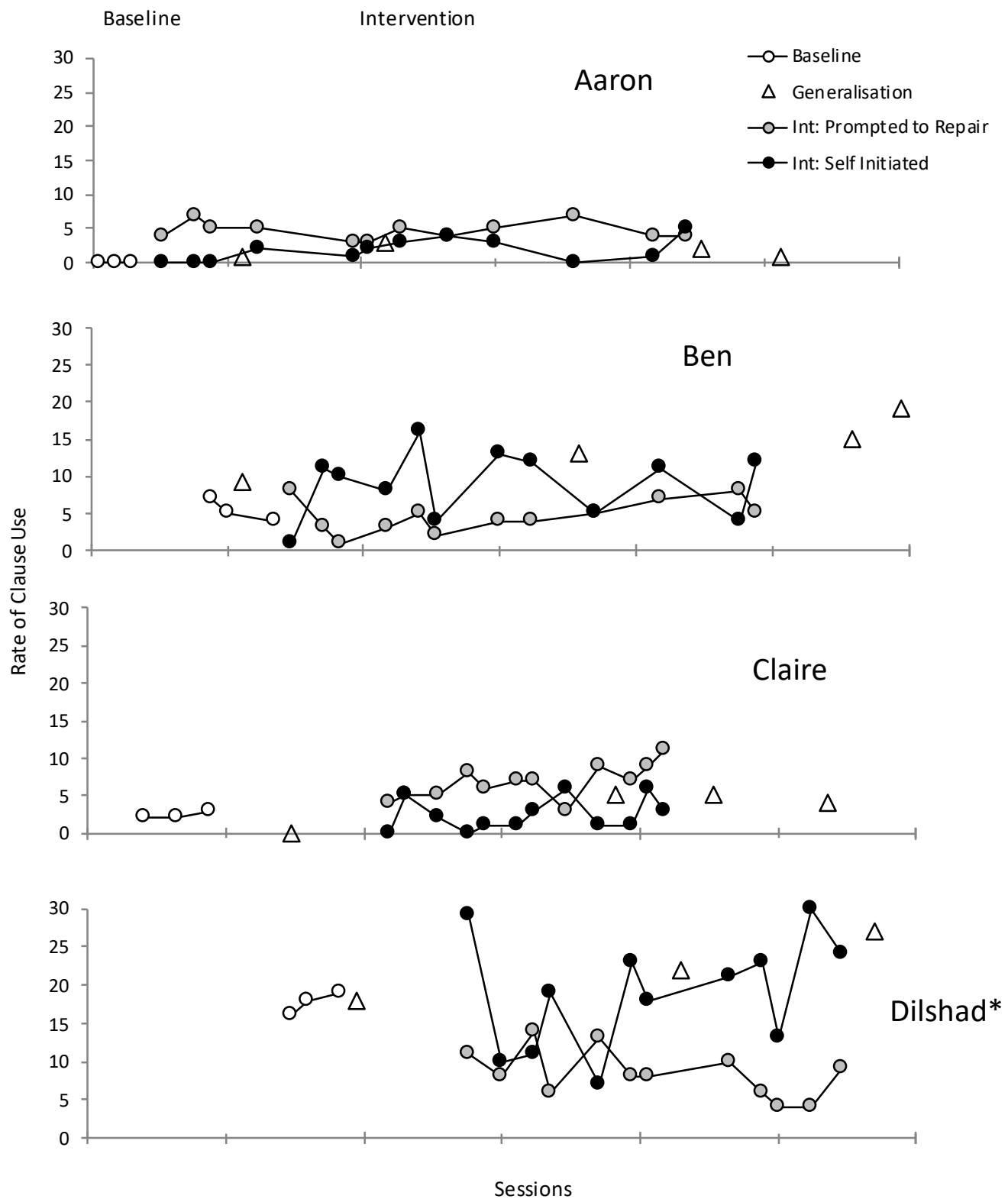
Figure 1. Example of Speech Generating Device[a] (SGD) Page Layout



NB. When touched, plain rectangular cells speak the word displayed and enter it into the message area, at top. Cells with dark upper corners link to further pages for other word choices. Words are entered into the message area in order, as they are selected. Touching the message area speaks the full utterance.
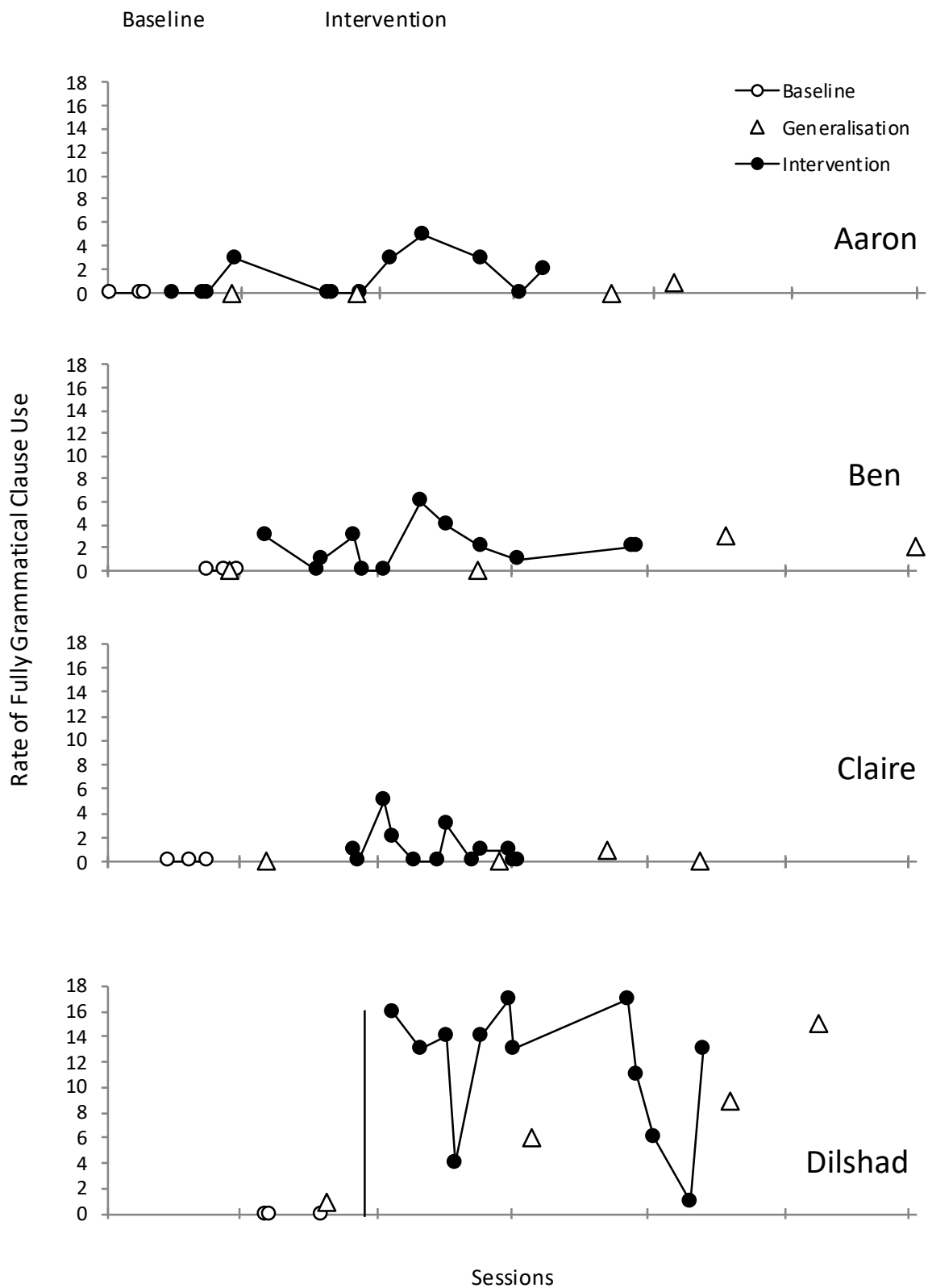
[a]Clicker Communicator App™
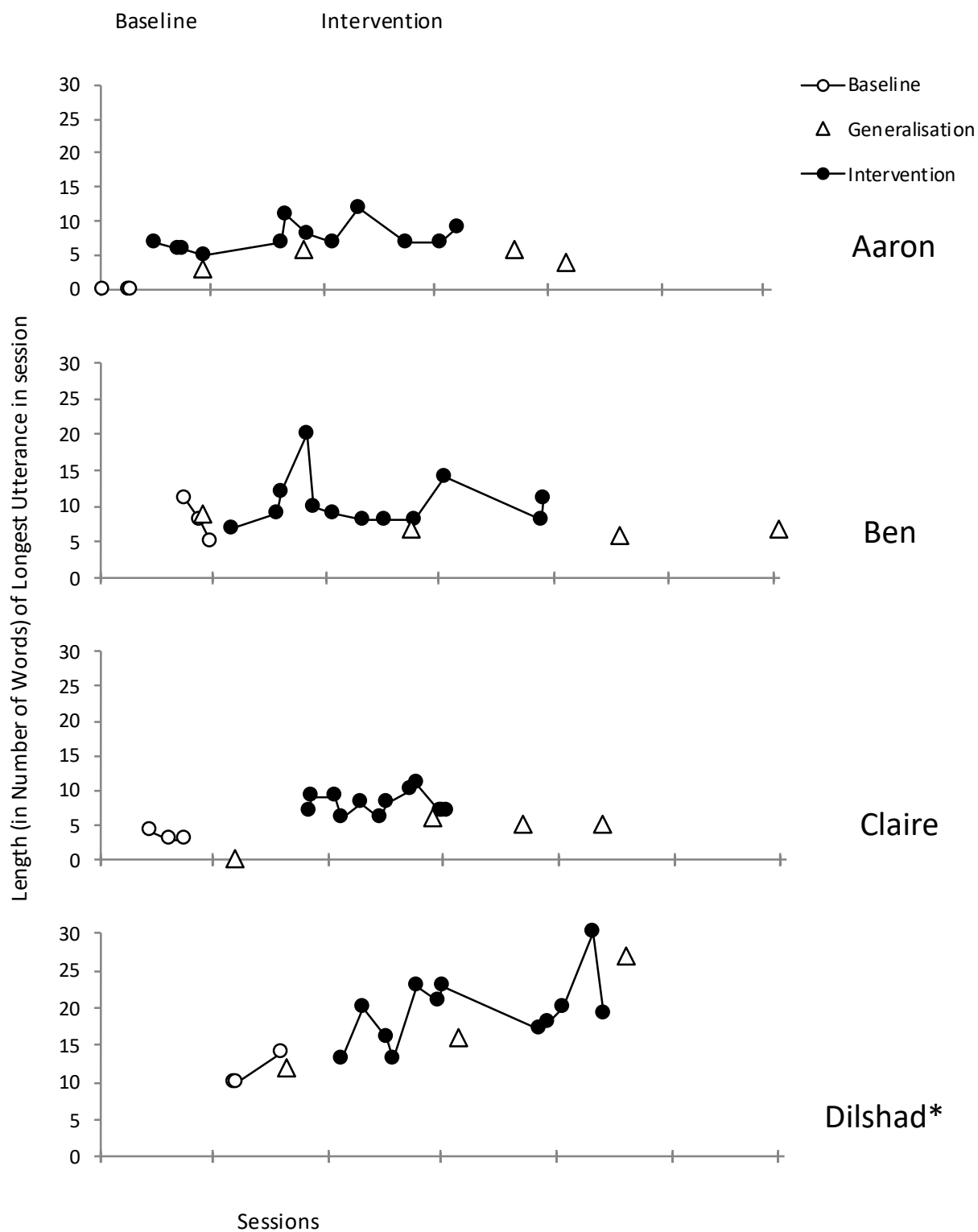
**Figure 2. Rate of Clause Use**



NB.* **Rate of Clause Use for Dilshad's 4$^{th}$ Generalisation session = 38 (NOT shown)**

**Figure 3. Rate of Fully Grammatical Clause Use**



Sessions

NB. Intervention sessions show fully grammatical self-initiated and prompted to repair clauses
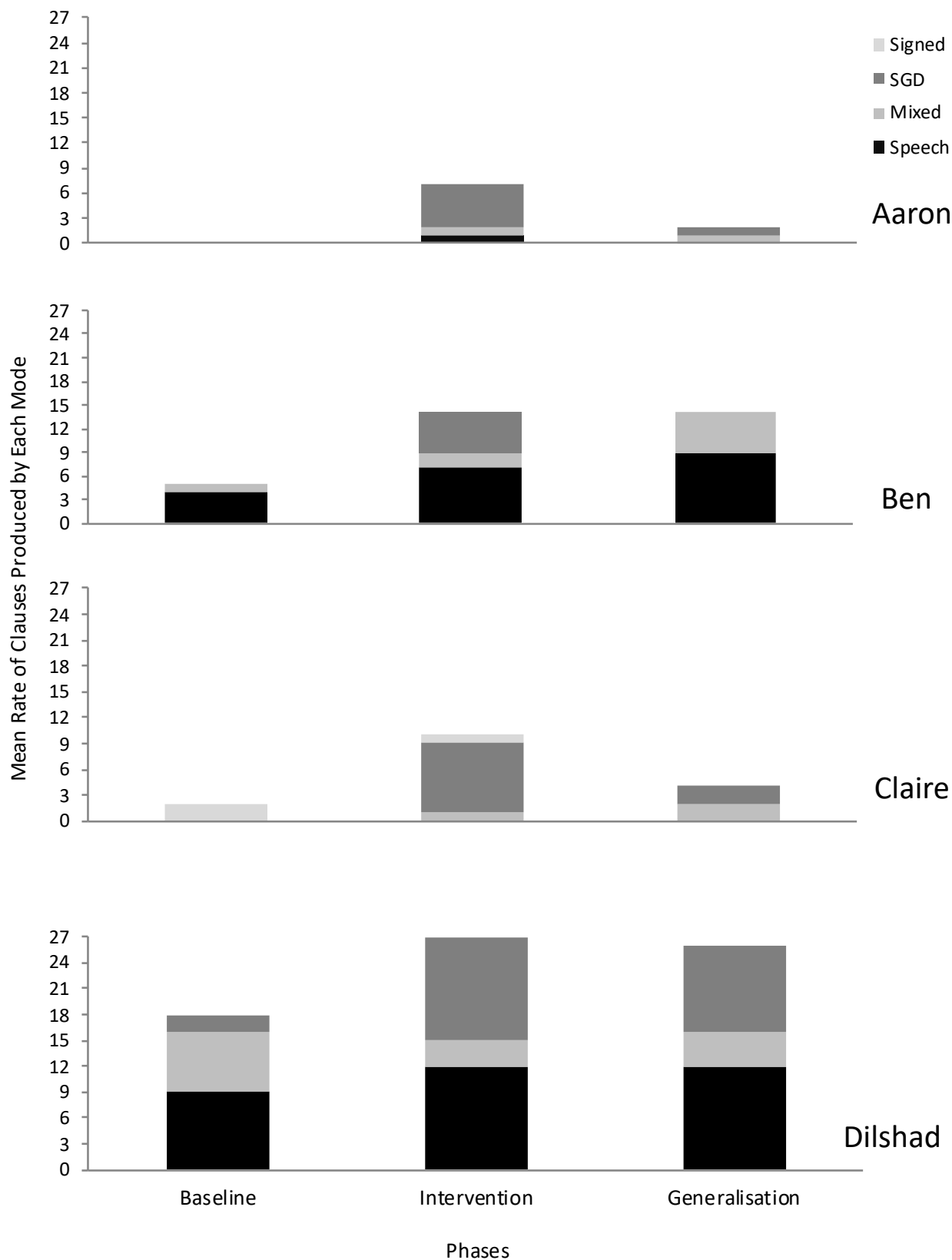
**Figure 4. Length of Longest Utterance in each session**



NB *Length of Longest Utterance for Dilshad's 4th Generalisation Session = 48 words (NOT shown)

For interventions sessions the longest utterance may be either self-initiated or prompted to repair

**Figure 5. Mean Rate of Clause Production by each Mode of Communication in each Phase**

Supplemental Material S1. *Mean Values for the Dependent Measures in Baseline, Intervention and Generalisation Phases*

| Child | Number of Sessions | | | Mean Rate of Self-Initiated and Prompted to Repair Clause Use | | | Mean Rate of Fully Grammatical Clause Use | | | Mean Number of Words in Longest Utterance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | Interv | Gen | Base | Interv | Gen | Base | Interv | Gen | Base | Interv | Gen |
| Aaron | 3 | 12 | 4 | 0 | 7 (2/5) | 2 | 0 | 4 | 0 | 0 | 8 | 5 |
| Ben | 3 | 12 | 4 | 5 | 14 (9/5) | 14 | 0 | 2 | 1 | 8 | 10 | 7 |
| Claire | 3 | 12 | 4 | 2 | 10 (3/7) | 4 | 0 | 1 | 0 | 3 | 8 | 4 |
| Dilshad | 3 | 12 | 4 | 18 | 27 (19/8) | 26 | 0 | 12 | 8 | 11 | 19 | 26 |

Note: Base = Baseline Phase, Interv = Intervention Phase (Self-Initiated/Prompted to Repair), Gen = Generalisation Phase

Table S2: *IRD and Tau-U*

| Participant | Dependent Measure | IRD | Tau-U | P Value | CI 85% |
|---|---|---|---|---|---|
| Aaron | Self-Initiated Clauses | 0.67 | 0.67 | 0.08 | 0.11<>1 |
| | Fully Grammatical Clauses | 0.0 | 0.42 | 0.28 | 0.14<>0.97 |
| | Longest Utterance | 1.0 | 1 | 0.009 | 0.45<>1 |
| Ben | Self-initiated Clauses | 0.67 | 0.47 | 0.22 | -0.082<>1 |
| | Fully Grammatical Clauses | 0.75 | 0.75 | 0.05 | 0.19<>1 |
| | Longest Utterance | 0.25 | 0.36 | 0.35 | 0.19<>0.92 |
| Claire | Self-initiated Clauses | 0.50 | -0.17 | 0.67 | -0.72<>0.39 |
| | Fully Grammatical Clauses | 0.50 | 0.5 | 0.19 | 0.054<>1 |
| | Longest Utterance | 1.0 | 1 | 0.009 | 0.45<>1 |
| Dilshad | Self-Initiated Clauses | 0.50 | 0.22 | 0.56 | -0.33<>0.78 |
| | Fully Grammatical Clauses | 1.0 | 1 | 0.009 | 0.45<>1 |
| | Longest Utterance | 0.67 | 0.89 | 0.02 | 0.34<>1 |