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Review Article

Speech and communication in cerebral palsy

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Abstract. Children communicate using speech, vocalisation, facial expression, gesture and body movement. The motor disorders of cerebral palsy (CP) may affect the movements needed to produce any type of communication signal. Movements intended to be the same may vary in range, speed, strength and accuracy and as a result communication signals may be difficult to understand. Children's communication development may also be affected by cognitive or sensory disturbances, which are also common in CP (1). This paper will describe the speech and communication difficulties often experienced by children with CP and will summarise the interventions that have been found to be clinically effective with this population of children.

Key words: Cerebral palsy, speech, communication, language, children

1. Speech disorders

Motor speech disorders (dysarthria) are associated with all types of CP-spastic, dyskinetic and ataxic. However, little is known about the prevalence of dysarthria in CP. We know that it is more common in dyskinetic CP than spastic forms (2, 3), and that estimates of the overall prevalence of dysarthria in children with CP are around 50% (2, 4). However, exact prevalence figures for the presence and severity of dysarthria are not currently available, as speech is not currently measured in CP surveillance registers.

Children with different types of CP share many speech characteristics and it is difficult for clinicians to differentiate between the CP types when listening to speech recordings (5). The perceptual similarities may be due to the developmental nature of the disorders or the presence of mixed disorders.

Speech production relies on several underlying processes-respiration, phonation, resonance and articulation. To produce speech *respiration* is controlled so that exhaled air is forced from the lungs through the vocal folds and into the oral and nasal cavities. At the larynx, the vocal folds vibrate to turn air pressure (aerodynamic energy) into sound (acoustic energy) in the process known as *phonation*. The *resonance* of the vocal tract is determined by its shape, and is altered by movements of the jaw, soft palate, lips and tongue. For example, if the nasal cavity is not closed off during speech, nasal resonance is produced and speech sounds nasalised. *Articulation* refers to the movements of the jaw, tongue and lips, which further shape acoustic energy to create vowels and consonants. When describing the components of speech production researchers and clinicians also talk about prosody, which refers to the rhythm, stress and intonation patterns of connected speech. Prosody is created by changes in pitch, syllable duration and loudness, which in turn depend on respiratory and laryngeal control.

Movements for speech are rapid and demand considerable coordination and control. Dysarthria in children with CP often affects all processes - respiration, phonation, resonance, articulation and prosody. Children may have difficultly controlling their breathing for speech. They may have shallow breathing and may speak on short bursts of air, which might make their voices quiet, especially in longer utterances (6). Children may also have difficulty in coordinating exhalation with phonation. They may exhale and then start to speak when a significant proportion of their breath has been exhaled. This may lead to them running out of breath and speaking on residual air. The vibration of their vocal folds may be slow or irregular, which can create low pitched, monotone and breathy voices (7). Children's voices may sound harsh or vary

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rapidly in pitch. Reduced control of the soft palate may lead to speech sounding nasalised, and reduced control of the tongue and lip muscles is evident from reduced range of consonants and vowels that can be produced in speech (8-11). Difficulties in controlling the vocal tract can range from mild, with slight imprecision of speech in words and phrases, to profound, with a complete inability to produce any intelligible speech.

Children with CP and communication difficulties are at risk of lower quality of life and reduced participation (12-14). The aim of speech and language therapy is to help children to communicate effectively and independently in all situations, thereby increasing their access to education and social life. For children with severe or profound disorders speech may not be effective as the main means of communication and alternative and augmentative communication (AAC) systems should be implemented to enable children to express themselves and their ideas clearly. For children with less severe disorders therapy may serve to increase the intelligibility of their speech.

2. Speech intervention

Research has shown the different motor control needed to produce movements for sucking, chewing and speech (15). Motor learning theory also tells us that motor learning is task specific (16). Therapy to improve speech production should therefore focus on speech, rather than oral exercises that use the same body structures.

As dysarthria affects all processes involved in speech production, from respiration to articulation, therapy needs to address each of these processes. Clinicians and researchers recommend that intervention focuses on controlling respiratory effort and coordinating exhalation and phonation, as these processes underpin the production of a robust acoustic signal (3,17,18). Treatment for articulation is only advised when other aspects of speech production have been/are being addressed, as imprecise "production of speech sounds (which is the most common perceptual characteristic of dysarthria) is not simply an oral articulatory problem, and is usually the result of laryngeal, velopharyngeal, respiratory and oral articulatory problems" (18). Thus, more precise articulation and improved intelligibility is achieved through developing control of breathing for speech, increasing background effort and slowing speech rate (3,18,19).

Therapy to increase respiratory effort and coordination of exhalation and phonation for the production of loud, clear voice starts with the production of isolated vowels and moves to words and phrases so that children can practice controlling their voice in functional speech. Children are taught to maintain sufficient breath support for words or phrases and to breathe at appropriate points in phrases. For some children this might be between each phrase in a sentence: "*The man*" "*is feeding*" "*the dog*". Other children may be able to produce longer utterances between breaths "*The man is feeding*" "*the dog*". Therapy may also include modulating pitch, loudness and timing for prosody (20, 21). As this type of therapy aims to help children to learn new motor behaviours it should follow motor learning principles: therapists should provide frequent feedback to facilitate the production of the target behaviour and then fade feedback once the target has been reached, in order to aid retention; therapy should be given intensively so that children can practise of target behaviours frequently; targets should be randomised in practice, rather single behaviours being practiced repetitively; and children should be given provided with knowledge of their results (22-25).

Therapy focusing on breathes support and voice production, which follows the motor learning principles above, has been associated with changes in the ICF levels of body function and activity. Increased lung volume and greater muscular effort (26) have been observed post therapy. Changes to children's voices with reduced fluctuations in pitch and increased volume have also been observed (27, 28). More importantly clinically, however, is change to children's speech intelligibility. For a group of children with mild to severe disorder average increases in intelligibility post therapy of 15% have been observed. For some children with more severe disorders this represented a doubling in the number of words that are understandable in single word and connected speech (21). The above studies suggest that intervention focusing on clear voice production is effective in changing speech and intelligibility in clinical settings. It is now important that research includes measures of change at the ICF participation level, and to investigate if the intervention has a positive impact on children's involvement in social and educational activities and facilitates everyday interaction (29).

Following or in conjunction with therapy to maintain breath support and increase control of the coordination of exhalation and phonation, intervention may also address nasality and articulation. Behavioural therapy for nasality has

been described in text books and includes motor exercises to raise the soft palate and close off the nasal cavities (19). However, there is currently insufficient evidence to evaluate the effectiveness of this type of intervention (30). The fitting of palatal lifts (acrylic prosthetic orthodontic appliances, which extend from the hard to the soft palate to close the velopharynx) has been recommended for some people with CP (30), but is not widely practiced.

Therapy to improve articulation may involve slowing speech rate, which allows children time to make the precise movements for speech sound production (19). Slower rate could be an additional focus of therapy targeting breath support and voice, and may have generalised effect on articulation. However, the effects of rate change have not been addressed specifically for children with CP.

Therapy may also address the production of individual speech sounds. Some children may be able to produce sounds in some but not all places within words. For example, they may be able to produce '*d*' at the end of a word, but may say '*g*' instead of '*d*' at the beginning of words. In these cases therapy may focus of producing contrasting words that begin with'd and '*g*'; e.g. '*gate*' versus '*date*'. If children are not able to make a target sound (usually a consonant) therapy that includes visual feedback may help them to learn to move their lips and tongue to produce the target sound or an approximation of it. Electroplatography (EPG) has been tried with successfully for a child with CP (31), but has not been widely evaluated for this group. EPG involves the fitting of a removable acrylic plate on the hard palate. The plate has electrodes embedded within it. When the tongue touches the electrodes a visual display shows the where contact has been made. Bite blocks, which are small blocks held between the upper and lower teeth to stabilise the jaw, have also been used to help children to learn to move their tongue independently of the jaw to produce speech sounds (32).

Increases in intelligibility associated with therapy may help children communicate solely by speech, or may mean that they need to use AAC systems less frequently to augment verbal communication. In either of these cases, children may become more rapid in their communication exchanges and interaction may proceed more smoothly.

3. Communication

Communication depends on the sending and receiving of messages between at least two people. Communication signals can be sent using speech, vocalisation, facial expression, gesture and whole body movements. Each of these modes of communication can be affected by the motor disorders of CP as the underlying movements may vary in range, strength, speed and precision. Consequently, children's verbal *and* nonverbal signals may be difficult for their communication with partners to understand. Because CP often results from very early damage to the developing nervous system, communication difficulties may be evident from infancy, and there may never be a time in the child's life when communication follows the usual pattern of development.

Early interaction between parents and infants without motor disorders is positively reinforcing. Nondisabled infants produce communication signals that their parents can interpret and the parents then respond in the manner predicted by the child. For instance, a preverbal infant may look at a toy, reach towards it and vocalise. The parent will watch them associate the child's attention with the object and when they see that the child cannot physically obtain the object and it is given to the child. The children will thus obtain the object they desired and parents will be satisfied that they have acted appropriately (33). Children with motor disorders may also try to reach an object and vocalise. However, due to primitive reflexes they may not be able to reach towards an object and look at it at the same time. Furthermore, they may not be able to coordinate the timings of their movements so that they reach and vocalise at the same time. Communication signals may therefore be difficult for the parents to interpret and they may give the child a different toy. In such an instance the child will not probably appear content and communication will satisfy neither the child nor the parents (34).

To accommodate their child's difficulties and to enable interaction to be completed smoothly and parents may manipulate interaction successfully so that their child has opportunities to produce the communication signals that are intelligible. However, for many children with severe motor disorders intelligible signals may be limited to 'yes', 'no' and requesting objects or activities within view. As a result of this, parents are restricted to asking children closed questions or questions that demand children point to an object nearby. For example, they may hold up a video and then a toy car and ask *'Do you want the video? Or the car?'* Restricted patterns of conversation, in which parents choose topics and ask questions to which children make simple responses, conveying limited information have

been observed for children who vary widely in age and motor disorder severity (35,36).

In addition to their difficulties controlling the movements for communication children with CP may also have cognitive impairments, delayed language development, and sensory impairments (1), which will affect all their processing of spoken language and further delay their expressive communication development.

4. Communication intervention

The goal of communication therapy for children is to become active and independent communicators in all of their daily environments. To do this they need to develop as full a range of communication skills as possible and to have an intelligible means of expressing all their needs and ideas.

By two and a half years of age non-disabled children have usually acquired most of the skills that they need to engage in conversation (37). They take an equal role in interaction, starting about half of all exchanges with their parents, and can negotiate communication breakdown. They use communication to:

- Request attention
- Request objects or actions
- Request information
- Request clarification of a speaker's utterance when they have not heard or not understood
- Provide information / make comments
- Provide clarification by repeating or revising their utterance when they have not been understood
- Signal 'yes' and 'no'
- Express their personality e.g. humour, sarcasm

In early childhood, speech and language therapy assessment should include observation of the child in everyday settings to observe which skills they *regularly* use in conversation and testing of the child through play to investigate which of the above skills they *can* use if given the opportunity to do so. It should also be noted *how* the children convey these communication skills, e.g. by gesture, vocalisation or speech (38, 39).

Skills that are neither elicited through testing nor observed in usual settings may be taught by modelling and behavioural techniques. For example, children may be taught to request objects by eye pointing to them and / or vocalising (40,41). However, not all children may be expected to acquire a full range of the above skills. Some children with intellectual impairments, for example, are able to express only a limited number of simple comments and may not be able to repair conversation by selecting an alternative way of communicating a message.

Skills that are elicited through testing, but not observed in general conversation, can be generalised by changing the communication environment. This will involve training of children's conversation partners, most notably their parents and nursery workers, teachers etc, in order to provide wider communication opportunities for children. Training for conversation partners covers the process of interaction, the importance of letting children lead conversation and directing others in order to help them to become active and independent communicators, and how to encourage children to use individual communication skills. Training can be provided to parents and children on an individual basis (42) or to groups of parents (43). Training has been successful in helping parents to direct interaction less and become more responsive to their children's communication, and has been associated with children taking more turns in conversation, starting more exchanges within interaction and asking more questions and making more statements (42,43). The training programmes can be intensive and demanding in terms of time and commitment for parents. For example, in the Hanen parent programme, it takes two to talk (44) which was investigated by Pennington et al (43). Group is comprised eight sessions over twelve weeks, each session lasting between two to two and half hours. In addition to the group training sessions, three individual home visits are made for this programme to enable therapists to coach the parents in the techniques they have learned in the group sessions. However, the commitment is seen as an acceptable and useful investment in their child's future, as parents continue to use the strategies they learn on the programme as their children grow and communication develops (Pennington and Noble, in press).

Most of the communication skills listed in the bullet points above can be used without language. For example, children may comment on the size of an object by using gesture and they may signal that they have not understood someone by vocalising using falling and rising pitch and looking quizzical. However, the range and complexity of ideas that may be expressed without language can be very limited. Children whose speech is often unintelligible may require augmentative and alternative systems of

communication (AAC) to supplement their natural modes.

The aim of AAC is to provide children all the vocabulary they need to communicate independently. AAC systems are divided into aided – where a separate piece of communication equipment is provided, such as a picture chart or voice out put communication aid - and unaided, where no separate equipment is needed, e.g. sign. Aided systems include objects, photographs, pictures, pictorial symbols, letters and words. Children who require aided AAC usually start with a light tech system, such as a chart or book containing symbols or words etc. They may also benefit from high tech systems which have voice output. There are now many high tech devices available, ranging from a single switch to produce a single message to complex devices storing thousands of words and phrases which can be built up into sentences. The choice of system is dependent on children's physical, cognitive and sensory skills (45), and it is important that the AAC system is provided appropriately for the child's developmental level.

AAC systems will be usually new to children's parents, family and teachers as well as the children themselves. Like early communication therapy, AAC intervention needs to involve both the children and their conversation partners. Children need to be taught how to access the vocabulary in their new systems and produce words and phrases at the appropriate points in conversation. Conversation partners need to be taught how to incorporate the system into spoken interaction, how to model its use in conversation, where words/phrases are located in aided systems, and how to add words and phrases to allow children to keep abreast of changing vocabulary needs. Detailed discussion of the implementation of AAC is beyond the scope of this paper but can be found in many excellent text books (e.g.(46-49).

It should also be remembered that communication is a highly emotive issue for parents and the introduction of technology to supplement communication may not be always welcomed initially (Pennington and Noble, in press). However, there is now a body of evidence to support the introduction of AAC and to suggest that AAC may facilitate speech rather than hinder its development (50, 51), which may allay some parents' fears. Furthermore, research involving parents and users of AAC systems also suggests that a family centred model of intervention, with AAC systems provided to meet the specific communication needs as expressed by parents and familiar caregivers, may increase acceptability and adoption of new communication systems so that children can truly express all their ideas effectively and take a full and active role in all areas of their lives (52,53).

5. Conclusion

Children with CP have specific but varied communication difficulties which require an individualised approach to intervention. Difficulties may range from mild speech disorder to profound difficulty controlling any movements for verbal or nonverbal communication and severe language delay. The aim of all speech and language therapy should be help children develop as a full a range of communication skills as possible and to be able to express their ideas intelligibly. Depending on the severity of children's motor difficulties and other accompanying disturbances intervention may focus on the teaching of individual communication skills, speech production or on the provision of AAC to supplement children's natural forms of communication. As communication involves at least two people, it is important that therapy involves not only the children with CP but also their parents and other frequent communication partners if children are to become active and independent communicators in all of their daily environments.

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