A Comprehensive Review of Methods for Treating

Childhood Apraxia of Speech

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Abstract
Childhood apraxia of speech (CAS), also known as developmental apraxia of speech or developmental verbal dyspraxia, is a developmental disorder that affects a child’s ability to vocalize their thoughts. Sounds, syllables, or words can be very difficult to say because there is a miscommunication in the brain that affects the coordination of the anatomical structures of speech production (jaw, tongue, etc.) (Childhood Apraxia of Speech a). This is a highly variable disorder in the sense that it presents differently in every child; therefore a treatment that works for one child may not work for another. Many treatments involve multisensory inputs, but it is not clear whether these inputs alone make the greatest difference in a successful therapy, or whether other factors such as the duration of therapy or number of repetitions of a sound are as or more important. Published research on the efficacy of the different treatments is scant, and the majority of articles are case studies. Very few studies include more than four children. Such small study samples weaken generalized conclusions about the treatments. This paper will review the studies of the various treatments and will show that the therapies with both multisensory inputs and repetition provide the most effective treatment.

One possibility for treatment that I will explore more in depth is board games. Presently, many computer games are available to children with CAS, but since these games do not have a community of online players, this eliminates a beneficial social aspect of therapy. Board games create the opportunity for a social atmosphere as well as a fun one. The more enjoyable atmosphere that comes hand-in-hand with games helps the child feel more at ease during the therapy session, which in turn can improve the child’s learning ability and endurance during treatment (De Bruijn 2011). This paper will look at what makes educational games effective and fun, and how games have been used in other areas of therapy. I will present a theory for a game that incorporates multisensory inputs and repetition, but which also uses the entertaining elements of games to present the therapy in a less clinical and friendlier light.
1. Introduction

This paper will survey some of the current therapy methods for childhood apraxia of speech, with the intent to make a recommendation as to which are the most effective. The other published surveys (e.g., Morgan and Vogel 2009) conclude that there simply is not enough evidence to make a concrete recommendation. While I have also come to this conclusion, I found two common factors in the successful therapies that could be combined in a game for children regardless of their stage of therapy. These factors are multisensory inputs (which consists of tactile, visual, and auditory cuing during speech production) and repetition. The most common sensory input in the studies included in this review is tactile, closely followed by visual. Tactile input consists of any prompting on the part of the therapist in which the therapist’s hand touches the patient’s face to elicit a certain sound response. Visual inputs are more varied; they can be hand gestures, exaggerated mouth postures and movements, or the digital representation of what is happening during speech production (as in electropalatography). Finally, auditory inputs are either target sounds or words spoken by the therapist in unison with the child or recorded sounds or words played for the child to repeat. Among the treatments reviewed, only two explicitly required auditory input. All reviewed treatments required repetition.

Both multisensory input and repetition are necessary for a treatment to be effective, and both of these factors can be combined in a game for children. Games create a more enjoyable atmosphere and help children feel more at ease during the therapy session. In turn, this atmosphere can improve children’s learning ability and endurance during treatment (De Bruijn 2011).
Section 2 pertains to the background of childhood apraxia of speech—what it is, why it is such a difficult disorder to treat, and what those treatments are. Section 3 will review those treatments in detail, outlining their application and the evidence of their effectiveness. Section 4 discusses games in education and therapy, and Section 5 argues that games can be used successfully in speech therapy. I will conclude in Section 6.

2. Childhood Apraxia of Speech

2.1 What it is

Childhood apraxia of speech (CAS), also known as developmental apraxia of speech or developmental verbal dyspraxia, is a developmental disorder that affects a child’s ability to express their thoughts through speech. There is usually nothing wrong with the child’s understanding or ability to think—they know what they want to say—but producing certain sounds and sequencing syllables or words are very difficult. Despite a lack of strong consensus as to the cause of CAS, most experts believe that it results from a miscommunication in the brain that affects the coordination of the jaw, tongue, etc. (Childhood Apraxia of Speech a) to produce speech, which makes it a phonetic disorder, rather than a phonological one.

While CAS can express itself in many different ways, problems with certain sounds are more likely to occur than others. Generally, fricatives, affricates, and consonant clusters are the most troublesome for adults with apraxia (Rosenbek 1973). This does not seem to hold true for children, however, who tend to have more trouble with vowel production (Childhood Apraxia of Speech 2013b). As might be expected, people with CAS are more likely to have trouble with an entire word if it begins with one of the difficult sounds, as opposed to the word ending in that sound (Rosenbek 1973). If
the word begins with the problematic sound, there is no easing into it or using other sounds to make it easier to say; it is the first thing out of the child’s mouth, and the difficulty of even starting the word can be an intimidating prospect. Another problem that generally co-occurs with CAS is an inability to understand some aspects of the prosody of language (Murray et al. 2012), mainly prosodic word boundaries. For example, a child would find differentiating between *I scream* and *ice cream* very difficult.

CAS is a lifelong disorder in several ways. First, many people with CAS have persistent CAS, which means that children do not grow out of it and struggle with their disorder for their entire lives. Typically, these people have very slow progress in therapy and once therapy stops, they regress. The disorder is also exacerbated by fatigue, anxiety, and other emotions. Persistent CAS is also different from acquired apraxia, because acquired apraxia does not present until adulthood, whereas someone with persistent CAS will have it from childhood to adulthood. Another way in which CAS has lifelong impact is that people who had CAS and overcame it or have persistent CAS, tend to have a higher rate of depression and a lower socio-economic status than nonspeech-impaired adults (Murray et al. 2012). In the majority of these cases, this disorder takes a lot of time for improvement to begin to show, and the family needs to be really involved in the whole therapy process (Childhood Apraxia of Speech a).

Sometimes, CAS is too severe and treatment through therapy becomes unproductive. It is important that the goals set for the child are realistic. If a child enters therapy completely unable to speak, it is unreasonable to expect that therapy will enable the individual to do so. In these cases, alternative forms of communication, such as sign
language or aided communication systems, need to be considered (Childhood Apraxia of Speech a).

2.2 Challenges to Treating CAS

Treating CAS is challenging in part because the cause of the disorder is unknown. Some experts think it is caused when an area of the brain is underdeveloped, while others believe genetics are responsible, but no research definitively supports either hypothesis (Childhood Apraxia of Speech b 2013). Without understanding what is causing this disorder, therapists can only apply treatments that target the symptoms.

Another difficulty is that there is no agreement among experts about the features of the disorder. In a survey conducted in 2003, speech-language therapists were asked for the top three diagnostic features they used for CAS. The results showed that there was no universal feature used to diagnose CAS, with more than 50 different features listed. The three most common features were inconsistent speech, oral-motor difficulties, and groping behavior during speech (Moriarty 2006). Because of this inconsistency in the diagnostic features of the disorder, there are no reliable statistics on the prevalence of the disorder, but some experts estimate that it occurs in approximately one out of every one thousand children (Childhood Apraxia of Speech c).

Experts hold many different opinions on what CAS is, how it is diagnosed, and the best treatment to use. This situation is even more complicated because there are so few studies on the efficacy of different treatments, and the studies that do look at efficacy are mainly case studies or involve around five participants. Therefore very little data exist and study conclusions cannot be applied to the whole population of people with CAS, yet
there are an abundance of treatments. In the next section, I will describe the following treatments:

Electropalatography
Feedback frequency
Integral Stimulation and DTTC
PROMPT system
Touch-cue method
Adapted cuing technique
Melodic intonation therapy
Computer games

3. Description and Efficacy of some Treatments for CAS

3.1 Electropalatography (EPG)

EPG is a technique that involves a pseudopalate, which is customized for each child. This artificial palate has 62 different sensors that detect tongue-palate connections during speech. These sensors relay the information to a computer monitor where the child can see in real time exactly what his or her tongue is doing and how its positioning needs to change (Nordberg 2011). This is, obviously, not an inexpensive procedure, and so the therapist needs to make sure that the visual, auditory, motor, and cognitive skills of the child are sufficient, and that the child has sufficient motivation to commit to the treatment (Carter 2004). If the child does not meet the criteria, EPG should not be used, because it is unlikely the child will reap the full benefits of this therapy.

Other factors need to be considered before starting a child on EPG therapy. A study by Carter (2004) looked at factors that might predict a child’s success with EPG, and found that age/maturity, how well the child was able to attend to the treatment, motivation of the child to succeed, and lack of structural abnormalities, such as cleft palate, were all good indicators. They also found that the effect the disorder had on the
child—whether it was that the child physically could not produce the sound or that the child could not understand the idea of the sound they had to produce, both of which can be considered CAS—was a helpful feature to evaluate. They predicted that the children with the production difficulty would benefit more than the children with the conceptual sound problems. The final factors that were useful guides for the researchers were those related to the actual therapy and what was needed. Children with less complex disorders had a higher chance of effective therapy because they would be able to spend more time on each of the specific problems than children who had more complex issues (Carter 2004). Other studies done by Dagenais (1995) and Nordberg (2011) have also concluded that EPG is an effective treatment for children with many kinds of articulation disorders, including CAS.

Despite the above studies, EPG is not a guaranteed fix, despite taking advantage of visual cues and repetition, which I am arguing are important for an effective treatment. EPG lacks tactile and auditory inputs, which would add to the multisensory experience of the child and make the treatment stronger. EPG is also a little too dependent on the abilities of the child, as well as how severe the disorder is, to be universally recommended for children with CAS. In a relatively mild case of CAS, EPG would probably work, but a different, less expensive treatment would probably work just as well. Children with more severe CAS would get some benefit, but EPG should be the last resort, because the cost of the treatment is high and the child is not guaranteed to make significant progress.
3.2 *Feedback Frequency*

Feedback frequency is not necessarily a treatment for CAS, but it can be helpful in implementing other treatments. This is a technique that simply requires the therapist to give feedback on the sounds that the child makes. There is high-frequency feedback, in which the therapist comments after every trial, and reduced frequency feedback, where the therapist only comments after half of the trials (Maas 2012).

Feedback frequency is a universal teaching technique. It is used when intrinsic feedback, such as knowing when and where your tongue touches your alveolar ridge, is not enough to learn from mistakes.

Feedback frequency has had differing results in the past. In some studies, high-frequency feedback was more beneficial, while in other studies reduced frequency feedback was more effective. It appears that adults respond more favorably to reduced frequency (Austermann Hula 2008), but children seem to have better results with the high-frequency feedback (Maas 2012). One compromise is to have the feedback rate decrease over time so that the participant can learn to depend on themselves instead of the therapist for feedback (Edeal 2011). Studies have not concluded that high-frequency feedback is better than reduced frequency feedback overall (Maas 2012). Like most other therapies for CAS, it seems that the best method is to use the feedback rate that each individual child seems to require, based on retention rates and their ability to apply learned sounds in one word to another word.

Adding feedback frequency to a child’s therapy is unlikely to be detrimental, especially if it is adjusted appropriately for each child. It can also strengthen one of the
three kinds of multisensory feedback outlined in Section 1 by emphasizing the input that
the child is not attending to.

3.3 Integral Stimulation and Dynamic Temporal and Tactile Cuing (DTTC)

Integral stimulation is a technique that involves repetition and imitation, with the added
benefit of visual and auditory models (Bowen 2013), such as recordings or pictures.
Since the creation of this technique, it has influenced the treatments for people with
functional articulation disorders, dysarthrias, and acquired apraxia of speech. It involves
giving a high level of support to the individual at the onset of therapy. This means that in
addition to the client speaking slowly with the clinician, there are tactile inputs, such as
touches to the face or adjustments of the jaw and lip postures. As the client is able to
produce these utterances more accurately, the visual and tactile inputs lessen or increase
to provide the right amount of support until they are no longer used at all and the client is
able to produce repetitions of increasingly difficult utterances (Bowen 2013).

Speech language pathologists and therapists used the basic structure of integral
stimulation to create most of the CAS therapies that are available today. The therapist
says the word or syllable with the child, the child looks at the therapist as the word is
pronounced, and the child presumably listens carefully (or as carefully as they are able)
to the therapist. DTTC is a variation on integral stimulation that was developed by
Edythe Strand for nonverbal children. This method is for children who cannot achieve a
close approximation of consonants or vowels (Bowen 2013). It involves eight steps, listed
in Figure 1 in the Appendix. This treatment focuses on the conditions of the therapy
session, such as the number of practice utterances and speech sounds per session and the
kinds of things that are done to retain the child's attention, which are aimed to give the child more independent and automatic speech skills (Strand 2008).

A different study done by Strand (2006) shows that of four children, three began to change their utterances appropriately soon after treatment began. While this is promising, nothing specific about the treatment can be determined to be necessary for improvement. There were certain factors that were kept constant between trials, but not how often the sessions were, how many trials per session, or how parental involvement might have contributed to the success or failure of the treatment (Strand 2006). All that can be said is that the treatment seemed to work.

A third study by Strand (2000) was a case study of a young female who had undergone two years of other kinds of therapy with no results. At the beginning of the study, it was estimated that about 10% of her utterances were comprehensible with context. After undergoing DTTC for at least 33 weeks, four times each week, the patient showed improvement in her intelligibility, especially on the phrases that were relevant to her everyday life (No, Hi Daddy, I don't know, etc). She still experienced several problems, but the target sounds and words improved, as did nontarget words that included target utterances (Strand 2000).

A fourth study looked at four essentially nonspeaking males, all around the age of six (Rose 2007). They had all had speech therapy previous to this session, and all but one of them were of normal intelligence. At the end of the treatment, three of the participants had shown improvement. The study concluded that the frequency of treatment, a high number of repetitions of the sounds, practice with family, and a decline in the instances of highly specific feedback were all contributing factors to the success of the treatment.
The lack of improvement in the fourth participant was thought to be due to lack of motivation, not because of the inefficacy of the program (Rose 2007).

Several conditions for DTTC therapy are needed for the child to develop the necessary skills for independent speech. For example, DTTC is more effective when it is used in conjunction with tactile, gestural, and prosodic cues or melodic intonation therapy techniques (Bowen 2013). In short, it is more successful when it uses multisensory inputs. While these are all important, probably the most important factor is that the therapist be able to accurately “read” the child and their abilities during that session. CAS is a condition that varies from day to day; some days the children do much better than others, and the therapist needs to be able to accurately judge what a child is capable of doing on any given day (Strand 2006). He or she needs to be flexible in which stage of the treatment they work on—a child who could successfully go through stage 5 of DTTC one day might need to go back to stage 4 the next session. Progress will not be made if the clinician resolutely sticks to a linear progression through DTTC, because if the child needs to go back to stage 4 from stage 5, they will not learn anything during therapy if the therapist continues with stage 5 anyway. That is why being flexible is even more important than overloading a child with trials or not having enough sessions in a given week.

It seems that integral stimulation and DTTC can be used effectively on children with CAS, as long as there are multisensory inputs along with the treatment. This shows that while repetition and imitation are sufficient to improve a child’s speech, multisensory input is what makes a treatment truly effective.
3.4 Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT system)

The PROMPT system is a treatment that does not rely on imitation for success (Bradford-Heit 2005), unlike most other treatments. It is organized based on the theory that CAS is a movement disorder as opposed to a neurological one, and so focuses on reprogramming the brain’s pathways so that the child can eventually speak without thinking about the movements necessary to make sounds (Hayden 1984). The premise is that tactile inputs will help solidify any changes to the brain’s pathways that happen when learning new speech movements (Grigos 2011). This is promising because a few studies have shown that imitation is not actually a good technique to use on children with CAS (Bradford-Heit 2005).

PROMPT works by imposing a target position for every sound, which eliminates the need for the child to guess at where the placement might be (Hayden 1984). The

![Diagram](image)

**Figure 2.** Tactile Signals for tongue-palate connections (Hayden, 1984).
therapist cues these placements by touching specific places on the child’s face and throat. Figure 2 shows the cues for the tongue-palate connections, Figure 3 shows the jaw height for the vowels, and Figure 4 shows the facial cues that are used for signaling nasality in consonants, whether or not the sound is voiced, and tenseness in the vowels (Hayden 1984).

An important aspect of PROMPT therapy is that the child’s original speech pattern is not disrupted. Rather, the old pronunciation habits are guided toward the target

**Figure 3.** Diagram for the jaw heights and their associated vowels (Hayden, 1984).

**Figure 4.** Contact points on the face for prompting certain sound features (Hayden, 1984).
positions. As the child progresses from single sound utterances to coarticulation, timing of the cues becomes much more important. The cues must be given so that the right amount of time elapses for the speech to sound natural (Hayden 1984).

A study by Grigos (2011) evaluated the effectiveness of PROMPT by studying two male children. One had a speech disorder, and the other, who was used as a control, did not. The boy with the disorder made progress with the different aspects of speech he struggled with, most significantly in the area of controlling his jaw height (Grigos 2011).

Another study included four children, all between the ages of three and a half and six (Dale 2013). Two of the children received the full PROMPT treatment throughout the duration of the experiment. The other two children only received the full PROMPT treatment after a period of receiving PROMPT treatment without tactile input. At the end of the experiment, all of the children had made improvement, but the children who had tactile input throughout the experiment showed slightly greater gains than the other pair (Dale 2013). This study shows the importance of multisensory input for a successful treatment. The PROMPT system, one of the more successful treatments, lost efficacy when the researchers removed the multisensory input. These inputs need to be present for the child to make as much progress as he is capable.

Bradford-Heit’s article (2005) described two case studies, one with a boy and one with a girl. Both had persistent CAS and had seen therapists before with no results. A six-week study period showed that the boy did benefit from PROMPT therapy, but the researchers believed that more time would have yielded greater results. The girl quickly picked up on the new consonant articulations and was able to apply what she had learned to other areas of her speech (Bradford-Heit 2005).
This treatment appears to work well on children with CAS and has the common factors of multisensory inputs and repetition. As with the other treatments, however, much more research needs to be done on the treatment before effectiveness in the larger population can be concluded.

3.5 The Touch-Cue Method (TCM)

The touch-cue method is similar to PROMPT in that the cues for sound production are on the face and neck (Korpilahti 2011). As of 1984, there were eight standard cues on the face (Bashir 1984), shown in Figure 5. If the child is experiencing difficulty regarding the voicing of the consonant, the therapist puts a finger on the child’s larynx while their other hand cues the consonant on the child’s face. For the vowels and other consonants not given in Figure 5, the therapist can create his own cue, but it is necessary that the cue be

![Figure 5. The different facial prompts for TCM (Bashir 1984).](image)
Stage 1  Nonsense syllables  This stage focuses on drilling monosyllabic nonsense syllables. Auditory (therapist saying the sound) and visual stimuli (drawing the child's attention to the therapist's mouth) are provided in this stage, along with the cues.

Stage 2  Nonsense syllables and short words  This stage focuses on putting together the previously learned nonsense syllables into polysyllabic nonsense sequences, as well as real words.

Stage 3  Words  This stage uses the sequencing skills that the child has learned to create multiword utterances, and eventually spontaneous speech.

**Figure 6.** Stages to TCM as defined by Korpilahti & Martikainen.

consistent throughout therapy (Bashir 1984).

TCM is different from PROMPT in that there are three distinct stages for TCM (Korpilahti & Martikainen 11), summarized in Figure 6. PROMPT is more loosely structured and relies more on the therapist's judgment. The stages for TCM are broken down into sub-stages (not shown in Figure 6) that are easier for the child to synthesize. Progression between stages is dependent on the accuracy of the child's productions, lack of backslide between sessions, and readiness of the child to go to the next step. Therapy is discontinued once the child is always able to produce intelligible speech and can self-correct speech most of the time (Bashir 1984).

The Korpilahti (2011) case study used a combination of therapies for a child with suspected CAS. Melodic intonation therapy (MIT) was given first (see Section 3.7), and TCM was given second. The subject made significant gains after TCM, and the child started correctly sequencing novel words when they were related to the practice sounds after TCM therapy (Korpilahti 2011).
This result needs to be interpreted cautiously, however. TCM alone only uses tactile input, and it is possible that the results from the TCM study were skewed because the researchers utilized MIT, which incorporates auditory input, first. When the children were exposed to the tactile input of TCM, they had also been exposed to the auditory input of MIT. The results for TCM were potentially affected because of this. In addition, there are not any studies that only look at TCM, so the results from this study cannot be confirmed. The addition of more of the multisensory inputs would possibly make this a more effective treatment.

3.6 Adapted Cuing Technique (ACT)

ACT uses visual input in addition to auditory input to help the child produce speech. The theory behind this is that visual inputs are better assimilated by apraxic speakers than auditory (Klick 1985), and so by giving them a visual to go along with the auditory, they will be more likely to remember what needs to happen if they receive a certain auditory stimulus.

For ACT, the visual stimulus is the therapist’s hand, which mimics the movement happening in her mouth as a word is produced (Klick 1985). The tongue’s trajectory, not just the static position, is shown by moving the hand to the left, right, up, down, etc. The exceptions to this are the nasal consonants: the therapist signals [ŋ] and [n] by moving her hand to her nose, and [m] is cued on the lips. Consonant stops are cued by a quick movement of the hand away from the speaker, while consonant continuants are cued by a slower, sideways movement. Finally, individual speech sounds are cued by finger movements. These movements are loosely based on the ASL alphabet, and the therapist
“spells” out words based on how they sound, not how they are actually spelled (Klick 1985).

Vowels are cued differently from consonants, as might be expected. For all vowels, the hand is held in a “c” configuration, with the fingers pointing towards the therapist’s cheek (Klick 1985). The jaw height is demonstrated by the distance between the thumb and other four fingers are. So, for a high vowel like [i], the fingers and thumb would be close together, while for a lower vowel like [o], the fingers would be farther apart. For the other aspect of vowels—tongue backness—the therapist moves his/her hand to the placement. So, for a front vowel like [i], the hand would be up by the lips, while for a backer vowel like [o], it would be slightly in front of the ear. The therapist cues diphthongs by moving the hand from the first vowel position to the second vowel position. So [ai] would be cued by moving the hand from the [a] position to the [i] position. These cues are not meant to be static representations of speech sounds. They are meant to show the fluidity of speech and to guide the child in their productions (Klick 1985). This therapy is very similar to TCM, but they differ in two ways. The first is that ACT has much more structure in the cuing system, and the second is that the TCM cues touch the child’s face whereas ACT shows the cues on the therapist’s face.

In one case study (Klick 1985), there was a great deal of improvement over a six-month period. The subject went from a two/four word vocabulary to producing novel sentences. The parents reported more use of speech at home, and it was more intelligible than what the subject had produced before ACT sessions. This would suggest that ACT is a very useful technique, supported by its use of two of the three multisensory inputs as well as repetition, but this was just one study with one subject. No other published studies
of the effectiveness of this treatment were identified in the literature searches conducted for the current review.

3.7 Melodic Intonation Therapy (MIT)

MIT for children with CAS was originally developed for adults with aphasia, a speech disorder similar to CAS that is usually the result of a stroke. Helfrich-Miller adapted the therapy for children with apraxia. The aim of the adapted MIT is to take advantage of the musicality of language and to use music to support utterances. Melody, tempo, rhythm, and stress are all elements that belong to both music and language (Korpilahti 11). Research that shows that the neural pathways for language and music are not entirely separated, and MIT capitalizes on this overlap. MIT also assumes that by singing, new pathways for speech can be made (De Bruijn 2011). Helfrich-Miller theorizes that the music moves the speech tasks from the left hemisphere of the brain to the right, and this allows the patient to create new pathways for producing speech. Either way, there is something about making music out of speech that allows a patient to work around any neurological impairments they might have regarding speaking.

MIT appears to be a technique with varying levels of success. Helfrich-Miller (1994) did a study with three children who displayed gains in articulation and sequencing abilities at the conclusion. The case study reported by Korpilahti and Martikainen (1994) showed that the subject made gains in vowel production, but nothing else.

Music therapies are employed for other speech disorders, such as speech music therapy for aphasia (SMTA). One aspect of SMTA that was necessary, and that is probably necessary for MIT as well, is that the patient needs to be comfortable with singing. If he is not, the gains in therapy are not large (De Bruijn 2011). This likely has to
do with the extra effort required to make the patient comfortable with singing in addition to learning new sounds that they cannot quite produce.

MIT would not be a therapy to use with every child. For those who are comfortable with singing and are able to do it, MIT could be a very useful technique, but for those who are uncomfortable with it, the therapy would be more stressful and less therapeutic than intended (De Bruijn 2011). The failure of MIT to be more successful for a broader range of people may be in part because it only incorporates auditory input. Children with CAS have already been exposed to auditory input, yet it has not taught them what they need to know to produce speech. For whatever reason, be it the lack of multisensory inputs or an ill-chosen input, the studies reviewed here suggest that MIT does not work universally enough to be the mainstay of treatment for children with apraxia.

3.8 Computer games

A wide variety of computer games are available for children with speech disorders. One website lists 27 different language games for children ages one through six (Online Games and Activities), and a Google search revealed several other websites with similarly lengthy lists of computer games for children with speech disorders. Many of these games require parental involvement because the child will not have the necessary skills for playing the game, but the parent is there mostly to move the mouse, do any other computer-oriented task, or keep the child’s attention on the game. Most games have the child working with the alphabet or colors, and a few have the child doing activities that involve putting pictures or tasks in the right order (Online Games and Activities).
Unfortunately, a literature search did not locate any research on the efficacy of computer games for CAS, possibly because they are designed for helping out at home more than in the clinician’s space. This does not, however, mean that they are irrelevant tools for children who are struggling. As I will elaborate on in Section 4, games have been effective teaching tools in the classroom and in child therapy, and so could be just as effective in teaching children about speech and what they need to do to improve theirs.

### 4. Game Therapy

Games are a useful teaching tool for many reasons. Many video games are useful because they challenge the player, and yet they keep the player engaged because he or she perceives constant progress (Murray 2004). Games can also be helpful in the development of a child’s social, cognitive, language, and fine-motor skills (Catapano 2005). Most importantly, people retain information best when they are entertained (Murray 2004), and games are great for keeping people entertained. When people use creativity to work towards their goals and the consequences of their work can be observed, they are better able to process the information and figure out what they do not know (Murray 2004).

Because games are such diverse tools, they are used in a variety of settings, from school classrooms to psychological therapy for children (Matorin 1996). They have actually been used as a therapy technique with children from the early 20th century, when Anna Freud used them to help her younger patients talk about events that otherwise would have been too difficult for them to talk about. Games are currently used by child therapists across several disciplines, and the use of board games in therapy stems from their use in classrooms. While it has not been documented very thoroughly, therapists
suggest that games promote motivation on the part of the patient, and as Anna Freud noted, the more unwilling children are more likely to participate if there is a game because they do not necessarily view the game as therapy (Matorin 1996).

An important consideration when designing games as a therapeutic technique is the age-appropriateness of the game. If you give an infant a computer game and expect them to learn on their own, nothing is going to happen. In addition to being age appropriate, the game needs to be interest-appropriate as well. One way to accomplish that for young children is to incorporate items they come across every day into the game (Catapano 2005). For older children, it might be more worthwhile to introduce aspects of chance or competition into the game (Robinson 2012). The additional chance or risk associated with games may actually enhance participants’ experience and help them retain information (Camp 2012).

Several different theories have been proposed as to what makes a game a good one for learning. Rob Houser (1998) presented seven principles of what makes a game effective for learners, summarized in Figure 7 in the Appendix. Granted, these principles are intended for computer games, but the basic concept underlying each of the principles can be adapted to other kinds of games. Regardless of the medium, all games aim to entertain people, so what makes one game medium effective can be adapted and applied to a different game medium.

Garris (2002) believes that the principles are control, mystery, challenge, sensory stimuli, and rules/goals. The player needs to feel that they are in control of the game. They need to be able to figure out the game on their own and not have all of the information given to them. At the same time, there needs to be an element of mystery. If
they can figure out everything from the beginning, there is no point in the player continuing the game. This requires the right level of difficulty and a certain level of chance. Sensory stimuli are helpful in retaining the player’s engagement. If offered a choice between a computer game that used a white screen as a background and one that used images, the computer game with images would probably retain the player’s interest for longer just because there is more to see on the screen with images. Lastly, goals are important as feedback for the player. By reaching their goals, they get the sense that they are improving (Garris 2002).

A final point about games: children really like them. When asked which subject in school they like best, children choose the ones that include hands-on activities (Fox 2004). They are drawn to board games and are eager to participate in therapy when there are games around (Matorin 1996). Games bring children together, even if it is only for a little while (Fox 2004). Having a community where the child has the same problems as everyone else in the group can take away pressures like embarrassment or the need to fit in. The child is already is accepted into the community because everyone there has the same problems and understands what it is like to have them. In essence, the children in group therapy become a support group that they probably will not find elsewhere.

While there are many computer games available for children with language disorders, a board game that brings together a group of children with language disorders does not yet exist. All of the games created specifically for speech disorders are single player, and multiplayer games are an undeveloped resource at present.
5. Proposal

In light of the evidence on the efficacy of treatments for CAS, as well as evidence for the benefits of games as teaching tools, I propose creating more board games or other physical games (i.e., not computer games) for children with CAS. These would be games specifically geared towards furthering therapy for children with CAS. They would include elements of phonology to improve the child’s understanding of how their disorder is affecting them, as well as the multisensory inputs that make the current treatments effective. I would also strongly encourage incorporating some of the therapy features of the PROMPT system and integral stimulation. These appear to be the most universally effective methods and so would be the most helpful techniques to use in a game intended for children with a wide variety of articulation problems.

There are three reasons for my recommendation of board games as a new therapy technique. First, board games are proven to be very effective tools in the classroom for promoting long-term retention, as described in Section 4. Long-term retention is an important goal for children with CAS. Also in Section 4, I reviewed why games are good tools for any kind of therapy that involves children. While neither classroom education nor psychological therapy closely mimics speech therapy, both of them involve aspects of what happens during a speech therapy session, and so it makes sense to use games in speech therapy, since games work so well for teaching and child therapy.

Second, while there are many computer games and online materials available for these children, there are three big problems with them. The first is that none of them are multiplayer games or incorporate an online community. The child performs tasks independently in front of a computer screen. These games are not social, but giving these
children opportunities to practice and improve their speech in social settings is very important. Studies have shown that children with CAS withdraw from group activities with nonspeech-impaired peers, and are more lonely and isolated than the typical child (Lemonnier 2010). Other studies suggest that adults with apraxia are at a higher risk for depression and generally have a lower socio-economic status than other adults (Murray 2012), which is another good reason to socialize children with CAS. These are children who really need to practice being social and become comfortable.

The second problem with the existing computer games is that there is no guarantee that the child is actually doing the speech exercises that the computer game is assuming, and there is no one around to provide guidance for incorrectly pronounced sounds. The third problem with computer games is that they physically cannot make use of the most important of the multisensory inputs: tactile input. Almost every therapy that uses some form of input uses touch—specifically the therapist touching the child’s face—but online games cannot make use of this most important cuing system. Maybe technological advances will some day address this shortcoming, but for now, the child is unable to receive tactile inputs through computer games, so this is not an optimal medium.

A final reason for promoting board games is that speech therapists are working with children, who generally like games. If children are enjoying what they are doing, even if it is learning about their disorder, they are more likely to relax, and when people are relaxed and enjoying therapy, the sessions can go for longer without the patient becoming fatigued (De Bruijn 2011).
While changing the computer game from single to multi-player would be a step in the right direction for treating CAS, board games would be even better than computer games. Using board games makes the children interact with other people face-to-face, without a computer screen in between them. The speech therapist would also be able to interact with the children more easily and make sure that the children are using the proper techniques, which would be harder to do with the child looking at the computer screen (unless, of course, you are using EPG).

Board games would not be used much for children who are first coming to therapy, though, because if they start exclusively with group therapy, the therapist will not be able to focus on the child’s specific problems or give them the necessary amount of attention for real improvement. The children who would be using game therapy a lot would be the ones who have become comfortable with therapy and whose condition has improved to the point where they do not need the therapist’s constant attention. In addition, a child who begins only with group therapy is unlikely to make a lot of improvement, certainly not as much improvement as they could make in one-on-one sessions with a therapist, because the therapist is focusing more on the problems more common in the group as a whole. Once the child reaches the point where they have learned as much from one-on-one as possible, group therapy could be very useful to implement for the psychological reasons stated earlier in this section.

The following board game proposal is for children between the ages of 5 and 10, and requires at least two but no more than four players.
5.1 Materials

4 mirror panels
1 game board with embedded sound players
4 game pieces
1 six-sided die with the numbers 1-3 only
1 Allen wrench
1 dry erase marker
2 sheets of stickers
16 coloring pages

Figure 8. Sketch of the proposed board game, with some instructions.
5.2 Goals

The object of this game for players to make their way around the board and gain as many points as possible. At the end of the game, the players can choose to save their points for the next time the game is played, or use their points to buy items, such as stickers or coloring pages or whatever else the therapist deems fit to offer the players. The goal is not for the players to play against each other, but rather for the players to play against themselves.
5.3 Instructions for the Therapist

**Set-up**

For each of the players who opt for visual input, attach a mirror to the board game so that it is facing the player who wants the visual input. Then write the appropriate sound symbols on the whiteboard squares and make the appropriate recordings. To make a recording, insert an Allen wrench into the hole between the play button and speaker, which can be seen in Figure 9. Hold it down for as long as the recording takes, and then remove the Allen wrench. This will stop the recording. If you are unsatisfied with a recording or want to change the sound, simply insert the Allen wrench once more and the new recording will overwrite the old.

**Play**

In this game, the therapist is a part of the game. They are there for the tactile inputs that the newer children need and the more practiced children can opt for. The older children who are learning to not be reliant upon inputs in general have to use their points to buy tactile cues for a sound. The other two multisensory inputs are provided by the mirrors and the sound players.

5.4 Instructions for the Players

To begin the game, use a normal die to decide who goes first. The first player then rolls the die that comes with the game and moves that many spaces forward. If the player lands on a square with a sound, they roll the die again and whatever number they get, they produce the sound or sound cluster that many times.

If

- the player pronounces the sound correctly the right number of times, then they get 2 points.
• the player does not pronounce the sound correctly but attempts to pronounce it the correct number of times, then they get 1 point.
• the player does not attempt to pronounce the sound the right number of times, they get 0 points.

As a player advances in one-on-one therapy, the therapist can decide to start requiring the player to buy tactile cues. The player can forego the mirror and the sound players when he or she feels comfortable with doing so.

If
• a player does not use the mirror during their turn, they get an additional 2 points that turn.
• a player does not use a sound player during their turn, they get an additional 1 point that turn.

The points would act as money, and the child can “purchase” rewards from the therapist at the end of the game. Rewards could be things objects like coloring pages or privileges like choosing the next game to play. By using a reward system, the children are not playing against each other, but against themselves. That way, less advanced children can play with more advanced children without feeling like they are at a disadvantage.

Another option would be to adapt games that are currently available. One such game would be MaNiKi, in which the child is given cards with a sound that represents an instruction. This would be the perfect kind of game to adapt because sounds are already built into the game and are a fundamental aspect of it. There are probably many more of these kinds of games that can be used until board games for children with speech disorders are developed.
6. Conclusion

As so many of the studies I read have already pointed out, much more research remains to be done on CAS before firm conclusions can be determined about the efficacy of different treatments. More research should probably be done on the effectiveness of the treatments before board games that target speech disorders are created. Board games created before there is a more comprehensive understanding of the disorder will not necessarily use the most effective methods for improvement.

The most effective treatments are those that involve multiple sensory inputs and have the appropriate amount of repetition according to the individual child’s capacity at that session. The three multisensory inputs considered here were tactile, visual, and auditory. At least one of these inputs is included in the therapies that I have reviewed in this paper, and the treatments that include more than one of these inputs appear to be more effective than those that do not. But as I already stated, more research into these treatments is needed.

One technique several other fields have used to ameliorate psychological difficulties is game therapy, which could be incorporated into the speech therapist’s repertoire of possible therapies to try with particularly reserved patients. Games can easily incorporate the multisensory inputs necessary for a successful therapy, and confer several benefits, such as relaxation and stronger retention, that come from using games in therapy or teaching. Both teaching and therapy happen during a therapy session with a child who has CAS (therapy for the mouth postures, teaching for phonetics and what the rules of the language require). The game I proposed can be used with patients further along in their treatment who do not need the constant attention of the therapist, as well as
patients who are at the beginning of their therapy. It is structured so that the patients at the beginning of their therapy can play this game just as easily without feeling at a disadvantage.

This disorder is very difficult, both for the patient and the therapist. With more research into causes of the disorder, which treatments are most effective, and how new therapies can incorporate games to create a better therapy and learning environment, this disorder can become easier to manage. Research could be better directed by publication of the unsuccessful trials. If data from studies that also document treatment failures were made available, the percentage of failed versus successful studies of a particular therapy could be compared. Possibly, small patient samples could be combined for a larger analysis. Both methods could allow for a more informed judgment of which treatments are ultimately the most successful. Only then can a truly comprehensive view of the treatments for the disorder be formed.
## Appendix

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Imitation</strong></td>
</tr>
<tr>
<td>2</td>
<td><strong>Simultaneous production with prolonged vowels</strong></td>
</tr>
<tr>
<td>3</td>
<td><strong>Reduction of vowel length</strong></td>
</tr>
<tr>
<td>4</td>
<td><strong>Gradual increase of rate to normal</strong></td>
</tr>
<tr>
<td>5</td>
<td><strong>Reduction of therapist’s vocal loudness</strong></td>
</tr>
<tr>
<td>6</td>
<td><strong>Direct imitation</strong></td>
</tr>
<tr>
<td>7</td>
<td><strong>Introduction of a delay</strong></td>
</tr>
<tr>
<td>8</td>
<td><strong>Spontaneous production</strong></td>
</tr>
</tbody>
</table>

**Figure 1.** The steps of DTTC (Bowen)
| Principle 1 | Users should be able to learn how to begin using the application quickly and with minimal effort. |
| Principle 2 | Users should always know what they are supposed to do to succeed |
| Principle 3 | Users should be provided only enough instruction to get started and keep going |
| Principle 4 | Users should not be distracted physically or psychologically from the task at hand |
| Principle 5 | Users should receive helpful suggestions related to the task they are performing, which they can adopt or ignore |
| Principle 6 | Users should be immediately successful with the application and be gradually introduced to its more complex aspects through staged interfaces |
| Principle 7 | Users should be aware of how effectively their actions are helping them achieve their goals at all times |

**Figure 7.** Summary of principles for a good game (Houser 1998).
References


