



Can you hear me? Breaking the Silence of Dyarthria Utilizing Technology

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Abstract

This study focuses on language delays associated with autism spectrum and intellectual disabilities and the use of speech generating devices for those individuals with such afflictions. Specifically, this research will focus on the areas of Autism, intellectual disabilities, ToM, Speech Generating Technology, and EF to provide one picture of the problem being studied.

For this study, the following items will be the focus of the study while excluding number five from the criteria: (1) Individuals with severe dysarthria or who are completely non-verbal. (2) Individuals who use speech enhancement services such as speech therapy or Voice Output Communication Devices (VOCA) [1]. (3) Age of individual shall not matter so long as the individual is utilizing speech therapy Voice Communication Output Aides for speech enhancement/building. (4) Afflicted Individuals must be enrolled in an eligible program that offers speech therapy and/or device usage as part of treatment (5) Afflicted Individuals who are Mild/high functioning autistic and Asperger individuals will not be included as they can clearly verbalize. The issue this study will not cover is the in-depth look at the anatomical damages per MRI or other imaging measures to gain a separate picture of how brain damage affects the speech and auditory areas of the brain.

Keywords: Therapy; Communication; Therapy

Introduction

Theory of Mind (ToM) and Executive Functioning (EF) have been linked in the literature to understand how individuals with autism and Intellectual Disabilities (ID) perceive the world around them in relation to others.

The distinction between the two concepts begins with the Theory of Mind, how one perceives another's reality such as feelings, moods, and imagination outside of their own [2]. The Theory of Mind has been consistently referenced throughout the literature as being a way one perceives the mental and emotional state of others [2]. This theory embraces the skills required to manage social communication and relationships in both human and non-human primates. More effectively, the theory was developed on the basis that certain mentalizing mechanisms and cognitive abilities give rise to awareness that others have a mind, desires, intuitions, intentions, and emotions [2]. However, one important aspect about the Theory of Mind is the evolution of such a theory depends heavily on the increased size of the neo-cortex, preferably the frontal lobe [2,3].

Another important fact concerning the theory of mind states that the development of such a mind begins around the ages of roughly 3-4 years, with initial progression starting around eighteen months of age when language begins to rapidly develop [2]. Language appears as the foundation for the theory as without language development, there would be no theory [2]. Early language development has been a common predictor of later ToM ability in children whose Broca's area has full developed [4]. Although simple forms of Theory of Mind depend largely on the visual functions of mirror neurons, higher orders of the theory depend on pragmatic thought patterns. How does the theory of mind develop in those with autism and intellectual disabilities when considering how a child without autism or a developmental delay brain develops is what this research wants to answer [2-4]. The textbook definition of a normally developed brain in a child would be the ability to talk, walk, and engage in pretend at the target age of one to two years [3,4]. A further exploration into the executive functioning of the brain of an individual with autism and intellectual disabilities would help bring to light what has not been explored in the literature.

Autism Spectrum Disorder is a neurodevelopmental disorder with a prevalence of six to one thousand affected children and adults nationwide [2,3]. Intellectual Disabilities affect about 1 in 12 children between the ages of 3-17 in the United States that are related to voice, speech, and language [5]. Other conditions related to intellectual disabilities are Spasmodic dysphonia, a voice disorder caused by involuntary movements of one or more muscles of the larynx (voice box), can acquire aphasia (a loss of the ability to use or understand language) and develop a condition known as persistent developmental stuttering [6-8]. The genes that were discovered to create the above symptomology are similar to the genes that were discovered to create the classic symptoms of autism, the mutations and deletions of the FOXP1 and FOXP2 genes [9]. The mutation of PTEN tumor suppressor gene show prominent autistic symptomology, placing both disorders that create issues for the individuals afflicted side by side. However, with either genetic disturbance, theory of mind develops poorly in connection with pragmatism and pretend play, which often leaves parents, guardians, and care takers with more questions than what can be provided.

It is difficult for children with poor ToM to assess their own mental states, but adults and adolescents with autism spectrum or a mild intellectual ability, within normal IQ range, have been known to perform conceptual ToM tasks at various levels of complexity [2,9]. Children with moderate to severe autism and intellectual disabilities, on the other hand, have limited understanding of what terms such as idioms and metaphors refer to [2,3]. The good news is that due to the ToM being malleable in children and adolescents, affected individuals can perform better when properly motivated to respond appropriately in social interactions [2,10].

The Executive Functioning (EF), where Theory of Mind typically develops, is another piece to the puzzle of understanding the pragmatics and overall functioning of an underdeveloped brain due to autism and intellectual delays. Executive functioning is in the brain's frontal lobe and is the main control center of the brain [3,11]. EF controls one's fluid intelligence, planning, behavior, and language to name a few. Theory of mind and the executive functioning are the basis of language development and the main control center for several of the body's main functions [3,11]. Therefore, it is strongly suggested that Theory of Mind and Executive functioning are linked in the development of one's active social function [3,11]. In fact, the neural networking of the ToM should be sought in the developing brain circuitry shaped by the interpersonal

communication with others [2,3,11]. In other words, the theory of mind can be shaped by simple communication with the right techniques by behavior therapists and clinicians by utilizing proper intervention techniques such as goal tracking or Antecedent, Behavior, and Consequence sheets (ABC sheets). It is likely that the interactions between the EF, ToM, and their wiring to social influences are important for an intact ToM development. The effective forming of this network of specialized regions in the EF can be thought of as the social brain [2,3,9].

The gaps in the literature this researcher is seeking to fill are the connections between the Theory of Mind, Executive Functioning, and language development and if Voice Input Output Communication Aide/Voice Output Communication Aide devices can assist individuals who are non-verbal and/or severely delayed find their voice. More specifically, this study is interested in how effective a VOCA device would be to the individual when used in a home, clinical, school, or school like setting such as a day program [12]. For this study, the researcher shall design an exploratory qualitative survey questionnaire to survey care takers of Speech Generating Device (SGD) users to understand how effective a VOCA device is so individuals who are non-verbal and severely delayed can express their wants and thoughts, despite not being able to verbalize [1,12]. The survey shall be specifically written from the perspective of these care takers as they are those who would be able to provide detailed explanations of how an affected individual uses these devices and for how long a device has been used. The themes emerging from these will be coded within the research to reflect how one event affects another. This includes the likeliness of the individual's ability to get their needs met using a Speech Generating Device in their specific setting. An example would be if an individual were to make a request for a snack or needing to use the restroom. The care taker, clinician, or direct support professional would be alerted to the individual's needs and respond to the individual accordingly.

Research Problem

DeVillers and DeVillers [4] and Iacoboni [10] discovered a special set of neurons in the brain's primary somatosensory area that are linked to speech that can enable any individual to voice their concerns and wants. The set of neurons discovered are called mirror neurons [4,10]. These neurons are located in the following areas of the brain: pre-motor cortex, the supplementary motor area, the primary somatosensory cortex, and the inferior parietal cortex [4,10]. However, for several sets of autistic and intellectually disabled children with verbal delays who utilize Speech Generating

Devices (SGD), their care takers found using such devices helped them in gaining what was missing in the lives, their voice [13,14]. The question posed is whether the devices are more effective in school settings considering the nature of communication and interactions that occur in that setting than other settings. Past researchers made convincing cases regarding the role of language development using SGD in several settings, but the one setting that has limited literature is SPG device use in the home [12-14]. A child with an understanding of what they desire, listening and hearing language spoken by the child to understand what they most desire is what helps their care takers provide for them [4,10]. We can observe behavior in expressing wants and needs, but the proper verbal expressions for that child's age range can indicate the maturity of the ToM and development of the executive functioning for their stage of life [4,11]. The specific behaviors observed would lead to the second case of how the child obtains the information for a conversation. For example, when one verbally states their exact wants, the individual that can clearly verbalize will effortlessly head to the destination to get those specific wants met. This approach to ToM development, therefore, focuses on the importance of learning words as labels for mental states [4].

What kind of language reflects or supports the development of ToM reasoning to give researchers an understanding of the one's maturity is what several studies seeks to answer. Recent research focused on the verbs that reflect the one's mental state [4]. Rarely do children express their own and/or another's' beliefs until around four years of age. This study has been replicated with children who are slightly and moderately language delayed, but has not been studied with children or even adults whom are non-verbal and severely delayed in language [1,4]. Therefore, to fill the research gap, examining data provided by the population of care takers who care for individuals with dysarthria using Voice Output Command Aides (VOCA's) in either a school, home or day program setting will hopefully answer the researcher's pressing research question.

Problem Statement

Considering the gap in the literature the researcher seeks to fill, the specific problem being addressed is ToM, EF, language delays, and the use of Speech Generating Devices. By combining the four areas mentioned, the researcher hopes her study will fully investigate that despite one's inability to verbalize, their Executive Functioning and Theory of Mind either is or not intact to develop proper speech through the proper use of a SGD [2,4,10]. Mirror Neurons

have been identified in the literature as one of the main factors of language development, their functioning being firing at the sight or sound of another person or noises [10]. The main "job" of the mirror neurons, in addition to theory of mind, is to aid humans in aligning their behaviors with their peers during social interactions without regard to inhibitions [4,10]. In stating such, mirror neurons fire at the sight of another's reactions, even if the individual does not mimic their cohort through language or even physical imitation [4,10,11]. However, if the desire to mimic is strong enough, the individual will mimic their cohort, despite not knowing if their actions are ethical or unethical. Due to their biology that aids one in the development of their language, mirror neurons fit into the research network that will hopefully explain the impairment in the executive control autistic and intellectually disabled individuals experience. As previously mentioned, a normally developed child can express their wants and needs through verbal expression around the age four, but autistic individuals who cannot express their needs are not able to verbalize their wants, despite their age.

Purpose Statement

The purpose of this study is to understand how effective the afflicted individual's specific neural networks function with autism and intellectual disabilities. Further, the researcher's aim is to understand how VOCA usage and speech therapy are assisting the individuals who cannot verbalize for themselves and if either is aiding the individual in their goals to gain their voice or improve their speech. The researcher shall specifically sample and survey a group of care takers of VOCA users from two Facebook Assistive Technology Groups to gain an understanding of how the users (1) Utilize the devices, and (2) Understand how the device users utilize their SGDs such as for attention or when something is needed such as a bathroom break or specific items utilizing themes within the data as told by their care takers. Since the invention of advanced technology, Voice Output Communication Aides were created to help those with dysarthria to find what was missing in their personal vocabulary, their ability to gain their voices [12].

Research Questions

Can non-verbal individuals communicate their needs through Speech Generating Devices such as Voice Output Communication Aides?

Can individuals with severe communication delays communicate their needs through Speech Generating Devices such as Voice Output Communication Aides?

Hypothesis

Despite the inability to vocalize their wants, non-verbal and severely delayed individuals demonstrate an intact executive functioning and theory of mind when using SGD/VOCA devices.

Conceptual Framework

In order to provide valuable knowledge of the framework that provides and explains key concepts of this study, several aspects of the study shall be discussed, for example, Theory of Mind. The clinical aspects of autism and Intellectual Developmental Disabilities and other core developmental mental issues will also be among the aspects discussed, particularly how ToM, autism, and IDD impact the social outlook and interactions of individuals with communication disorders.

Theory of mind is a broad construct reflected in numerous areas of knowledge and skills [15]. Like language, theory of mind develops over time and builds from foundational precursor skills to complex understanding of how mental states and behavior interact in others [15,16]. Precursors of theory of mind include joint attention, appreciation of intentionality, recognition that different people have different perspectives, and pretend play [2,15]. Throughout the first few years of one's life, the development of language and theory of mind are entangled in a complex way. Infants engage in joint attention and demonstrate appreciation of others' intentions within the context of communicative acts [4,10,16]. However, children with autism and intellectual disabilities do not understand the concept of appreciating and understanding of mental states and behavior interactions of others. Instead, the child is stuck at the stage of egocentrism unintentionally due to their inability to recognize and appreciate another's world outside of their own. Like their language development, their ToM is not fully developed [2,3,15].

Theory of Mind and language development in autism is the most researched areas in the literature to date and according to ToM, communication refers to the full range of verbal/linguistic and non-verbal means for interacting with others [17]. Individuals diagnosed with autism and are verbal will voice sentences that are not related to the conversations they are having with others [18]. For example, an individual may count from one to five repeatedly during a conversation that is not related to numbers or may continuously repeat words he or she has heard from another prior, a condition called echolalia [19]. Echolalia is a delayed and immediate language abnormality that is a diagnostic characteristic of autism as rigid and repetitive language, for example, the individual

responding to a question by repeating the question asked to them [19]. Immediate and delayed echolalia occurs when the child repeats words someone stated moments prior that may or may not have been directed to them. While language delays in autism has been prominently researched, similar cognitive disorders such as Intellectual Developmental Disabilities (IDD) share a trait with autism in how ToM and language is affected.

Whether the individual experienced an anatomical accident such head trauma that created their intellectual disability or it emerged as the individual began to age, the development of language will almost always be impacted [20]. Intellectual disabilities, much like autism spectrum disorders, affect the executive functioning system in the brain where the language area, Brodman's area 44 and 45, is located [2,3]. Brodmann's area 44 and 45 serve different functions in the frontal lobe as displayed through an fMRI and is activated bilaterally [21]. However, the fMRI displayed main left hemisphere dominance during tasks requiring naming, judgments of phonology, semantics, and syntax. Broca's region is also activated during acquisition of grammatical rules, discrimination of speech sounds, production of words, estimation of time intervals, and reproduction of rhythms [11,21]. Thus, Broca's region seems to be involved in both perception and production of speech.

During the last decades of the 20th century, aphasia models were developed to illustrate the brain's organization of language to identify the genesis of certain language disorders associated with autism, IDD, and other mental deficits. Different categories of language disorders were reported in cases of brain damage, depending upon the specific location and severity of the damage [22]. The models were specifically named as Wernicke and Broca aphasias as both brain areas correlate to speech production, comprehension, and repetition [22]. However, damage to Wernicke's area (located in the left temporal lobe) or to the auditory cortex of the temporal lobe can lead to hearing deficits and ultimately, hearing impairments [11].

Hearing is critical to language development as communication is to speech and learning (Asha.org, 2015). Individuals with listening difficulties due to a hearing loss or auditory processing problems are at risk for developmental delays. An individual experiencing language delays will display the common signs which is linked to ToM delays (1) what is being stated to them such as their name, (2) simple hand gestures such as pointing, (3) concepts and following directions, (4) answering questions, and (5) identifying objects, numbers, and colors at the appropriate age (Adler, Bass,

and Watson, 2018). Final sound processing is performed by the parietal and frontal lobes of the human cerebral cortex, but will not be processed properly if the associated auditory cortex, Wernicke's, or temporal lobes are damaged.

If suspected language deficits are not monitored or the individual is not tested for language delays, challenging behaviors will manifest into the individual's social functioning due to the level of frustration of not being able to verbalize [23]. These behavior challenges may include the following behavior characteristics (1) non-compliance, (2) property destruction, (3) tantrums, (4) meltdowns, and (5) physical aggression towards self or others [20,23]. While these challenging behaviors occur in four to nine percent of typically developing children, the behaviors disturbances have been observed in twenty five percent of children with IDD and ASD [20].

According to DSM-V and ICD-10, the criteria for defining qualitative impairments in social functioning, language, and communication include the features delineated in both the APA and ICD-10. It is interesting to note that there are significant parallels between the features that are diagnostic of the social and the communication impairments [18]. Social interaction and communication are in some ways inextricably linked to one another, especially during the crucial developmental stages that mark the point when autism and intellectual disabilities become strikingly evident [18,24]. Understanding autism and intellectual disabilities as symptomology outlined in the DSM-V, ICD-10, and having an understanding of why Applied Behavioral Analysis was created surrounding the issues of language delays is very important to this study, especially when said subject was built on an extensive history of myths that the researcher is working to debunk.

Applied Behavioral Therapy (ABA) was developed to help those with language delays articulate communication [20]. The particular focus of the therapy is through direct therapy sessions utilizing picture cards, routine boards, or utilizing speech generating devices so the individual can communicate via technology [20]. In order to reduce problem behaviors associated with not being able to voice one's thoughts due to their aphasia, Applied Behavioral Analysis was developed to aid severely dysarthric and nonverbal individuals in getting their needs met through a series of tasks [20]. The ABA tasks consist of picture cards, writing, and gestures from trained therapists for afflicted individuals to follow to enable them to communicate with therapists to get their needs met. Trained ABA therapists/ line therapists' attempt to modify antecedents and/or consequences of specific problem behaviors

to discourage a problematic behavior and encourage an alternative behavior [20,23]. Functional behavioral analyses provide detailed measurement of potential instigators of challenging behavior, such as need for attention or help, escape from demands, attempt to get what is wanted, protest, or self-stimulation for severe dysarthric/non-verbal individuals [20,25].

Definition of Key Terms

- The term "autism" refers to the neuro-developmental disorder that affects communication, behavioral, and social domains within the individual diagnosed [3,18,26].
- The Cerebrum or Cerebral Cortex is the brain's complete structure with defining sulci, fissures, and grooves that separate each lobe of the brain that have very specific functions [310,11].
- The Executive Functioning is the area of the human brain, specifically the orbital frontal cortex, that controls higher order functioning such as planning, behavior, IQ, personality, and concentration, to name a few, that allows for everyday functioning [3,11,27].
- Intellectual Developmental Disabilities (IDD) is a disability characterized by a significant limitation to both intellectual functioning and adaptive behavior as expressed in conceptual, social, and practical adaptive skills. This disability originates before age 18 [9,11].
- Mirror Neurons are specialized neurons that allow one to align their behaviors/actions with those of the model and have a role in speech development [3,4,10].
- Error Neurons: The brain's ability to process how an individual makes mistakes [28].
- Speech Impairment: is a type of communication disorder that is accompanied by hearing loss, brain injury, neurological disorders, intellectual disabilities, and physical impairment [5,29,30].
- Theory of Mind is defined as one's ability to understand their reality as well as another's at the appropriate age [2,4].
- Orbital Frontal Cortex is the area of the frontal lobe where the executive function has been theorized to reside. This is an area of concern in the diagnosis of autism [3,410,11].
- Voice Output Communication Aide/Speech Generating Device: Speech Generating Devices (SGD) or Voice Output Communication Aids (VOCA) is portable electronic devices that allow people using them to create a message and produce speech [1,12].

- Pragmatic Speech is how one is able to express themselves through spoken language [2,3,11].

Significance of Study

This study will contribute to not only the continuing studies of language disorders associated with autism and intellectual disabilities, but to the educational curriculum involving the use of SGDs for individuals with moderate to severe dysarthria. Individuals who are non-verbal or severely delayed in language development may benefit from this study which may highlight the proper use of VOCA devices for individuals with moderate to severe dysarthria. This study may also provide insight into the use of VOCA devices in several settings and allow this researcher to make recommendations about those settings for VOCA devices.

Conclusion

Theory of mind is based on one's ability to state what is on their mind and what they desire due to the theory being based on language development [2,11]. The maturity of Broca's area 44 (Broca's area) in the frontal lobe of the human brain is responsible for one's ability to speak and gain an understanding of their and another's reality with the aid of mirror neurons [4,10]. However, communication disorders that accompany certain disorders such as autism and intellectual disabilities, specific diagnostic criteria must first be met before a treatment plan can be written for that individual to acquire the services needed so speech therapy and assistive technology can be provided. The research questions and hypothesis for the study ultimately seeks to specifically understand that, despite one's inability to speak, they can understand what is being said to them and though technology can reply or even put together words to form a sentence, thus attempting to hold a conversation, despite the diagnosis the individual has that contributes to their communication disorder.

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