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Research Article

Neurodiversity-Affirming Motor Speech Intervention for Autistic Individuals with Co-Existing Childhood Apraxia of Speech: A Tutorial

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Abstract

Clinicians are shifting their views on autism from a medical model of disability to a neurodiversity-affirming model, which embodies the idea of embracing and supporting all neurotypes from a strengths-based lens. We present the Motor Speech Intervention for Neurodiversity Affirming Practices (MIND-AP) framework for addressing speech motor issues in autistic children. MIND-AP integrates strength-based, neurodiversity affirming practices with motor speech treatment to provide connection-based, intervention for individuals dually diagnosed with autism and motor speech deficits. Currently, there is limited knowledge of how to implement motor speech interventions specifically for an individual with such dual diagnosis. The MIND-AP framework is comprised of 3 levels: 1) Bodily autonomy and sensory regulation; 2) Language and communication; and 3) Motor speech intervention. This tutorial article will introduce the levels and components of MIND-AP and provide evidence-based clinical strategies to support autistic individuals with motor speech deficits in each area of the framework.

Introduction

Currently 1 in 36 children are identified as autistic [1]. Communication difficulties in autistic children may range from minimally speaking, late talking to even hyperlexia [2,3]. Research has shown a portion of autistic children between the ages of 3 and 4 years do not develop the ability to speak beyond a few single words [4]. These communication difficulties may stem from cognitive linguistic differences, limited language, issues in speech attunement to ambient language, co-occurring oromotor disorders, and speech sound disorders including motor-based issues such as Childhood Apraxia of Speech (CAS) [5-10].

Studies have indicated a co-occurrence of CAS with autism [10,11]. CAS is a persistent and difficult to treat motor speech disorder and when this co-occurs with autism, it increases the complexity of diagnosis, educational strategies, and support services [5,11].

Studies on minimally speaking autistic children suggest that consonant/phonetic inventory and underlying speech motor impairment were significant predictors of expressive language development [12-15]. Interestingly, variables such as response to joint attention, parent responsiveness and communicative intent did not significantly predict expressive language improvements in autistic children [15]. These findings highlight the contribution

of speech production abilities to expressive language and communication in autistic children. As pointed out by Saul and colleagues, severe persistent expressive language difficulties in autistic children may indicate the presence of a co-occurring speech-motor issue rather than a consequence of core autism symptoms [14,15].

There are several effective and evidence-based motor speech interventions for non-autistic individuals with CAS (e.g. [16,17] however, these approaches were developed specifically for the non-autistic population and are not aligned with neurodiversity-affirming practice nor with consideration of the differences in neurophysiology, emotional and sensory regulation/sensory processing, differences in joint attention, language acquisition, differences in learning styles, autistic individual's passionate interests (critical for engagement and participation), and communicative preferences of autistic individuals (with the exception of pilot work by Beiting & Maas; Bottema-Beutel et al. [5,18]).

Neurodiversity movement and autism

There is no universally accepted definition of neurodiversity. The term was first described by Singer and embodies the idea that differences in thinking, sensing, processing, moving, communicating, and socializing are an integral part of one's personhood [19-21]. Autistic self-advocates suggest that these unique variations in processing and experiencing information differently than non-autistic individuals is central to their identity [22-24]. Dallman et al. point out that, autistic individuals live interesting and full lives, not despite their diagnosis but because of their embodied autistic experience [24]. However, many autistic individuals acknowledge that these differences lead to struggles in a neurotypical world. These may range from autistic burnouts from trying to suppress natural autistic responses and adopt neurotypical social alternatives [25], struggles with sensory overload [26,27] to limiting natural forms of self-regulation (*i.e.*, stimming) to avoid the deficit narrative and social stigma [24,27]. A neurodiversity affirming practice understands, acknowledges, and respects these traits and behaviors as natural to their neurobiological makeup [28].

More recently, speech-language pathologists and allied disciplines are shifting their view of autism along with the interventions and methodologies used to support this population [5,24]. As more autistic adults step forward and share their experiences and views, many practitioners are modifying their treatment practice that are more child-led and aligned with neurodiversity-affirming practices and self-advocacy [24]. To incorporate neurodiversity-affirming practices, clinicians must have a general understanding of the ways in which autistic individuals learn language, process sensory information, and experience the world around them. In the same way that traditional speech and language therapy approaches need altering to better support our autistic clients, so do motor speech therapy approaches.

There is limited knowledge of how to implement motor speech interventions specifically for a dual diagnosis of autism and CAS. One recent proof of concept research attempt geared towards modification of motor speech intervention for autistic individuals was conducted by Beiting and Maas [5]. This study piloted the Autism Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) approach which included several modifications such as video modeling, preference assessments, frequent rewards, and a combination of drill and play-based practice. The study's findings were mixed with 2 of 3 children failing to improve and only one child demonstrating significant gains at follow-up, further justifying the need for extensive research in motor speech interventions which embody neurodiversity-affirming practices. Apart from this pilot work on technique modifications in the literature (e.g., [5]), there are no explicit conceptual frameworks and/or systematic intervention strategies which align with neurodiversity-affirming practices to assist clinicians in implementing or modifying current motor speech interventions for this subpopulation. Specifically, interventions need to implement a dynamic view of the individual's support needs in various areas while incorporating a strengths-based model rather than a treatment approach which is based on the "diagnosis" and methodologies created prior to the neurodiversity movement [24].

The purpose of this paper is to introduce the Motor-Speech Intervention Neurodiversity-Affirming Practice (MIND-AP) framework as a tutorial for addressing speech motor issues in autistic individuals. MIND-AP is a neurodiversity-affirming clinical resource tool to guide clinicians when working with this population. MIND-AP framework is aligned with several concepts from contemporary models such as the Social Communication, Emotional Regulation, and Transactional Support (SCERTS; [29]).

The current paper will discuss the following:

1. Introduce the MIND-AP framework and its core concepts.
2. Discuss application of neurodiversity-affirming practice within evidence-based motor speech interventions.
3. Provide clinical strategies for SLPs to support autistic individuals in each area of the framework.

Materials and Methods

MIND-AP Clinical Framework

MIND-AP framework is based on 3 core concepts: Neurodiversity-affirming, connection-based and child-centered approach. This framework was developed based on experimental data and contemporary recommendations across several rehabilitation science disciplines [5,18,24]. We will briefly describe the 3 core concepts next.

Core Concepts

Neurodiversity-affirming practice

Clinicians are shifting their views on autism from a medical model of disability (which views autism from a deficits-based lens with a goal of "fixing" the individual) to a neurodiversity-affirming model, which embodies the idea of embracing and supporting all neurotypes from a strengths-based lens [5,18,24]. The medical model of disability focuses on changing an individual in order for them to fit into societal-based expectations based upon neurotypical brain function [30]. These medical representations of autism generally do not include the everyday and lived experiences of autistic individuals [18]. Often a compliance-based approach is implemented to reinforce the individual's expected behaviors by rewards or punishment which is based on the broad expectations of neurotypical societal norms [31,28]. This may look like a clinician using a behavior approach to allow the child brief interaction with and limited access to preferred items or activities, or the withholding of a reinforcer to decrease unexpected behaviors that are not typically seen within neurotypical norms of behavior, function, and development. This approach may appear to be effective in changing behavior, but it comes at the expense of the individual's mental health [32]. The compliance-based approach is harmful to the individual as it promotes masking or social camouflaging, which is a strategy autistic individuals use either consciously or unconsciously to appear less autistic and more neurotypical to fit in and be accepted [33]. The compliance-based approach misses the bigger picture as it does not allow the individual to understand their unique differences. When an individual does not understand their differences, strengths, or challenges, it is more difficult for the individual to identify, access, and use the supports that are available to them. This subsequently hinders the individual's ability to acquire self-advocacy skills so they can receive necessary support [34,28].

Donaldson et al. describe neurodiversity-affirming practices as support interventions in which therapists focus on the client's strengths as a means to support their challenges while respecting the client's uniqueness [30]. For example, by viewing a child's play preferences as individually based, we can better support the child on their learning journey, as the child can feel validated and empowered. Building upon a child's strengths rather than using a deficit-based model sets a child up for success as it allows clinicians to meet a child exactly where they are in their development while promoting positive self-identity, agency, and self-determination which is a goal consistent with ideals of autistic self-advocates [30]. The intent of neurodiversity-affirming practice is not to make the individual "less autistic" but to provide needed support, foster self-advocacy skills, and improve quality of life by affirming autism as a fundamental part of the individual's identity [18,35,28]. Many autistic individuals prefer the use of identity-first language (autistic person) as opposed to person-first (person with autism) as autism cannot be separated from the individual and is part of the individual's identity [23]. A study from 2016 indicated 61% of the UK autism community members preferred to use identity-first language [23, 36].

Additionally, neurodiversity-affirming clinicians are also shifting away from describing autistic individuals as being "on the spectrum" and are now using descriptive language within a dynamic framework [18]. In medical models, autistic individuals were previously described as "low" or "high functioning"; whereas with a neurodiversity-affirming framework, individuals should be described based on their strengths and support needs in various areas such as sensory regulation, emotional regulation, communication, socialization & executive functioning [18]. For example, an autistic individual may be strong in executive functioning and sensory regulation but have difficulties in emotional regulation and socialization. Another important part of neurodiversity-affirming practice is listening to the first-hand experiences and perspectives of autistic individuals and providing support and developing intervention plans which are aligned with their preferences, culture, and identity [30, 36]. This includes understanding that direct eye contact may be a stressful experience for an autistic individual [37]. Autistic self-advocates have long expressed that eye contact is uncomfortable, can lead to their dysregulation, and a lack of eye contact does not mean an autistic individual is not listening, or attending to the speaker. Honoring individual preferences by not requiring eye contact is both neurodiversity-affirming and can positively impact overall sensory regulation during speech therapy sessions.

Connection-based practice

A connection-based model honors neurodiversity-affirming principles and utilizes the social model of disability which seeks to change the environment so that the individual can receive and understand the specific and beneficial supports they need to thrive in a given environment or situation [30]. A connection-based approach seeks to understand the individual's unique differences and preferences, ranging from preferred activities to sensory preferences, and sensory challenges. An example of such can include a clinician providing unlimited access to preferred items and activities, sensory supports, and encouraging all forms of communication while establishing a safe and trusting environment, with the goal being interpersonal (clinician-client) connection. In doing so, we are working on the bigger picture of decreasing prompt/reward dependency, increasing self-regulation, self-awareness, and self-advocacy, and then introducing motor speech intervention. By establishing a strong clinician-client connection and fostering empowerment and individualism, the clinician is setting the foundation for a strength-based, child-centered (see next section) intervention which can ultimately maximize the

client's response to motor speech intervention.

Child-centered practice

A child-centered approach allows the child to lead the sessions based on their interests and play preferences, so that meaningful interactions and naturalistic opportunities for language and motor speech practice can occur. Such interactions can be relevant and facilitate natural communicative exchanges. Centering sessions around the clinician's interests and therapy agenda, does not support intrinsic motivation, child-initiation, learning through play, increasing duration of interactions or engagement through interests [31]. For example, McDuffie et al. found that autistic children responded better to linguistic mapping when the adult followed the child's lead and commented on the child's actions and interests as opposed to adult-directed labeling when the child shifted personal attention to the adult's comment [38]. A clinician-driven treatment does not foster individualism or empowerment of the client. Generally, child-centered approaches include applying clinical strategies such as modeling language and speech targets which are meaningful to the client, presenting concepts using a play-based model, and acknowledging their preferred play patterns. Play is an activity meant for enjoyment, sometimes regulation, but should always be intrinsically motivating. When working with an autistic individual, we need to remember that autistic play often looks different from play in neurotypical individuals. For example, Child A may play with cars by driving the car up and down the ramp and then racing the cars; whereas Child B may spin the wheels on the car and then line the cars up in a sequence of colors to resemble a rainbow. Both children are playing and both forms of play should be seen as valid.

Thus far we have briefly discussed the three core concepts or pillars of MIND-AP Framework (neurodiversity-affirming, connection-based and child-centered), next we will discuss the process of application of neurodiversity-affirming practice within motor speech interventions.

Results

Application of neurodiversity-affirming practice within motor speech interventions

Within the MIND-AP framework the application of neurodiversity-affirming practice progresses across three levels of focus or layers, and intervention must progress from the inner core (Level 1) outwards (Level 3; See Figure 1 and Figure 2). Each layer builds upon the previous layer and each previous layer must be maintained throughout the intervention process. At the core of the framework is sensory regulation and bodily autonomy which need to be continually supported throughout the intervention. Next, individual preferences and supports for language and communication must be established. This is followed by the last level where implementation of motor speech intervention takes place. The focus of the MIND-AP framework is to integrate strength-based, neurodiversity-affirming practices with evidence-based motor speech treatment to provide connection-based intervention for individuals dually diagnosed with autism and motor speech issues such as CAS. The framework is intended to support any current evidence-based motor speech interventions such as Dynamic Temporal and Tactile Cueing (DTTC; [39]), Kaufman Speech to Language Protocol (K-SLP; [40]), Rapid Syllable Transition (ReST; [16]), Biofeedback Treatment [41], Motor Speech Treatment Protocol (MSTP; [17]) and Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT; [42]).

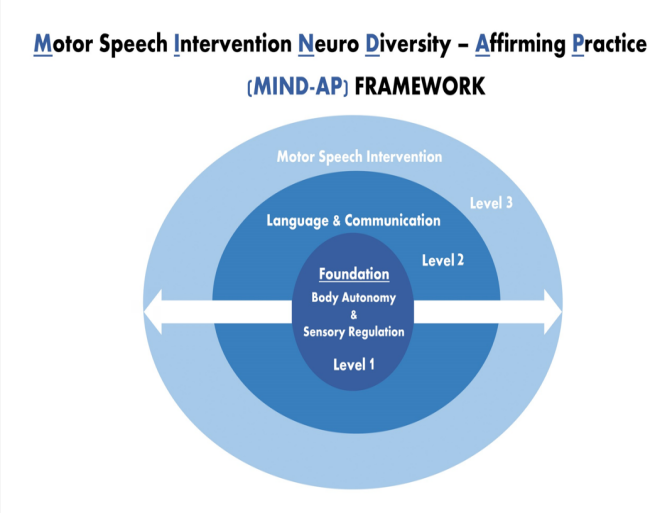

Figure 1: Illustration of Motor Speech Intervention Neuro Diversity – Affirming Practice (MIND-AP) Framework

Note: Depicts the focus, direction, and progression of intervention within the MIND-AP framework. Neurodiversity-affirming practice must progress across three levels of focus or layers, and intervention must progress from the inner core bodily autonomy and sensory regulation (level 1) outwards to language and communication (level 2) and finally to motor speech intervention (level 3).

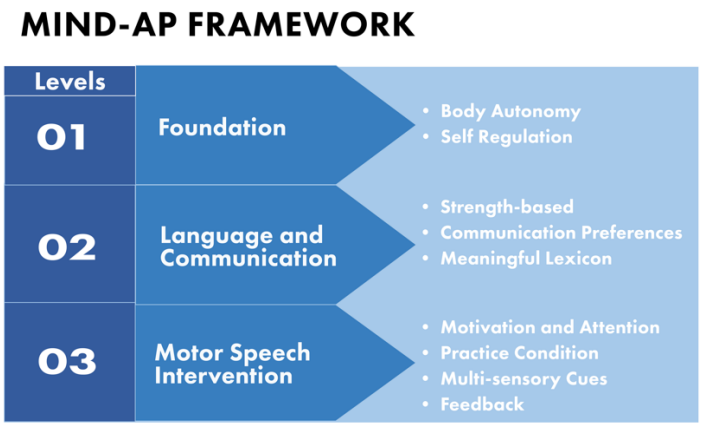

Figure 2: Focus of intervention within the levels (1, 2 and 3) of MIND-AP framework

Levels of focus

Level 1: Foundation

This level consists of core foundational elements of body autonomy and sensory regulation. Without addressing these foundational elements, it would be difficult to make successful progress to teaching language and communication and/or implementing motor speech interventions.

Body autonomy

Bodily autonomy is commonly described as the self-governing of one's own body; further, a person's right to have control over their own body [28]. This includes having the right to consent/assent or dissent to physical touch and tactile input. The concept of bodily autonomy is an important piece of neurodiversity-affirming motor speech intervention as several approaches (e.g., DTTC, PROMPT, K-SLP) use tactile (touch) input as a component of the treatment used to teach placement of sounds and oral-articulatory movement transitions. As clinicians we have the opportunity to make a big difference in a child's life beyond our sessions so honoring a child's body autonomy should be at the core of our treatment sessions [28]. Teaching body autonomy is especially important with children who have communication challenges and more specifically, autistic children. There is data to suggest that individuals with an autism diagnosis have an increased chance of experiencing physical, emotional, and/or sexual abuse when compared to non-autistic peers [43]. A recent study surveyed a sample of autistic adults. A high amount of autistic adults within the sample reported experienced some form of sexual victimization after age 14 and into adulthood [44]. Individuals with complex communication needs are not only at risk for abuse, but also at risk for not being able to effectively report abuse. Prizant and Fields-Meyer stated "because of their neurological challenges, people with autism face tremendous obstacles of three kinds: trusting their body, trusting the world around them, and most challenging of all, trusting other people" [45]. It is our responsibility as clinicians to implement best practices that foster an individual's sense of bodily autonomy. Receiving permission from a child before using physical prompts, reinforces the concept of bodily autonomy by affirming that the child has a right to their body, to how their body is touched, and who touches their body. Honoring body autonomy fosters a safe environment conducive to a child's learning. If we do not honor a child's bodily autonomy, we send an inadvertently harmful message that any adult is allowed to touch their body even if they are uncomfortable or when they do not give permission.

As per the MIND-AP framework, strategies for honoring bodily autonomy when providing tactile input or using physical prompts during speech motor intervention can include:

a) Receiving permission/assent before somatosensory input (e.g., touch) is initiated.

b) Considering hand-under-hand prompting (for tapping blocks or pacing board).

c) Honoring all forms of communication which includes nonverbal communication such as body language. For example, moving away from the clinician when uncomfortable with touch or leaning into the somatosensory prompt (e.g., touch) provided by the clinician.

d) Discussing why you are providing somatosensory input.

e) Alerting the client before giving the somatosensory input (e.g., "Ready, I'm going to prompt you now" or "I am going to touch your cheeks now") and allow sufficient time for the client to process the information and give or withdraw their permission.

f) Implementing opportunities for ongoing consent/assent by continually checking-in throughout the session.

Sensory regulation

Along with respecting bodily autonomy, another core consideration for working with autistic individuals is sensory regulation. Differences in sensory processing, regulation, and experiences are commonly reported by the autistic community [46-51]. Studies suggest that autistic children may have differences in the sensory processing system [48]; autistic individuals are reported to seek sensory input from multiple sensory systems (auditory, vestibular, tactile, proprioception [51]) and auditory-and visual-processing differences are most frequently experienced sensory differences in autistic children [50]. In the study by Tomcheck and Dunn, a high percentage of the autistic sample reported sensory differences [50]. Additionally, tactile sensitivity symptoms were frequently reported among the autistic group [50].

Thus, each individual may have unique sensory preferences and different sensory experiences which relate to all 8 of the

sensory systems (auditory, visual, tactile, olfactory, gustatory, proprioception, interception, vestibular; [47]). When a child's sensory experiences are impacting their ability to learn or develop, the clinician needs to take a deeper look into how the child is experiencing each of the senses and corresponding sensory behaviors (e.g., sensation seeking, or sensation avoiding for each sensory system; [52]). This is the first step in the process of implementing the appropriate sensory supports to facilitate sensory regulation to maximize learning outcomes and efficient responding to external (therapist induced) or internal sensory information. There are various inputs used for motor speech interventions such as auditory, visual, and somatosensory [42]. A child needs to be in a state of optimal regulation to fully process external or therapist induced auditory, visual, and/or somatosensory input(s) for motor speech movements. When a child is not regulated, either from underwhelming or overwhelming amounts of sensory input, they are not in an optimal state for learning, participation, or engagement [49]. Those children with low sensory thresholds (i.e., easily notice sensory stimuli) may limit sensory overstimulation by avoiding or withdrawing away from sensory stimuli for example by moving away from noise source or covering their ears or getting out of a crowded room to avoid body contact [52]. On the other hand, autistic individuals with higher neurological thresholds for sensation may miss sensory stimuli. These individuals may be sensory seeking and may need a stronger sensory input for the individual's system to process the stimuli. In this case, firm pressure may be preferred over light touch [52,53]. From a sensory standpoint, meltdowns often result from an overwhelming experience of sensory information, cognitive overload, emotional factors, physiological factors (i.e., feeling thirsty, hungry, sick, etc.), or from difficulty filtering competing and/or irrelevant sensory information in the environment [49].

It is important for clinicians to consider the unique sensory experiences of their client to ensure they feel safe and secure in the environment, assist clients in preventing stress responses from input, and aid in maintaining regulation for an optimal level of learning. Additionally, understanding stimming, or self-stimulatory behavior (e.g., rocking body back and forth, finger-flicking, hand-flapping, spinning, or twirling), as a regulatory behavior should also be considered [54]. Although stimming can look different for everyone, and individuals who are not autistic may also stim, autistic individuals report stimming is beneficial and may be triggered to assist with self-regulation during times of distress from sensory input [55,54]. It is for this reason that instead of suppressing a client's non-harmful stimming, clinicians view stimming through a sensory processing lens and seek to understand the experience of the individual [54]. Awareness of the differences in the way autistic individuals experience somatosensory input and the responsiveness to provide ongoing sensory supports should be the guiding force for the construction of the session and the implementation of multi-sensory cueing/prompting within motor speech sessions.

Thus, the provision of sensory support and facilitating sensory regulation needs to be carefully considered for motor speech intervention in autistic individuals as a significant portion of the autistic community experiences sensory processing challenges that can impact learning and development [56,49]. Within the MIND-AP framework, strategies for supporting sensory needs have been broadly adapted from fidelity elements commonly reported in sensory integration interventions (e.g., [56]) and can include:

a) Adjusting pressure, timing, and duration of somatosensory cues and physical input to reflect the sensory preferences of the client (firm vs. light touch).

b) Open access to sensory activities. For example, do not force the child to produce a target word prior to receiving access to a sensory self-regulating activity (such as jumping on a trampoline). Withholding a sensory self-regulating activity as reinforcement or a break is considered compliance-based; access to sensory activities should not be contingent on the child's participation.

c) Integrate sensory and movement activity in the session to facilitate the child's optimal sensory state while simultaneously addressing motor speech targets. For example, using a swing for movement while modeling "go" as you push the child on the swing.

d) Setting up the environment to match the child's neurological threshold and sensory preferences. This can include dimming the lights, using calming music, and blocking competing background noises to decrease sensory overstimulation.

e) Continuous real-time adjustments to sensory input to facilitate optimal state of regulation. The clinician needs to "read" the child's sensory state by identifying when the child may be over- or understimulated. For example, altering positioning such as moving from a beanbag chair to a trampoline when the child is seeking movement and then to a mat when the child is satiated from the jumping.

Level 2: Language and communication

Once the core foundational level (autonomy and sensory regulation) has been established, therapy focus can now progress to Level Two: Language and Communication. Autism is marked by differences in communication and language development and paying attention to these differences and integrating them in a positive strengths-based approach ultimately leads to communication and language growth.

Strength-based

The clinician, support staff, and parents should collectively

identify which areas and skills are strengths for their client. Using the individual's strengths to help build those areas which are in need of support creates a space for the client to be successful and motivated to participate in learning. It is imperative to acknowledge special area(s)/topics of interest of autistic individuals as strengths and not just a "quirk" (e.g., see [57]). An individual's intrinsic (internal) motivation to learn and engage in various activities is stronger for preferred topics as opposed to non-preferred [57,58]. When a child is intrinsically motivated, the learning and interaction will come naturally. Strengths and interests are the foundation for learning [59].

To illustrate this point let us look at reading in autistic individuals. Reading at an early age is a common strength of many autistic individuals [60]. This is known as hyperlexia, which is an advanced ability to read beyond the child's chronological age. From a strength-based perspective, hyperlexia is viewed as a strength. Transferring this strength to a motor speech intervention context, an SLP can use orthographic representation as a cue for developing and executing a target speech motor plan or speech utterance. In this example, the clinician can write the target word on an index card and then slide their finger over each letter in the word to facilitate sound-to-symbol relationship to facilitate a motor plan as opposed to only using an auditory cue (e.g., "say what I say" or "repeat after me").

Below are four additional examples of using a strength-based perspective.

Child A:

- Strength: Child has strong interest in planets.
- Area needing support: Comprehension of location/positional concepts.
- Strength-Based Technique: Clinician can use the knowledge of planets to build more language concepts. For example, targeting concepts in the context of "which planet is NEXT to the earth?", "which planet is the FARTHEST from the sun?", "which planet/moon is behind during an eclipse?" The same can be applied to teach descriptors (big/small) as well, which planet is smallest, which one is big etc.

Child B:

- Strength: Likes music and memorizes melodies.
- Area needing support: expressive language: actions.
- Strength-Based Technique: Use music to target a set of verbs. For example, the song "open shut them", has action words and hand movements. Clinician can also use a sentence completion to elicit the words; "give a little tap, tap, ___".

Child C:

- Strength: Imitation skills. Child learns more efficiently by watching videos and then imitating.
- Area needing support: sound imitation
- Strength-Based Technique: Clinician can use video modeling of the SLP producing targets rather than asking the child to look at the clinician's face directly or looking at picture cards.

Communication preferences

Communication is a human right, and each person has the right to choose how they communicate [61]. Neurodiversity-affirming practice entails honoring all forms of communication, which can include but not limited to Alternative and Augmentative Communication (AAC), verbal, gestures, written, and signs [62-64]. The autistic client should have the opportunity to choose the mode of communication [65]. Access to various forms of communication needs to be available to the autistic client. The autistic client should also have the opportunity to switch between communication modes as many times as they want. For example, if the client's motor speech target is "ball", the client should have access to a picture of "ball" on their AAC device [63]. The clinician should honor verbal productions of "ball" or selection of "ball" on their device equally. In contrast, in a compliance-based approach the clinician might say "use your words" when the child selects "ball" on their AAC device. The latter does not honor communication preference of the child. Importantly, there is data to suggest that when autistic individuals use their preferred mode of communication, they demonstrate faster acquisition and better maintenance of what they learn (e.g., requesting; [64]).

Meaningful lexicon

The speech targets selected must be functional and meaningful to clients and families [66]. This concept has been popularized in several approaches (e.g., core vocabulary approach; [67]). For motor speech intervention, selected words should be both functional and align with the motor speech targets chosen. The following are examples of using meaningful lexicon within a neurodiversity-affirming motor speech intervention.

Child A:

- Motor target: jaw movement from close-open-close (CVC structure).
- Lexicon: The words "bob" and "mom" have the same jaw movement pattern, but unless the child's name is "bob" or knows a "bob", "mom" would be a more functional target.

Child B:

- Motor Target: Lip rounding (CV structure).
- Lexicon: The words "no" and "toe" have the same lip movement pattern, but "toe" would be only used when changing socks, shoe, or dressing; "no" would be more appropriate as it is a power word and supports execution of body autonomy.

Client C:

- Motor Target: Transitioning from bilabial to rounded vowel ("moo").
- Lexicon: Client is using a wheelchair and needs to clear their path in front. You can work on "moo" as an approximation for "move". In this case we are not teaching "moo" as part of farm animal vocabulary.

Additionally, teaching power words can be very functional for clients. In the current clinical context, we define a power word as a word that has meaning across contexts, can be used to manipulate their environment, supports execution of bodily autonomy and self-regulation and are frequently occurring in children's vocabularies. The speech motor plan for a power word benefit from being heard and produced multiples times in a day and across multiple contexts. Words like no, yes, up, go, more, done, and want are great power words to teach children.

Level 3: Motor speech intervention

This is the final level (Level 3) or layer within the MIND-AP framework. In this section we provide modifications to motor speech intervention which are aligned with neurodiversity-affirming practices. Autistic individuals who exhibit CAS, might have a difficulty participating in motor speech interventions developed based on non-autistic and neurotypical individuals and thus may exhibit a limited response to those motor speech interventions [5].

Current motor speech interventions may recommend one or more of the following: auditory and visual-based learning methods to improve speech production, focus directed to the clinician's face (e.g., DTTC; [39]), require high amounts of repetitions [68], require long sessions (45 min to 1 hour; [17]), are drill-based, may use nonsense words [16] or words selected from a set program (e.g., flashcards; [40]), clinician led, and depend on increased use of somatosensory inputs to child's oro-facial structures [42,40,16,17,41,39]. These aforementioned motor speech intervention recommendations/procedures are based on neurotypical and non-autistic individuals and do not for the following reasons align with neurodiversity-affirming practices:

a) The autistic community reports eye contact and gaze directed to a person's face may provoke a stress response or induce anxiety [37].

b) Repetitive drill-based and compliance-based intervention strategies do not support bodily autonomy and child-centered approach (lack of choice, forced participation).

c) Light touch [somatosensory input] to face used for tactile cueing may be dysregulating [52, 53].

d) Given limited language of many autistic children, selecting pre-set vocabulary words from a card is not meaningful or functional when targeting communication skills.

Level three of the MIND-AP is comprised of recommendations and modifications to the core components of motor speech intervention in order to better support autistic individuals who present with motor speech deficits. The overall goal is to better support autistic individuals during motor speech intervention by maximizing participation and communication while maintaining dignity and an awareness of brain-behavior differences. The following motor speech recommendations and modifications are aligned with neurodiversity-affirming practices and perspective.

Discussion

Motivation and Attentional Focus

Autistic children may have significant differences in attention and imitation which need to be considered during an assessment and/or intervention [5]. Motivation and attentional focus are key precursors for motor learning and can be tied directly into the sensory regulation and bodily autonomy (core layers of MIND-AP). If a child is dysregulated and/or feels unsafe, they would be less likely to participate and/or engage in the learning activity as their focus would not be on the activity. Alternately, if a child is regulated and/or feels safe, they would be more likely to participate and engage in the learning activity, thus maximizing learning. There is a stronger connection between special interests and engagement in autistic individuals when compared to neurotypical peers as autistic individuals are more intrinsically motivated to pursue knowledge pertaining to their area of interest [69]. For example, if a child is working on producing lip rounding in "go" and swings are motivating and regulating to the child, there will be more engagement and attention to the therapist when the therapist is pushing the child on the swing while targeting "go". The clinician can pause swinging, naturally interrupting the activity, and then model "go" for the child to imitate, or simply wait for an independent production. On the contrary, if the same child was presented with a non-preferred activity such as a card game "Go-fish", the same level of attention and motivation may not be observed. This is true for many children (regardless of neurotype); however, individuals who are neurodivergent (including autistic) are more susceptible to adverse reactions to forced participation in non-preferred activities as they may induce anxiety, trigger sensory overwhelm, meltdowns, and contradict bodily autonomy (in this case unable to make a choice). Additionally, forced participation in non-preferred activities is considered compliance-based and are not aligned with neurodiversity-affirming practices.

Specific to attentional focus, many traditional and motor speech therapy methods redirect child's attention to clinician's face or mouth with commands like "look at me" or "watch and listen" [39]. As previously mentioned, many autistic individuals display differences in gaze and eye contact preferences [70]. The requirement of attending to a person's face or mouth on demand

can induce anxiety or a stress response [37] and can result in the child shutting down and withdrawing from the activity. Modifying how we support attentional focus can make a difference in the effectiveness of an intervention. This can be achieved by using other methods which do not require direct attention to the clinician's face (e.g., video modeling, clinician covers their eyes with sunglasses, clinician uses a magnifying glass on their mouth to amplify movement). There are several strategies for facilitating motivation and attentional focus, these include:

- Check-in sensory support needs/regulation (refer to MIND-AP core layer)
- Check-in motivation and topic of interest for that session
- Ask the child what they would like to do
- Present choices
- Have them explore your materials
- Using strengths to build on areas needing support (see Strength-based Level 2)
- Hyperlexia; using written words to teach speech motor plans
- Balance demands
- Keep the activities simple and easy when focusing on complex speech tasks
- Select motor targets which are achievable for the client

Practice conditions: Dose

The number of practice trials (dose) is a key ingredient that facilitates motor learning [68]. In a clinical setting, dose is the number of times an active ingredient or teaching episode related to the treatment goal is delivered in a treatment session [71]. Typically, this number may range from 50 to 150 depending on the severity and type of speech disorder [71, 72]. The number of trials an individual can complete depends on various factors such as: understanding correct/incorrectness, sensory state, motivation, and attentional focus. Each child's threshold for the number of trials will differ and must be individualized. Given the sensory processing differences in autistic individuals a high number of practice trials (repetitions) may result in sensory overload and thus the clinicians need to be mindful of the amount of practice trials being used in the session. The clinician should be "tuned in" to the child's sensory needs in order to maintain regulation during the session to support the maximal number of trials. Using a neurodiversity-affirming approach means the clinician will follow the child's lead while guiding them to the next step. Many autistic children may need to start with 1 or 2 practice trials or even just feeling the input without expecting any output before progressing to practicing several trials at a time. The number of repetitions should gradually increase as the therapist-child trust and connection builds. Once the child trusts the clinician and understands the expectation, they probably will be more likely to engage in higher amounts of speech motor practice. Because there may be a slower start towards the optimal number of trials in a motor speech session [71], clinicians should expect a longer time frame for speech motor learning and be mindful of observed progress during set time frames for treatment.

Multi-sensory cues

Multi-sensory cues are commonly used in motor speech intervention which can include a combination of visual, auditory, somatosensory and can be a combination of all or some at any given time (e.g., [73,39]). Clinicians might have to use one mode of cueing at a time depending on the client's sensory preferences. For example, clinician modeling the word "mom" (auditory), while giving somatosensory input for "m" and then physically moving the jaw open for "om", and having the child watch a video of the production (visual) on every trial may result in sensory overstimulation. Alternatively, the clinician may opt to only use a somatosensory cue to elicit the speech motor movement or may alternate types of cues across trials to maintain the child's sensory regulation and attentional focus.

Somatosensory cues are a commonly used input for facilitating correct placement, pressure, and movement of a sound or word. As mentioned earlier (see section Level 1 Sensory Regulation), many autistic individuals process touch differently and may be sensitive to certain levels of pressure. Pressure can vary from firm to light and for those with a low neurological threshold for tactile input, light touch can be uncomfortable and distressing [52,53]. When using somatosensory inputs with autistic clients, clinicians may need to vary the level of pressure used for targeted sounds and words. For example, using light touch for lip closure when your client prefers more firm pressure, the clinician should consider adjusting the amount of pressure to use more firm input on the lips/jaw. If the somatosensory cues are not aligning with the individual's sensory preferences, the child might be labeled as having "tactile defensiveness" [74]. Some autistic individuals may demonstrate tactile defensiveness, which refers to an over responsiveness to somatosensory input such as light touch [74]. If a clinician is unaware of sensory preferences, this type of sensory input may be distressing for a child, lead to dysregulation, or contribute to a child having a meltdown [52, 53]. Thus, if a clinician is not providing appropriate sensory support or access to sensory support, the input provided by the clinician can be dysregulating if the child's sensory-perceptual-neurological system is not prepared to process the input. This can result in negative responses such as tactile defensiveness and self-withdrawal from engagement and limit motor speech treatment benefits.

Feedback: Type, timing & frequency

Two types of verbal feedback namely Knowledge of Results (KR; correct or incorrect) and Knowledge of Performance (KP;

cueing based on error e.g., "get your lips together") are typically reported in the motor learning literature and form an important part of most motor speech interventions [68]. Clinicians should be mindful of the language used for such verbal feedback as autistic individuals may have language-processing differences for interpreting abstract language [75]. Abstract concepts such as "smiley lips" or "happy face" when describing labial facial retraction should be avoided as these concepts assume everyone has the same visual representation of a concept; except not all happy people smile. Instead, clinicians should use concrete language when describing a motor movement as part of feedback. For example, when targeting labial-facial retraction, the clinician can use "lips go back" or "show your teeth". Clinicians can also incorporate different modes of feedback such as video recordings to show the client visually the outcome of their movement.

Clinicians should also be cognizant of their feedback timing when working with autistic clients. Many autistic individuals due to differences in sensory processing may require additional time to attend to and process sensory information, especially auditory input. Clinicians should allow for additional time for processing and responding. The child should be provided with an appropriate waiting period to respond to the clinician's corrective feedback. When using a neurodiversity-affirming approach, the clinician should not presume incompetence and move on too soon after assuming that the child is not listening.

Considerations for feedback frequency should also be included in treatment planning. High amounts of feedback can be dysregulating and overstimulating, especially high amounts of auditory feedback. Using alternatives to verbal/auditory feedback can maintain the client's sensory regulation by avoiding sensory overwhelm. For example, using high fives to indicate correct production or a tap on the shoulder to try again. Additionally, pictures depicting correct and incorrect mouth positions can also be beneficial (big mouth vs small mouth; KP feedback). When providing feedback auditorily, the clinician should use a voice that matches their sensory preferences. For example, if a child is hypersensitive, the clinician should use a quieter/calm voice and if a child is hyposensitive, the clinician can use a high energy voice.

Conclusions

We presented a tutorial on the MIND-AP framework, a neurodiversity-affirming clinical resource tool to guide clinicians when working with speech motor control issues in autistic individuals. With this tutorial, clinicians can better support autistic individuals during evidence-based motor speech sessions by aligning with neurodiversity-affirming practices and embodying an understanding and acceptance of different neurotypes. The tutorial is intended to support any current evidence-based motor speech intervention (e.g., DTTC, PROMPT etc.) to maximize the child's participation in motor speech sessions. We hope this tutorial will inspire and support future research in evidence-based motor speech interventions which embody neurodiversity-affirming practices.

Author Contributions

J.M, J.B and A.N contributed to the development and conceptualization of the model. All three authors (J.M, J.B and A.N.) contributed to the main manuscript and other materials. A.N. contributed to protocol standardization and research writing.

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Clinical application & uptake

To facilitate dissemination and uptake of clinical information described in this manuscript, we provide a sample session plan (Appendix A) and a preliminary checklist to structure intervention sessions and monitor adherence to neurodiversity-affirming practice principles during evidence-based motor speech interventions in autistic individuals (Appendix B). These materials will provide details on support strategies for adapting and implementing the principles of motor learning when working with autistic clients.

Appendix A describes a sample 30-minute session structure for an autistic child receiving motor speech intervention. The session plan is similar to previously reported evidence-based motor speech intervention therapy structure (e.g., [17]) but incorporates all levels (levels 1, 2 and 3) of the MIND-AP framework starting with body autonomy and sensory regulation and then integrates practice conditions and caregiver participation into the session.

In appendix B we provide a preliminary fidelity checklist to assess an intervention's adherence to underlying MIND-AP framework principles. The checklist contains key structural (session structure) and process elements (intervention principles: dose, practice schedule, feedback amount, type, delay etc.) present in motor speech interventions and is based on previously published literature in this area [5,76,68,17,56]. Such fidelity checklists with further validation and testing could be used in outcomes research or clinical practice document accuracy and consistency of the application of neurodiversity-affirming practice principles during evidence-based motor speech interventions in autistic individuals.

Agenda	**Action**	**Activity**	**Client Example**
0-5 minutes	Welcome & Review	• Discuss and observe child's sensory state and temperament. • Discuss with the client or caregiver/teacher how their day is going. • Brief review of home practice to identify successes and challenges	• Caregiver said client had a great day at school. • Caregiver mentions client loved their homework activity. • While walking to the speech room, client was covering his ears • Competing auditory and visual input in the hallway.
5-10 minutes	Sensory Regulation	• Check-in on client's sensory state and provide calming or alerting sensory strategies and activities. • Assess client's behavior: Is client regulated or dysregulated?	• Client entered the room and went to the swing. • SLP dimmed the lights, we co-regulated by singing a preferred song. SLP sung slowly and quietly (ABCs) • To bring client to an optimal level of arousal (e.g., from high to optimal) • Client removed his hands from his ears and stood up and went to the shelf. • Client said "ka" and pointed to the cars.
10-15 minutes	Acquisition Phase Pre-Practice	Massed/blocked	Speech Target "on" • SLP places toy cars on the floor and asks the client to come sit on the mat. Client gets their AAC device and comes over. • Activity: lining up the cars ON the mat. • Procedure: SLP hands the client a car, then models "let's put ON" while providing multisensory cueing as appropriate. • Client may or may not imitate "on", Client can also use their AAC device to select "on", SLP can model on AAC • SLP then places the car on the mat. Then the SLP grabs another car and repeats the procedure.
15-20 minutes	Practice Phase Activity 1	Varied Practice	Speech Targets: on, up, da/down • The client then retrieved the car ramp from the shelf. • The therapist picks up a car and models UP as the car goes up the ramp. The client grabs a car and puts it on the ramp. The therapist models UP and provides multisensory cueing as appropriate. The client says UP and pushes the car up the ramp. • The therapist then models "down- da" as the car nears the ramp while providing multisensory cueing as appropriate. The child imitates DA as he pushes the car down the ramp. • The client also has an interest in turning on the flashing lights on the car. The therapist also targeted ON when the client gestured for the therapist to turn on the lights on the car.

20-25 minutes	Practice Phase Activity 2	Varied Practice	Speech Targets: on, up, da/down • The client indicated he was finished with the cars by getting up from the mat and moving to the slide. • The clinician accompanies the client to the ladder of the slide. Clinician models "Let's go up" and the client then says UP. Clinician provides feedback and multisensory cues. Client says UP. Clinicians says "good opening your mouth" and then the client climbs up the slide. The clinician then models "down-da" and the clients says "da" and goes down the slide. • The trials repeat as the client goes up and down the slide.
25-30 minutes	Wrap-up/ transition	Discussion Home carryover	• Clinician asks the parent to come into the room. • Clinician summarizes session regarding target words, the context for the words, and the level of cueing needed. • Clinician provides 2 ideas for home carryover of the targets. At home, the client enjoys playing with spinning gears and number blocks, so clinician suggests to mom ways to model: on, up, and da/down during the child's preferred activities at home.

Appendix A: Sample 30 Minute Session Structure Motor Speech Session using MIND-AP Framework.

Evaluating Clinician: _____ Date:_____

This 35-item checklist can be used to assess the level of adherence to MIND-AP framework. Adherence is defined as the usage of prescribed intervention techniques/procedures implemented in the session and the absence of proscribed practices (Checklist adapted with permission from Namasivayam et al., 2015). At least 30 of 35 items (>85%) must be present to meet minimum fidelity to MIND-AP framework

APPENDIX-B: MIND-AP Framework Fidelity Checklist.

Section 1. Foundational:

Body Autonomy	The clinician honors the client's bodily autonomy throughout the session by acknowledging assent/dissent. Initial assent and check in throughout the session.	□
Sensory Regulation	The clinician supports the client's sensory needs throughout the session by providing open access to calming and alerting activities and by making environmental modifications reflective of their sensory preferences. Assess client's current sensory status using the Winnie Dunn's Model of Sensory Processing (Dunn, 2007). Environmental supports (sound, lighting, seating) throughout session. Integrate sensory modifications/activities and movement into the sessions as needed	□ □ □ □

Section 2. Language and Communication:

Strength Based	Clients' individual's strengths/interests are used build those areas which need support (e.g., child with hyperlexia: orthographic representation may be used as a cue to develop and execute a speech target). Intervention should not be focused on making an individual neuro typical might not target greetings if not natural for the child.	□ □
Communication Preference	The therapist honors all forms of communication (signs, verbal, AAC, gestures) always, even during motor speech practice. Honor all communication attempts with or without eye contact (also see intervention technique section)	□ □

Meaningful Lexicon	Speech targets selected must be functional and meaningful to clients and families (e.g., power words: go, yea, no, up, more, done, want etc.)	□

Section 3. Motor Intervention:

PREREQUISITES AND SESSION STRUCTURE		
Prerequisites		
1	Motivation and Attention: Environment reflects the child's sensory preferences (to keep the child calm and regulated). Check-in motivation and topic of interest for that session. Environment is rich with the child's preferred activities. Provide access to the preferred toys. Offer choices and avoid making the child participate in non-preferred activities Use items that naturally disappear/ recurrence (like bubbles) rather than taking things/toys away (compliance based) Online adjustments: Is the clinicians tuned into the child? Clinician's responsiveness to a child's actions. Does the clinician know the child's threshold for tolerance/frustration and adapt in real-time by providing opportunities to discontinue or take a break.	□ □ □ □ □ □
Session Structure		
1	First activity. The focus of the first activity is to achieve sensory regulation and attain engagement, connection and establish trust. The activities should be child-led, motivating, and naturalistic.	□
2	Caregiver Participation ● Review home practice successes and challenges. ● The caregiver participates in a practice activity. ● Explain relevant information, demonstrate for the caregiver and provide coaching for home practice. ● Strategies for incorporating the child's target words/speech movement goals into everyday routines are discussed.	□ □ □ □
3	Skill Practice. Therapist is flexible with the amount of activities used during skill practice and is mindful that the child might not transition between 3-4 activities- there might be only 1 activity with a progression.	□
TECHNIQUES AND PRINCIPLES (Active Ingredients)		
Intervention Techniques		
1	Watch and listen. Therapist is aligned with the child's communicative preferences by not forcing eye contact and is using alternative methods for "watch and listen"(e.g., video modeling, clinician covers their eyes with sunglasses etc.)	□
2	Reduced speech rate. Clinician modified their rate of production and the child's production to facilitate accuracy of production (no change from typical model).	□

3	Multi-sensory cueing. Clinician is aligned with child's need for increased processing and response time to cues provided. Talk to the client about why you are providing somatosensory input Alert the client before giving the input (e.g., "Ready, I'm going to prompt you now") Offer your hand instead of initial physical touch Clinician is mindful of the child's sensory preferences and makes modifications to the cues as needed (e.g., light touch vs firm touch, loud vs quiet voice for modeling). Specific consent (assent/dissent) is requested from client when providing somatosensory cues. Assent/dissent may include verbal or nonverbal means (saying yes/nodding head/leaning into touch cues or saying no, putting hand up to stop/leaning away from cues etc.). Assent and dissent may not always be verbal so read their body language.	□ □ □ □ □
Motor Learning Principles		
1	Intervention Dose: Clinician has a strong sense of the number of repetitions their autistic client can tolerate to maintain regulation. The repetitions are embedded in child-led, naturally occurring, sensory-rich, motivating activities.	□
2	Practice: Clinician provides opportunities for massed and then distributed practice within the session while monitoring client's regulation.	□
3	Feedback: Knowledge of Results (KR): KR feedback aligns with client's communicative and sensory preferences and may include alternative methods for feedback such as high fives, pictures, or keeping the verbal input at a minimum. High frequency of verbal feedback may be dysregulating. Knowledge of Performance (KP): KP feedback is delivered via concrete concepts to describe the speech motor movements. Avoid abstract wording such as "happy mouth" or "smiley mouth" instead use "lips go back" or "show your teeth". Clinicians allows for additional time for processing and responding to feedback	□ □ □