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Tutorial

Reason-Based Recommendations From a Developmental Systems Approach for Students With Needs Across Functional Domains

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ABSTRACT

Purpose: This tutorial aims to introduce school-based speech-language pathologists (SLPs) to developmental systems theory as a framework for considering interactions across functional domains, such as language, vision, and motor, for students with complex needs.
Method: This tutorial summarizes the current literature on developmental systems theory in its application to working with students who have needs in multiple domains of functioning in addition to communication. A hypothetical case of a student, James, with cerebral palsy, cortical visual impairment, and complex communication needs, is presented to illustrate the primary tenets of the theory.
Results: Specific reason-based recommendations are presented that SLPs can put to practice with their own caseload in direct response to the three tenets of developmental systems theory.
Conclusions: A developmental systems approach will be useful in expanding SLP knowledge of where to begin and how to best serve children with language, motor, vision, and other concomitant needs. The tenets, including sampling, context dependency, and interdependency, and the application of developmental systems theory can be instrumental in providing a way forward for SLPs struggling with the assessment and intervention of students with complex needs.

When assigned to work with a student with complex communication needs (CCN), speech-language pathologists (SLPs) may start with a thorough review of the student's case history. This review may lead to the discovery of myriad needs in functional domains besides speech and language. In addition to communication impairments, students with CCN frequently have co-occurring sensory impairments impacting vision or hearing and motor impairments impacting their fine or gross motor abilities. SLPs are accustomed to the assignment of care for functional domains to different service providers, such as physical therapists (PTs) who address gross motor skills and teachers certified in visual impairment (TVIs) who address vision. However, SLPs must demonstrate a foundational understanding and careful consideration of all body systems relevant to the students they serve, for it is these coexisting systems that play a large part in how students are able to develop language and communicate. To provide comprehensive assessments and interventions, it is necessary to consider functioning in other areas due to the possible interaction with and cascading impact on communication. No two students present identically, making the consideration of other domains a critical and ongoing component of service provision for each individual student. Many questions arise, such as the following: What can an SLP do to better understand how limited independent mobility might impact augmentative and alternative communication (AAC) system selection methods available for a child? How can an SLP best plan for intervention when motor and visual impairments seem to be impacting a child's ability to explore their environment?

Incorporating a developmental systems approach may lead to a better understanding of the interaction between multiple domains across time and contexts within

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an individual. Careful consideration of individual students should lead to a perspective on human behavior and functioning that results from dynamic, developmental systems which are complex and fluctuating but also stable and coordinated (Thelen & Smith, 1995). D'Souza and Karmiloff-Smith (2016) stated, "At every level of an adaptive, complex system, one cannot ignore its developmental history and environmental context" (p. 8). SLPs would be remiss to overlook functioning and behaviors in domains outside communication as they complete assessments and plan for interventions. A developmental systems approach based on the tenets of sampling, context dependency, and interdependency (D'Souza & D'Souza, 2019) can be instrumental toward helping SLPs to think critically about how to ultimately address communication for students with CCN.

This tutorial is intended to present considerations for interactions across developmental domains, specifically in language, vision, and motor domains, within the context of a developmental systems framework in application to a case study example. Typical developmental milestones in language, vision, and motor are presented, as well as cross-domain interactions, such as the impact of each domain on joint attention development. The three primary tenets of developmental systems theory are introduced and illustrated in relation to the case study. In the absence of an evidence base for recommendations specific to individuals with CCN, visual needs, and motor needs, we propose reason-based recommendations grounded in developmental systems for SLPs to consider for working with students with low-incidence disabilities and complex needs. SLPs are encouraged to extrapolate the implications from the case example of James to other students on their caseloads with communication, sensory, and motor needs.

Case Example: James

James is a 5-year-old student new to your caseload with CCN resulting in his limited use of facial expressions and body movements to communicate. You would like to consider the introduction of aided AAC to supplement James' current modes of communication and to support his ability to communicate for a variety of purposes. Complicating James' communicative needs are his additional diagnoses: cortical visual impairment (CVI) and spastic quadriplegic cerebral palsy (CP). CVI, a neurologically based disorder due to damage or atypicality in the visual pathways or processing centers of the brain (Huo et al., 1999), is the most common visual impairment in children (Blackstone et al., 2021); however, you have never had a student with this diagnosis before. For James, CVI is apparent by his sustained gaze to things that move, his difficulty with finding a preferred object on his tray when other objects are present, and his lack of coordination to look at something and reach for it at the same time. You know that access to aided AAC systems typically relies on vision (Wilkinson & Jagaroo, 2004) and motor capabilities to some extent. James' CP diagnosis impacts his ability to independently walk and to use his arms with control and coordination. Due to his motor, vision, and communication impairments, James has little to no control over his social and physical environments. He uses a wheelchair that is directed by others and needs assistance to reposition himself. As James' SLP, you feel overwhelmed at the thought of addressing communication for a student with so many areas of concern. You are not alone, as SLPs are increasingly assigned to work with students with serious neurological impairments due to improved preterm survival rates (Chang & Borchert, 2020).

Key Developmental Milestones and Cross-Domain Interactions

When working with students with complex needs such as James, teasing apart development into distinct domains is difficult; however, it may be beneficial to better understand systems separately before embracing system intersectionality. Modern educational and medical systems force the assignment of each functional system to a specific provider such as SLPs who address communication and occupational therapists (OTs) who address fine motor skills. Do developmental milestones early in life really occur singularly within one domain or are cross-domain interactions apparent at every stage of development? A closer look at the development of visual attention, actions on objects, and vocalizations in relation to James' case allows for further exploration of this question.

Visual Attention

For most students on an SLP's caseload, visual attention is not something that presents as a concern. Most children have previously acquired this skill. In contrast, for a student such as James, the coordination of visual attention is important to understand, as it may be a key precursor to his development in other areas.

Visual attention is modulated by both bottom-up and top-down aspects (Treue, 2003). Visual exploration early in life allows infants to gather information about their environment and to orient their gaze to arousing or salient information (Markant & Amso, 2016). Treue (2003) described bottom-up aspects of visual processing as "properties of the incoming sensory signals" (p. 428) that

need to be parsed for relevance and importance. Top-down aspects of visual attention arise in areas of the brain that control attention and eye movements necessary for more detailed assessment of salient aspects in a visual environment (Treue, 2003). Together, these two aspects allow infants to develop more fine-tuned visual attention. Typically, infants develop selective attention around 4–6 months of age, which allows them to process an intended target more efficiently and to suppress distractions (Markant & Amso, 2016). This more mature attentional control allows infants to be flexible in different environments and disregard things that are not important. After 6 months, babies begin to complete tasks that require more executive function control through anterior attention systems (Reynolds & Richards, 2019).

James' diagnosis of CVI results in differences in visual processing from other children his age such as a preserved visual attraction for looking at things that move and for looking at things with light. Initially, you think to describe his vision as infantile or delayed but have been told that these characteristics are hallmarks of an early CVI diagnosis. It seems that when James is shown an object, he is delayed in his ability to visually attend. When he does look at the object, his gaze appears fleeting, or he gazes from his peripheral rather than central vision. After consideration of typical development in visual attention, you realize that James may have difficulty with both the top-down and bottom-up aspects of visual attention. Attributes of objects such as motion and light are incoming sensory signals that James does not seem able to disengage with visually. These attributes attract his visual attention. Even when competing stimuli are present, James does not seem able to suppress the distraction or attraction to movement and light.

Action on Objects

As an SLP, you are also not typically concerned with a student's inability to reach for, grasp, and manipulate objects. If difficulties with these skills arise, a referral to an OT is made to address these weaknesses. In James' case, his inability to exert intentional control over objects in his environment has diminished his opportunities for learning about cause and effect.

Piaget (1964) wrote, "to know an object is to act on it" (p. 176). He described operations as actions that result in knowledge. Object manipulation helps children to learn about their impact on the environment and other people, leading to experiences related to cause and effect. In typical development, children develop and fine tune motor skills that allow them to better control experiences with objects and people in their environment through reaching, grasping, and acting on objects (Iverson, 2010). Piaget described four main stages that children progress through, which represent different levels of understanding and controlling objects. The stages include sensory–motor operations, preoperational representations, concrete operations, and formal or hypothetic–deductive operations. Within these stages, infants learn more about objects and their environment through direct interactions. Due to this article's focus on students such as James, the sensory–motor operation stage is described in greater detail. Orienting to, extending to reach, grasping, manipulating, and releasing are all component skills that enable an infant to perform actions on objects (Kim et al., 2018). The development of these skills enables children to learn about intentionality, described as purposeful, goal-directed behavior (Beukelman & Light, 2020). Interactions between oneself and an object or between two objects provide opportunities for children to learn about the specific properties of objects and their relationships to one another (Iverson, 2010). Furthermore, manipulation of objects may lead to a child's increased understanding of their impact on the environment and other people, aiding in the development of intentionality.

James was diagnosed with spastic quadriplegic CP at birth, which impacts all four of his limbs. Due to this diagnosis, James is unable to independently move his trunk or legs. He depends on his personal nurse and parents to put him in his wheelchair, readjust his posture, and move him throughout his environment. James has difficulty volitionally moving his arms. When he does use his arms, the movements are spastic and uncoordinated. He is unable to coordinate both arm movements and looking at the same time, making it challenging to reach for objects. James rarely reaches for or independently interacts with objects placed on or near his wheelchair. James has few opportunities to experiment with cause and effect, such as observing what would happen if he pushed something off his tray. In turn, James is not afforded chances to truly impact his environment or communication partners. Incidental learning opportunities are decreased due to James' limited independent motor abilities. When considering AAC options for James, a few challenges come to mind. First, you are unsure whether James has fully developed causality and intentionality. To use aided AAC, he must be intentional in his pursuit of conveying a message to a communication partner through the selection of vocabulary and/or symbols. Second, you feel perplexed about how James might be able to motorically (and visually) access potential aided AAC systems.

Vocalizations

Vocalizations fall within the domain of communication, and therefore, as an SLP, you are cognizant of

developmental milestones in this area. In James' case, those closest to him continue to question his intentionality when he does vocalize. You know intentionality to be essential for James to succeed with AAC.

Austin (1962) separated the prelinguistic vocalizations of infants into three distinct acts described as perlocutionary, illocutionary, and locutionary. Perlocutionary acts are not intentionally used by an infant but are attributed communicative meaning by communication partners (Bates et al., 1975), such as when a baby cries and the parent attributes an emotion such as sadness. The transition to illocutionary vocalizations occurs when the infant intends to impart meaning to a listener and the communication partner receives it. Partner sensitivity, along with consistent and reciprocal responses to a child's communicative behaviors, is crucial for learning about intentional communication (Wilcox et al., 1990). An example is when a child intentionally vocalizes, and the communication partner responds. Infants in this stage direct their vocalizations toward their communication partner and use vocalizations along with other communicative behaviors (Harding & Golinkoff, 1979). Locutionary acts occur when a child uses sounds or words for a specific referent introducing symbolism (Harding & Golinkoff, 1979). Locutionary acts often coordinate gesture and speech intentionally (Esteve-Gibert & Prieto, 2014). Readers are referred to the study of Bates et al. (1979) for a comprehensive discussion of the emergence of symbolic representation.

James is described as an emerging intentional and body-based beginning communicator. He inconsistently uses facial expressions and body movements to signal preferences. For example, James slightly turns his head away when presented with food that is unfamiliar to him. His parents use his facial expressions to interpret his comfort and feelings. His vocalizations often appear to transmit his emotions; however, his family has been unable to consistently discriminate the meaning of his vocalizations. James lacks control of his articulators, which results in a difficulty with controlling or shaping his vocalizations to sound differently. Due to this lack of control, it is hard to decipher whether James uses vocalizations to represent differences in meaning. Despite James' ability to use facial expressions, body movements, and vocalizations to communicate some messages, his family wishes that they could better interpret his communication signals. James' family attributes his vocalizations to sometimes mean very specific things, but you are unsure.

Joint Attention: An Illustration of Cross-Domain Interactions

James' case highlights the overlap between the functional domains of language, motor, and vision, which appear impossible to separate completely. For James to perform actions on objects, he must first visually attend to the objects. For James to explore the change in vocalizations that occur when he brings an object to his mouth (Iverson, 2010), he must be able to attend to the object and then reach for it. Clearly, all three domains are interdependent. Working with a child such as James will require careful inspection of the subskills that children typically develop without conscious thought as you help him to build toward communicative competence. Joint attention is one essential precursor to language development and communicative competence that marries the three previous domains discussed.

Joint attention involves shared and coordinated attention between an infant, another individual, and something of interest. Infant attention to other humans begins around 3 months of age. Around 5 months, infants begin to show interest in object manipulation (Bigelow, 2003). With an increase in social interaction, object play, and visual development, infants from 6–12 months of age increase in their ability to coordinate visual attention to both objects and communication partners. They can follow adult directives to attend to an object and begin to learn that they can also direct others to attend to an object (Bigelow, 2003). Salley et al. (2016) distinguishes between infants' ability to both respond to joint attention by following the gaze or gestures or others and initiate joint attention by directing the attention of others. Both types of communicative behaviors represent growth in the ability to regulate executive attention and to engage socially (Salley et al., 2016).

Around 1 year of age, infants increase their understanding that other people serve as "intentional agents" (Laakso et al., 1999, p. 208). Children gain understanding of the environment around them, the use of objects for purpose, and the control that people can exert on the environment and objects. Typically, young children can initiate movement toward an object of interest or direct a communication partner toward the shared object through gesture or language (Moore et al., 2019). This causes communication partners such as parents to respond with either action or language in return. James' family has difficulty recognizing if he is visually engaging with objects in the environment when they attempt to get him to look at something. Due to James' lack of visual, motor, and linguistic responses, they often do not recognize or attribute meaning to his small, idiosyncratic movements or facial expressions that he makes in response to stimuli. Similarly, James has not been able to focus his parents' attention on things that he is interested in from his environment. When he sees something that he enjoys, he does not always visually attend to it in a manner that would be expected, and he cannot reach for it. Due to the limited movement of his articulators, James also has trouble adjusting his vocalizations to represent differences in meaning. Typical joint attention episodes involve the coordination of visual attention, hand

movement toward an object, and vocalizations to gather the attention of the communication partner. You realize that James' ability to respond to and initiate joint attention may be limited. Prior to jumping into AAC-based intervention, you realize that skills such as joint attention may require your focus in intervention.

Primary Tenets of Developmental Systems Theory

Joint attention is only one of James' many possible abilities that are influenced by the interactions between functional domains. Once you begin breaking skills down by the contributions of various functional domains, it can become overwhelming to know where to start assessment and intervention efforts. A developmental systems approach may prove valuable as a starting point for clinicians. Investigations with specific populations such as children in early intervention (e.g., Dunst et al., 2001; Paul & Roth, 2011), individuals who are deaf-blind (Holte et al., 2006), and individuals who utilize AAC (Gerber & Kraat, 1992; Lund et al., 2017) have alluded to the importance of an assessment and intervention approach that is grounded in an understanding of functioning across domains. An introduction to the three primary tenets of developmental systems theory (sampling, context dependency, and interdependency) in relation to James' case will provide an example for how SLPs may systematically apply the theory to students on their own caseloads.

Tenet 1: Sampling

Infants and children constantly sample their environment through various sensory inputs (e.g., vision, hearing, and touch), which consequently impacts the functional plasticity of their brains and the overall timing of development (D'Souza & D'Souza, 2019). Differences in the internal neural networks of infants, the external environments they encounter, and the interactions between the two result in individual variations in sampling (D'Souza et al., 2017). Specifically, for individuals with neurodevelopmental disorders, differences in internal neural networks may result in atypical external environments (e.g., reduced parental input) or difficulties with sampling of the external environment (e.g., diminished functional vision secondary to CVI; D'Souza et al., 2017). This could, in turn, impact the specialization or plasticity of their brain at the neuronal level of development. To illustrate sampling, consider that James is positioned in his wheelchair in the central room of his family home (the kitchen) after school as his parents and siblings go about their evening routines. Due to James' motor impairments secondary to his CP, he is unable to independently navigate his home environment, which decreases potential opportunities to learn new concepts, explore objects of interest, and engage in spontaneous interactions with his siblings. Therefore, sampling for James is constrained by both differences in his internal neural network (i.e., neural differences to his motor system) and external environment (i.e., constrained environmental access) and the interaction between the two.

Tenet 2: Context Dependency

Context dependency refers to behavioral development that emerges and is shaped across time by specific experiences within ecological contexts (Blumberg, 2017; Thelen & Smith, 1995). Specifically, this tenet of a developmental systems approach prompts consideration of the contexts or factors across time that might constrain or promote the development of behaviors (D'Souza & D'Souza, 2019). To illustrate context dependency, consider that James' use of functional vision is facilitated by black backgrounds and minimal competing sensory input when he is tasked to use his vision. At school, James' paraeducator works one-on-one with him in a single-colored background, clutter-free corner of the classroom. Due to the school's consistent efforts to use these environmental modifications, James has been able to use his vision to attend to and sometimes select between two solid color objects to make a choice. James' family reports minimal success with a similar task in the home environment. The interaction of environmental modifications across time in different contexts results in either the constraint or promotion of James' visual engagement to make a choice.

Tenet 3: Interdependency

This tenet of a developmental systems approach describes adaptable, diverse, and interdependent parts that change in response to the environment and constrain or support development in other domains (D'Souza & D'Souza, 2019). Developmental cascades are one way to think about the interdependency between systems. Iverson (2021) explained that changes in one domain can potentially lead to cumulative effects on other domains that may not seem related, which illustrates the interdependency and interrelatedness between developmental systems in areas such as vision, language, and motor. To illustrate interdependency, consider the previous description of James' difficulties with establishing joint attention.

Reason-Based Recommendations From a Developmental Systems Approach

While James' case was presented throughout the tutorial as an example, students with different profiles would benefit from the same careful examination of functional domains in interrelationships with one another. For example, consider a child with autism spectrum disorder with communication

needs who lacks fine motor control, frequently uses echolalic speech, and struggles to attend to the interests of communication partners. Likewise, think about a student with severe-to-profound bilateral hearing loss, nystagmus, speech production difficulties, and orthotics due to a leg length discrepancy. Additionally, even if a student on an SLP's caseload appears to be functioning within normal limits in related domains such as motor, there exists an interaction that will contribute to their communicative abilities. In lieu of empirical evidence specific to each child's unique presentation, the previously introduced tenets of a developmental systems approach provide a framework for reason-based recommendations for SLPs to consider when working with individuals with complex needs across domains (see Figure 1).

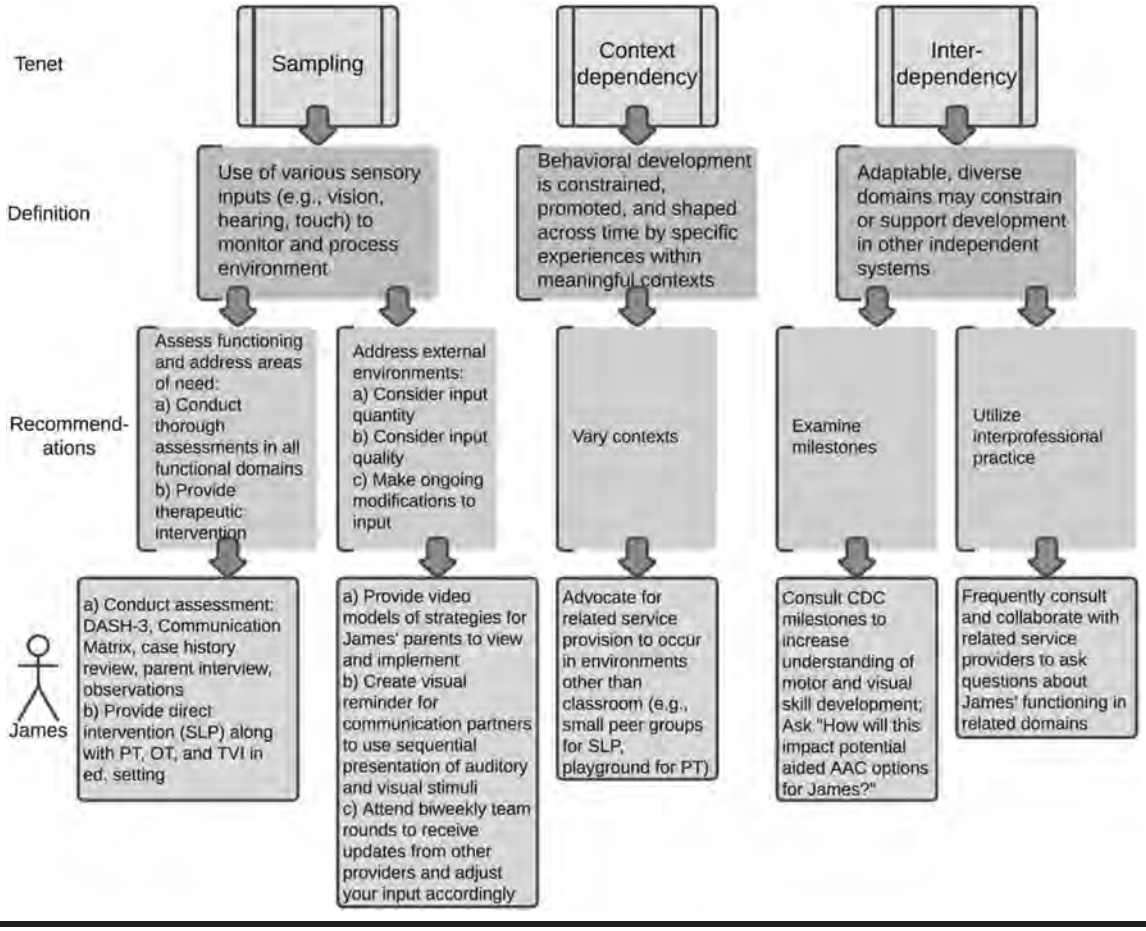
Sampling

As discussed above, there exist individual differences in sampling based on a child's internal neural network, external environment, and interactions between the two.

Assess Functioning and Address Areas of Need

SLPs should examine possible differences of the individual internal networks, in areas such as cognition and communication, for students such as James. Careful review of a student's medical and case history may provide insight on the specific causes of the student's challenges in functional domains. Additionally, SLPs should pursue further understanding of a student's functioning by utilizing assessments that account for individuals with needs in multiple functional domains such as the Callier–Azusa Scale for students who are deaf-blind (Stillman, 1974), the Developmental Assessment for Individuals With Severe Disabilities–Third Edition (Dykes & Mruzek, n.d.), and the Communication Matrix for students functioning in the early stages of communication who do not currently speak or write (Rowland, 2022). Provided with a case and/or medical history, the outcomes of assessment(s), and observations and family input, service providers can aggregate information on student functioning.

Figure 1. Reason-based recommendations from a developmental systems approach. DASH-3 = Developmental Assessment for Individuals With Severe Disabilities–Third Edition; SLP = speech-language pathologist; PT = physical therapist; OT = occupational therapist; TVI = teacher certified in visual impairment; ed. = educational; CDC = Centers for Disease Control and Prevention; AAC = augmentative and alternative communication.



In many cases, SLPs and other related service providers (i.e., TVIs for vision) will work to positively impact cognitive, communicative, sensory, or motor functioning of an individual through therapeutic intervention. An example of this is when SLPs work to address a deficit in receptive language by providing therapy to address goals in this area. James receives direct therapeutic intervention from you (the SLP), the OT, the PT, and the TVI in his educational setting. All service providers conducted assessments of James' functioning in the educational setting, as well as observations in the home prior to the development of his individualized education program.

Address External Environments

Another avenue to enact positive change is to address the external environment of the individual so that the input they sample is appropriate and individualized to their internal neural network.

Consider input quantity. Children with concomitant impairments often receive diminished access to incidental learning through experiences with their physical body and through social interactions with others (D'Souza et al., 2017). Motor impairments resulting in limited independent movement decrease their opportunities to sample more of the environment. Language impairments resulting in limited social language use to others decrease their opportunities to bid for attention or interaction. Bigelow (2003) described two types of self-knowledge that develop in young children including interpersonal self-knowledge and ecological self-knowledge. Interpersonal self-knowledge develops as children build a perception of self in relationship to others by establishing reciprocal gazes and responding contingently to one another. Ecological self-knowledge develops as children build a perception of self in relationship to their local environment (Bigelow, 2003). For children with vision, motor, and language impairments, both types of self-development may be interrupted. Consequently, their internal neural networks receive reduced input from external environments.

SLPs should be cognizant of the reduced quantity of input received by children with complex needs. Careful selection of targeted input (e.g., visually appropriate stimuli for a visual schedule, linguistically appropriate input to accompany learning activities such as shared book reading) across time and contexts is imperative to ensuring maximal exposure to appropriate input. You determine that it is critical for James' communication targets to be addressed throughout the school week and not just when you are present in his classroom; therefore, you create video models to share with his paraeducator so that she can practice with James when you are not present. Furthermore, you share these models with James' parents so that the same strategies can also be implemented in the home environment, increasing the quantity of input he receives.

Consider input quality. In addition to quantity, it is imperative that children such as James receive input that is appropriate to their level of functioning. For CVI, this involves careful examination of the visual behavioral characteristics present for that child. Difficulties with visual complexity are common to CVI and can refer to the complexity of a visual array, complexity of pattern on the surface of an object, complexity of the sensory environment, or complexity of human face elements (Roman-Lantzy, 2018). McCarty et al. (2021) found that the internal complexity of visual stimuli impacts visual engagement for individuals with CVI. Specifically, a picture of a single larger object was more eliciting of visual attention than pictures including an increased quantity and type of items. This evidence should prompt SLPs to examine the materials and, possibly, symbols introduced to students with CVI to ensure that the individual is able to visually engage. Similarly, in the domain of mobility, adaptive equipment such as hands-free support walkers needs to be carefully adjusted to provide students with the ability to use dynamic movements and to turn within a small radius. Equipment to compensate for challenges with motor skills must be individually tailored to achieve input quality (Wright-Ott et al., 2021).

For children with concomitant impairments, appropriate input across multiple domains must be factored into therapeutic decision making. For example, auditory and visual input may need to be presented sequentially rather than simultaneously to support processing. Children with CVI are known to have difficulties with visually guided reach, meaning that they may not be able to both look at and touch something at the same time (Roman-Lantzy, 2018). Sequential presentation may help facilitate their interactions. Not only should input to the child be tailored for appropriateness, but attention should be given to ensure that the child has access to multiple modalities for output. There may be times when they are able to compensate for weaknesses in one area by relying on a stronger area for expression. For James, you have decided to collaborate with his PT and his parents to determine whether his current wheelchair best supports his positioning and orientation to materials presented to him. You have created a laminated sheet attached to James' current chair to remind communication partners that sequential presentation of auditory and visual stimuli is necessitated based on his current levels of visual functioning.

Make ongoing modifications to input. Finally, ensure that modifications made to input are ongoing over time and continually reassessed for appropriateness.

School-based SLPs are accustomed to the mandate for frequent revisiting of educational programming and plans to update progress, goals, and accommodations. The need for ongoing monitoring is imperative to ensure that all functional domains are being supported appropriately for students such as James. You agree to attend biweekly team "rounds" (5-min team updates prior to the start of the school day) on James to receive information from related service providers. Frequent updates from related service providers will help you to tailor the input you provide during your interventions.

Context Dependency

This tenet can be interpreted as the importance of examining the environment, contexts, and timing of experiences provided to children such as James.

Vary Contexts

One important factor for SLPs to think about are the environments and contexts to which individuals with complex needs are routinely exposed. In many cases, environmental exposure and varying contexts are significantly reduced for children such as James due to their dependence on others for mobility. Wright-Ott et al. (2021) stressed the importance of self-initiated mobility for children with CVI to develop spatial cognition and memory, language development, social interactions, and physical activity. When children can move independently, they transition from passivity to active participation, which, in turn, increases their opportunities to socially engage with others (West & Iverson, 2021). SLPs must ensure that children with visual impairments, motor needs, and language needs are receiving input beyond what would be encountered when sitting passively in a wheelchair or stander. Children who are not independently mobile will require experiences and communication partners to travel to them or for partners to assist them in moving. Attempts at increasing environmental exposure must be ongoing across time. You decide to advocate for James's services to occur in settings other than his classroom, such as participation with two same-age peers for one of his weekly speech therapy sessions and inclusive recess with his PT for support to increase his participation in a natural context.

Interdependency

For children such as James, SLPs must be cognizant of the impact of development in related domains on a student's communication.

Examine Milestones

Prior to writing goals for communicative outcomes for students with complex needs, SLPs are urged to examine a child's milestones and development in other related domains. Using assessment results to piece together the skills that a child is exhibiting in comparison to the skills they are lacking in related domains may help direct the focus of communication intervention. Iverson (2021) explored the impact of delayed motor development on language development outcomes. Specifically noted was the impact of delayed or absent walking behaviors on language production. Decreased environmental exploration, reduced social interactions, inability to carry objects while moving, and diminished adult communication about actions and objects were all outcomes associated with delayed or absent walking behavior (Iverson, 2021). Blackstone et al. (2021) reported that most children with CVI continue to rely on body-based (unaided) forms of communication with limited access to symbolic language. As SLPs try to foster symbolic language development, they may lose sight of development in related domains that precludes symbolism. For children with CVI, visual processing differences will impact the development of visual attention. Visual attention is a necessary prerequisite for introducing visual symbols.

You have decided to consult the Centers for Disease Control and Prevention Developmental Milestones to help you better understand what motor skills James is currently unable to perform and how this might impact his ability to utilize aided AAC (Centers for Disease Control and Prevention, 2022). As an SLP, you know it is important to be cognizant of the cascading impact of developmental milestones in related domains on language.

Utilize Interprofessional Practice

A final and critical recommendation is the call for interprofessional practice. SLPs should not feel as though they need to know everything about each domain specific to the students they are working with. They should feel empowered to search for information in other domains relevant to their students, which may mean seeking out the professional opinions and services of other related providers. Blackstone et al. (2021) found a major barrier to AAC service delivery for students with CVI, which was "concerns about services being delivered in isolated silos with limited time allotted for interprofessional collaboration and planning" (p. 612). This is not a concern solely for students with visual impairments, as research supports the importance of interprofessional practice for working with myriad student populations such as those with Down syndrome (Wilkinson & Na, 2015) and those who are deaf/hard of hearing (Blaiser & Nevins, 2017). James is one of the most complex students on your caseload. You recognize that to pursue AAC options for James, the support and recommendations of other related service providers will be crucial.

Summary

A developmental systems approach will prove useful in expanding SLP knowledge of where to begin and how to best serve children with language, vision, and motor needs. The tenets of sampling, context dependency, and interdependency should be revisited frequently as students make progress to ensure that development across domains, contexts, and time continues to be a factor in service provision decision making. This tutorial has identified reason-based recommendations for clinicians to immediately put into practice. When describing reason-based practice, Archibald (2017) stated, "Given the highly variable conditions across school systems, classrooms, professionals, and students, it could be argued that the evidence-base can never be expected to adequately cover all eventualities making reason-based practice a perpetual responsibility for the SLP" (p. 14). For children with specific impairments such as CVI, the evidence base is lacking to provide systematic intervention steps; however, SLPs are urged not to delay intervention addressing communication outcomes. Students such as James are depending on SLPs and other related service providers to forge a path for their meaningful participation with their environment and communication partners.

Data Availability Statement

Data sharing is not applicable to this article, as no data sets were generated or analyzed during this study.

Ethics Statement

Ethics approval was not required for this study.

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References

Archibald, L. M. (2017). SLP-educator classroom collaboration: A review to inform reason-based practice. *Autism & Developmental Language Impairments, 2,* 239694151668036. https://doi.org/10.1177/2396941516680369

Austin, J. L. (1962). *How to do things with words*. Oxford University Press.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). *The emergence of symbolism: Cognition and communication in infancy*. Academic Press.

Bates, E., Camaioni, L., & Volterra, V. (1975). The acquisition of performatives prior to speech. *Merrill-Palmer Quarterly of Behavior and Development, 21*(3), 205–226.

Beukelman, D. R., & Light, J. C. (2020). *Augmentative & alternative communication: Supporting children and adults with complex communication needs*. Brookes.

Bigelow, A. E. (2003). The development of joint attention in blind infants. *Development and Psychopathology, 15*(2), 259–275. https://doi.org/10.1017/s0954579403000142

Blackstone, S. W., Luo, F., Canchola, J., Wilkinson, K. M., & Roman-Lantzy, C. (2021). Children with cortical visual impairment and complex communication needs: Identifying gaps between needs and current practice. *Language, Speech, and Hearing Services in Schools, 52*(2), 612–629. https://doi.org/10.1044/2020_LSHSS-20-00088

Blaiser, K. M., & Nevins, M. E. (2017). Practioner reflection that enhances interprofessional collaborative practices for serving children who are deaf/hard-of-hearing. *Perspectives of the ASHA Special Interest Groups, 2*(9), 3–9. https://doi.org/10.1044/persp2.SIG9.3

Blumberg, M. S. (2017). Development evolving: The origins and meanings of instinct. *WIREs Cognitive Science, 8*(1–2), e1371. https://doi.org/10.1002/wcs.1371

Centers for Disease Control and Prevention. (2022). *What is a developmental milestone?* https://www.cdc.gov/ncbddd/actearly/milestones/index.html

Chang, M. Y., & Borchert, M. S. (2020). Advances in the evaluation and management of cortical/cerebral visual impairment in children. *Survey of Ophthalmology, 65*(6), 708–724. https://doi.org/10.1016/j.survophthal.2020.03.001

D'Souza, D., D'Souza, H., & Karmiloff-Smith, A. (2017). Precursors to language development in typically and atypically developing infants and toddlers: The importance of embracing complexity. *Journal of Child Language, 44*(3), 591–627. https://doi.org/10.1017/S030500091700006X

D'Souza, D., & Karmiloff-Smith, A. (2016). Why a developmental perspective is critical for understanding human cognition. *Behavioral and Brain Sciences, 39,* Article e122. https://doi.org/10.1017/S0140525X15001569

D'Souza, D., & D'Souza, H. (2019). Emergent and constrained: Understanding brain and cognitive development. *Journal of Neurolinguistics, 49,* 228–231. https://doi.org/10.1016/j.jneuroling.2018.04.011

Dunst, C. J., Bruder, M. B., Trivette, C. M., Hamby, D., Raab, M., & McLean, M. (2001). Characteristics and consequences of everyday natural learning opportunities. *Topics in Early Childhood Special Education, 21*(2), 68–92. https://doi.org/10.1177/027112140102100202

Dykes, M. K., & Mruzek, D. W. (n.d.). *Developmental Assessment for Individuals With Severe Disabilities–Third Edition (DASH-3): Technical manual*. WPS.

Esteve-Gibert, N., & Prieto, P. (2014). Infants temporally coordinate gesture-speech combinations before they produce their first words. *Speech Communication, 57,* 301–316. https://doi.org/10.1016/j.specom.2013.06.006

Gerber, S., & Kraat, A. (1992). Use of a developmental model of language acquisition: Applications to children using AAC systems. *Augmentative and Alternative Communication, 8,* 19–32. https://doi.org/10.1080/07434619212331276013

Harding, C. G., & Golinkoff, R. M. (1979). The origins of intentional vocalizations in prelinguistic infants. *Child Development, 50*(1), 33–40. https://doi.org/10.2307/1129038

Holte, L., Prickett, J. G., Van Dyke, D. C., Olson, R. J., Lubrica, P., Knutson, C. L., Knutson, J. F., & Brennan, S. (2006). Issues in the evaluation of infants and young children who are suspected of or who are deaf-blind. *Infants & Young Children, 19*(3), 213–227. http://journals.lww.com/iycjournal/Fulltext/2006/07000/Measures_of_Working_Memory_Span_and_Verbal.00006.aspx

Huo, R., Burden, S., Hoyt, C., & Good, W. (1999). Chronic cortical visual impairment in children: Aetiology, prognosis, and associated neurological deficits. *The British Journal of Ophthalmology, 83*(6), 670–675. https://doi.org/10.1136/bjo.83.6.670

Iverson, J. M. (2010). Developing language in a developing body: The relationship between motor development and language development. *Journal of Child Language, 37*(2), 229–261. https://doi.org/10.1017/S0305000909990432

Iverson, J. M. (2021). Developmental variability and developmental cascades: Lessons from motor and language development in infancy. *Current Directions in Psychological Science, 30*(3), 228–235. https://doi.org/10.1177/0963721421993822

Kim, H. J., Lee, C. H., & Kim, E. Y. (2018). Temporal differences in eye–hand coordination between children and adults during manual action on objects. *Hong Kong Journal of Occupational Therapy, 31*(2), 106–114. https://doi.org/10.1177/1569186118819892

Laakso, M.-L., Poikkeus, A.-M., Katajamäki, J., & Lyytinen, P. (1999). Early intentional communication as a predictor of language development in young toddlers. *First Language, 19*(56), 207–231. https://doi.org/10.1177/014272379901905604

Lund, S. K., Quach, W., Weissling, K., McKelvey, M., & Dietz, A. (2017). Assessment with children who need augmentative and alternative communication (AAC): Clinical decisions of AAC specialists. *Language, Speech, and Hearing Services in Schools, 48*(1), 56–68. https://doi.org/10.1044/2016_LSHSS-15-0086

Markant, J., & Amso, D. (2016). The development of selective attention orienting is an agent of change in learning and memory efficacy. *Infancy, 21*(2), 154–176. https://doi.org/10.1111/infa.12100

McCarty, T. V., Sowers, D. J., Wolf, S. J., & Wilkinson, K. M. (2021). A preliminary study of the relation of visual attention to stimulus complexity and functional vision in individuals with cortical visual impairment: Implications for augmentative and alternative communication. *Perspectives of the ASHA Special Interest Groups, 6*(6), 1603–1617. https://doi.org/10.1044/2021_PERSP-21-00112

Moore, C., Dailey, S., Garrison, H., Amatuni, A., & Bergelson, E. (2019). Point, walk, talk: Links between three early milestones, from observation and parental report. *Developmental Psychology, 55*(8), 1579–1593. https://doi.org/10.1037/dev0000738

Paul, D., & Roth, F. P. (2011). Guiding principles and clinical applications for speech-language pathology practice in early intervention. *Language, Speech, and Hearing Services in Schools, 42*(3), 320–330. https://doi.org/10.1044/0161-1461(2010/09-0079)

Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching, 2*(3), 176–186. https://doi.org/10.1002/tea.3660020306

Reynolds, G. D., & Richards, J. E. (2019). Infant visual attention and stimulus repetition effects on object recognition. *Child Development, 90*(4), 1027–1042. https://doi.org/10.1111/cdev.12982

Roman-Lantzy, C. (2018). *Cortical visual impairment: An approach to assessment and intervention* (2nd ed.). American Foundation for the Blind.

Rowland, C. (2022). *The Communication Matrix: Technical manual*. The Communication Matrix Foundation.

Salley, B., Sheinkopf, S. J., Neal-Beevers, A. R., Tenenbaum, E. J., Miller-Loncar, C. L., Tronick, E., Lagasse, L. L., Shankaran, S., Bada, H., Bauer, C., Whitaker, T., Hammond, J., & Lester, B. M. (2016). Infants' early visual attention and social engagement as developmental precursors to joint attention. *Developmental Psychology, 52*(11), 1721–1731. https://doi.org/10.1037/dev0000205

Stillman, R. D. (1974). *The Callier–Azusa Scale*. https://eric.ed.gov/?id=ED102796

Thelen, E., & Smith, L. B. (1995). *A dynamic systems approach to the development of cognition and action*. The MIT Press.

Treue, S. (2003). Visual attention: The where, what, how and why of saliency. *Current Opinion in Neurobiology, 13*(4), 428–432. https://doi.org/10.1016/S0959-4388(03)00105-3

West, K. L., & Iverson, J. M. (2021). Communication changes when infants begin to walk. *Developmental Science, 24*(5), Article e13102. https://doi.org/10.1111/desc.13102

Wilcox, M. J., Kouri, T. A., & Caswell, S. (1990). Partner sensitivity to communication behavior of young children with developmental disabilities. *Journal of Speech and Hearing Disorders, 55*(4), 679–693. https://doi.org/10.1044/jshd.5504.679

Wilkinson, K. M., & Jagaroo, V. (2004). Contributions of principles of visual cognitive science to AAC system display design. *Augmentative and Alternative Communication, 20*(3), 123–136. https://doi.org/10.1080/07434610410001699717

Wilkinson, K. M., & Na, J. Y. (2015). Interprofessional practice in developing an AAC system for children with Down syndrome. *SIG 12 Perspectives on Augmentative and Alternative Communication, 24*(3), 114–122. https://doi.org/10.1044/aac24.3.114

Wright-Ott, C., Blackstone, S., & Pressman, H. (2021). *The significance of support walker mobility for children with cortical visual impairment (CVI), complex speech and physical needs: The Bridge School experience*. Closing the Gap.