PERSONAL STATEMENT

I am a strong candidate for the Loan Repayment Program (LRP) one-year renewal award due to my extensive research training, my research accomplishments studying vocal and communication development in typically developing and clinical populations, and my long-term commitment to advancing early communication interventions for children with motor-based neurodevelopmental disabilities like CP. My research experience and clinical expertise as a certified speech-language pathologist have enabled me to develop an independent line of research focused on the early identification of speech and broader communication impairments in CP, a population that remains critically underserved across the discipline of communication sciences and disorders.

During my doctoral and postdoctoral training, I gained extensive experience in longitudinal study designs, data collection, and analysis. These skills have been crucial in shaping my research approach to focus on capturing how motor impairments in CP influence communication trajectories over time. I have led and supported numerous studies that examined early vocal development in typically developing children, as well as vocal markers of communication impairments in children with CP and autism, resulting in 15 publications (10 as first author) and 19 first-author presentations at national and international scientific conferences. I was awarded two prestigious NIH institutional T-grants through NICHD (T32) and NCATS (TL1), which provided rigorous training in conducting research in intellectual and developmental disabilities and in clinical and translational research. I was also awarded a New Investigators Research Grant from the ASHFoundation which supported my initial investigations into infant vocal and communication behaviors in CP.

The LRP has been instrumental in reducing my financial burden, allowing me to focus on research productivity. Over the past two years, I made significant strides toward building an evidence base to understand the early vocal characteristics in infants at risk for speech impairments associated with CP, contributing valuable insights into the clinical field related to early prediction. I have also secured a tenure-track Assistant Professor position at Case Western Reserve University, a leading R1 medical research institution, where I will continue to expand my research program on early communication development in neurodevelopmental disabilities. The university offers a highly supportive environment for this work, with access to cutting-edge research resources and collaborative opportunities across departments. My work is well-aligned with the institution's emphasis on interdisciplinary research and community engagement.

My long-term goals include obtaining NIH R21 and subsequent R01 funding to further investigate speech, language, and communication trajectories in children with CP which is well known to be a population that demonstrates a wide range of strengths and support needs for speech and communication development. I also plan to develop evidence-based tools that clinicians can use to identify communication challenges earlier in childhood. This research will fill a critical gap in the field, providing clinicians with actionable insights and strategies to offer timely interventions to support individual needs.

Continued support from the LRP for a one-year period is crucial for maintaining the momentum of my research program as I transition into my independent faculty role. I am confident that my previous research accomplishments, coupled with my clinical background, interdisciplinary collaborations, and institutional resources position me to make significant contributions to the early identification and intervention of communication impairments in children with CP and other underserved motor-based neurodevelopmental disabilities.

RESEARCH ACCOMPLISHMENTS

During my initial Loan Repayment Program (LRP) award period (2022-2024), I made significant progress in advancing my independent line of research focused on the early prediction of speech impairments in children with neurodevelopmental disabilities. This research examined vocal characteristics of infants aged 6-24 months at risk for communication disorders, including cerebral palsy (CP) and autism. My accomplishments during this period include 18 scientific conference presentations and 15 publications (10 as first author and 4 under review). I also secured a tenure-track research faculty position at Case Western Reserve University (R1: very high research activity) which began in summer 2024. The long-term goal of my research remains in the early identification and intervention for communication impairments in young children with neurodevelopmental disabilities, ultimately enhancing their communication outcomes and quality of life.

Publications Based on Initial LRP Research Aims:

Vocal characteristics in infants at risk for CP: My research aimed to understand the developmental timing, patterns, and complexity of early marginal and canonical babbling characteristics in infants at risk for CP. The work led to several important publications, summarized below, which highlight the need for expanding research on infant vocal and communicative characteristics as predictors of speech motor impairments to support early diagnosis and intervention.

1. Two preliminary studies showed higher rates of marginal babbling and lower rates of canonical babbling in infants at risk for CP than typically developing expectations. These findings suggest preliminary evidence of prelinguistic vocal markers of speech impairment in CP (Long, Eichorn, et al., 2023; Long & Hustad, 2023).
2. A pilot study found that children with CP who have greater speech motor impairments at age four produced lower rates of complex vocalizations at twelve months in infancy, indicating early vocal markers may predict later speech impairment (Long et al., under review).
3. One study on 4-year-old children with CP and anarthria showed that these children predominantly remained in the earliest stages of vocal development, with limited consonant diversity, emphasizing the relevance of studying vocal markers in CP (Long & Hustad, in press).
4. A scoping review identified gaps in research on vocal characteristics in infants at risk for neurodevelopmental speech motor involvement, highlighting the need for longitudinal studies, standardized methodologies, and larger sample sizes (Long, Christensen, et al., 2023).

Additional Research Conducted During the LRP Period:

Vocal development in typical and autistic infants: I expanded my research to investigate perceptual and acoustic vocal markers of autism in comparison to typical vocal development. This work allowed me to expand my research area of focus to the examination of vocal characteristics as markers of neurodevelopmental disorders more broadly, with the goal to improve early differential diagnosis and treatment planning for children with complex communication needs.

1. We found small differences in canonical babbling rates between autistic and typically developing infants starting around 9 months, primarily in males, suggesting that sex differences should be considered in early autism diagnosis and support planning (Long et al., 2024).
2. One study found that both autistic and typically developing infants showed clear clustering of vocal types across the first year, suggesting that vocal category formation is a robust feature of early speech development in both groups (Su et al., 2024).
3. A study comparing acoustic patterns of vocalizations between infants later classified as typically developing, autistic, and language-impaired found that only typically developing infants showed significant effects of IDS on vocal acoustics, highlighting the role of social interaction in vocal development (Oller et al., under review).

Open science practices in communication sciences and disorders: I also contributed to research on the adoption of open science practices in communication sciences and disorders, a growing area of interest across

scientific areas of study. Our findings highlight the importance of promoting open science practices to enhance clinical research reproducibility, transparency, and accessibility.

1. A survey study identified low levels of knowledge and implementation of open science practices such as preregistration and open data, though researchers expressed a strong interest in learning about, and engaging in, these practices (El Amin et al., 2023)
2. Another study showed that open access articles in the field of communication sciences and disorders receive more citations and online attention than paywalled articles, underscoring the value of open access for research visibility (Long, Drown, et al., 2023).

Additional Accomplishments:

Grant Funding: I was awarded a third year of postdoctoral training through the UW-Madison Institute for Clinical and Translational Research (ICTR) TL1 program, focusing on clinical and translational research. Additionally, I received a New Investigators Research Grant from the ASHFoundation to support my research investigating prelinguistic vocal behaviors in infants at risk for CP. This funding enabled a comprehensive analysis of vocal production in young children with CP.

1. TL1 TR002375, NCATS, UW-Madison ICTR TL1 Postdoctoral Training Program, 08/23-07/24, Role: Postdoctoral Fellow.
2. New Investigators Research Grant, ASHFoundation, “Prelinguistic vocal behaviors in infants at risk of cerebral palsy under 24 months,” 12/22-12/23, $10,000, Role: PI.

Professional Development: I received extensive training in intellectual and developmental disabilities and clinical research methodologies through the LRP Period as a postdoc at UW-Madison. Presenting at key conferences, such as the Motor Speech Conference, American Speech-Language-Hearing (ASHA) Convention, American Academy of Cerebral Palsy & Developmental Medicine (AACPDM), and Symposium on Research in Child Language Disorders (SRCLD) expanded my professional network and fostered collaborative opportunities. I also deepened my understanding of translational research through auditing the “Translational and Outcomes Research in Health and Health Care” course in the School of Medicine & Public Health and participating in workshops like the Dissemination & Implementation Short Course and TL1 Research Summit. These experiences, combined with ethics and leadership training from the Waisman Ethics Seminar and the UW Postdoc Scientific Leadership Workshop have prepared me to lead an inclusive research environment.

Summary:

The progress made during my first LRP award period has significantly advanced my independent research program on communication development in children with neurodevelopmental abilities. My research has contributed to the scientific understanding of pediatric motor speech disorders and practical implications for early diagnostic and intervention. Building on these accomplishments, I have expanded my focus to include broader communication behaviors, aiming to understand how motor development impacts infant communication abilities. The financial relief provided by the initial LRP allowed me to focus on my research aims, resulting in high productivity. As I begin my independent research career as an Assistant Professor, continued LRP support will be essential to sustain this level of productivity and further advance my research to improve life-long outcomes of people with communication disorders.

RESEARCH PROJECT ACTIVITIES

Background & Hypotheses

Cerebral palsy (**CP**) is the most common childhood motor disability, affecting approximately 2-3 out of every 1,000 live births.[1] It is characterized by non-progressive disturbances in the developing fetal or infant brain, leading to motor impairments that often result in communication delays.[2] More than 50% of children with CP experience speech motor impairments that limit their ability to communicate effectively, engage in meaningful social interactions and participate in educational environments.[3–6] Despite these well-documented difficulties, the early identification of communication impairments in children with CP often occurs only after they have reached speaking ages when speech can be measured, delaying critical early communication interventions.[7,8] This delay has significant negative implications for long-term communication outcomes.

In typical development, motor milestones such as sitting, reaching, pointing, and walking serve as key organizers for communication and language development.[9] These motor achievements allow infants to engage with their environment, manipulate objects, and participate in social interactions that facilitate the development of key communication skills such as joint attention, gesture use, and play.[10,11] This dynamic process, referred to as a *developmental cascade*,[12] suggests that early motor achievements facilitate subsequent cognitive and communicative gains. In children with CP, motor impairments likely disrupt these cascades, limiting opportunities to practice key communication-relevant motor behaviors. This reduced engagement may impact domains such as gesture use, joint attention, and symbolic play, which are known precursors to language development.[13,14]

Prior studies have sought to establish the relationship between motor and communication abilities in children with CP.[5,15,16] However, relying on motor function alone risks oversimplifying this population's diverse communication abilities, leading to overgeneralization and potentially inaccurate clinical assumptions about individual capabilities. We know of no research that has examined the complex interactions between early motor and communication development in infants with CP beyond correlation studies. This pilot study aims to address this gap by establishing foundational data on early communication profiles and longitudinal changes in infants with CP, using the *developmental cascades framework*. This approach integrates insights from developmental psychology and developmental medicine, providing a novel perspective to explore how motor impairments in CP impact communication trajectories in infancy. Applying this framework will support a more nuanced understanding of these developmental processes, ultimately enhancing early identification of communication needs in this population and informing targeted intervention strategies.[17,18]

By applying this framework, his research will address clinical barriers to early identification of communication needs of children with CP. Specifically, I will longitudinally investigate the emergence of communication and symbolic behaviors using the Communication and Symbolic Behavior Scales (CSBS)[19] between 12-18 months in 10 infants with CP and 10 neurotypical (NT) infants to inform the identification of early markers that can predict which infants will require augmentative and alternative communication (AAC) interventions. Longitudinal tracking of motor and communication development between these ages is essential to capture how these abilities evolve in children with CP. This study aims to inform clinical practices by contributing to the facilitation of earlier, more targeted interventions to improve long-term communication outcomes for children with CP.

Aim 1: Characterize early communication profiles of CP and NT infants at 12 months. We will use Mann-Whitney U tests to compare scores across the seven communication domains on the CSBS between CP and NT infants at 12 months, establishing baseline differences in early communication abilities. We hypothesize that infants with CP will demonstrate lower scores across domains, reflecting early disruptions in foundational communication and symbolic behaviors in this group of children.

Aim 2: Evaluate the progression of communication profile changes over time in CP and NT infants. We will calculate summary change scores for each communication domain on the CSBS across three time points (12, 15, and 18 months) and use Mann-Whitney U tests to compare these changes between the CP and NT groups. We hypothesize that infants with CP will exhibit slower gains in communicative and symbolic behaviors over time, reflecting the cumulative impact of motor impairments on communication development.

Both aims are designed to be analyzed independently, allowing findings from Aim 1 to stand alone without affecting the longitudinal investigation in Aim 2. This structure enhances the feasibility and integrity of each objective. This project is positioned as a pilot investigation to validate methods and build infrastructure for

broader, long-term studies. By focusing on foundational aspects of communication and motor interplay in infants with CP, this project will establish a crucial referral pipeline that will enable future longitudinal research on a larger scale.

Clinical Significance: Research in children with CP has advanced our understanding of motor development, yet significant gaps remain regarding how these impairments affect early communication. Traditional developmental milestones often fail to consider the unique needs of infants with reduced mobility, leaving critical early communication needs under-addressed. This study applies a developmental cascades framework, specifically tailored to the challenges faced by infants with CP, to reveal how motor delays influence communication outcomes. This approach aims to inform targeted early interventions, improving immediate communication and positioning children for long-term social and educational gains. By establishing data-driven, CP-specific guidelines, this project will support a shift from reactive to proactive clinical practices. Our findings have the potential to extend beyond CP, informing early intervention strategies in other neuromotor conditions, reducing delayed interventions, and enhancing communication outcomes for children with a range of neurological disabilities. The study directly aligns with NIH funding priorities focused on advancing early identification and intervention for neurodevelopmental disabilities, fulfilling a critical need for data-driven approaches to support lifelong outcomes for children with CP beginning at the youngest possible age.

Innovation: This study innovatively applies a developmental cascades framework to early communication in CP, a perspective new to CP research and developmental medicine. By examining how motor impairments impact specific communication domains, this approach has potential to uncover critical pathways where communication delays emerge in the context of motor impairments, setting a precedent for tailored early interventions. The study's longitudinal design and use of the comprehensive and validated CSBS enhances its rigor, enabling precise identification of periods where communication delays can be detected. Future research stemming from this pilot study has potential to reduce gaps in current practices, offering clinically relevant insights that support a shift from generalized, reactive approaches to proactive, individualized care for children with CP who have unique speech and AAC needs. Through the integration of developmental psychology with clinical CP research, this project pioneers a foundation for innovative early interventions targeted for children with neuromotor impairments, addressing key communication needs in infants with CP.

Approach

Participants: This pilot study will include 10 infants diagnosed with CP (CP group), and 10 age- and gender matched neurotypical infants (NT group), all recruited between 9-12 months corrected age. Given the low incidence of CP in infancy (2-3 out of every 1,000 births), this sample size aligns with the feasibility constraints common in rare clinical populations and is sufficient in detecting preliminary effect trends in communication development between groups, with plans to continue to recruit additional infants per group to conduct even more robust statistical comparisons.

Recruitment: To ensure sufficient participant recruitment, we have established referral pipelines with University Hospitals Rainbow Babies & Children's Hospital and the United Cerebral Palsy of Greater Cleveland. These facilities have access to diverse clinical populations and are committed to assisting with study recruitment efforts. Our recruitment approach includes close collaboration with physicians, speech-language pathologists, and early intervention providers to identify eligible participants.

Recruitment for the **CP Group** will be facilitated by partnerships with the above listed medical and community resources in the Cleveland, OH area. These partnerships will provide access to eligible participants and establish a referral pipeline that supports future larger studies, enhancing long-term feasibility for research in this understudied population.

Recruitment for the **NT Group** will involve community outreach through local advertisements (e.g., flyers, social media, daycares, doctor's offices), and word-of-mouth referrals. The Clinical and Translational Science Collaborative (CTSC) of Northern Ohio will further assist with recruitment by providing targeted advertisements in healthcare settings and social media outreach. All infants will be followed longitudinally across the three time points of interest to capture communication developmental changes in infancy. Families will also be invited to continue their participation through 2-5 years to compare longer-term trajectories, wherein additional grant funding will be sought to sustain ongoing participation efforts.

Eligibility Criteria: Eligible participating infants will be between 9-12 months corrected age, have no known history of hearing concerns, and all families must report English as at least one language spoken in the home. Otoacoustic emission testing will be conducted at the first laboratory visit to confirm hearing status.
The **CP Group** will include infants with a confirmed diagnosis of CP by enrollment. Co-diagnoses will not be used as exclusionary criteria for this sample as these are common characteristics of the diagnosis of CP.
The **NT Group** will include infants with 1) no history of maternal pregnancy or birth complications associated with CP, 2) no known familial history of speech, language, or hearing disorders, and 3) neurotypical across all domains of development as reported by caregivers.

Study Design: This **longitudinal study** will involve data collection at three key age bands: "12 months" (12-14 months), "15 months" (15-17 months), and "18 months" (18-21 months"). All analyses will be conducted using infants' **corrected age**, adjusted from gestational age at birth. Each time point will assess communication and symbolic behavior performance to investigate communication developmental differences between the CP and NT groups. The selected age range to be studied captures a critical developmental period where both motor and communication growth is closely linked. Focusing on this age range will provide a targeted look at very early communication development in infancy, a developmental period and domain that is under-explored in the population of CP.

Assessment: Data collection will occur in a **laboratory setting** where each infant will participate in a 1.5 to 2 hour comprehensive communication assessment using the **Communication and Symbolic Behavior Scales (CSBS)**[19] at each time point. The CSBS is a well-validated and widely used tool for the early detection of communication delays in infants and toddlers at risk for developmental differences. The CSBS evaluates seven key communication domains (**Table 1**), all of which are critically relevant for understanding the interaction between motor and communication development in young children with CP. Although primarily used to detect delays in autism and general developmental disabilities,[20] the CSBS is a standardized and robust measure that integrates direct assessment and parent-reported information that is particularly well-suited for measuring early communicative behaviors. It's comprehensive evaluation across specific domains of communication make it the best available tool to address the aims of this project.

Table 1. Communicative Domains Assessed by CSBS

CSBS Scale	Areas Assessed	Relevance to CP
Communicative Functions	Why a child communicates (e.g., requesting, sharing)	CP may limit communicative functions due to physical limitations in engaging others
Gestural Communicative Means	Non-verbal communication through gestures	Motor impairments may restrict the ability to use gestures (e.g., pointing, waving)
Vocal Communicative Means	Vocalizations and speech development	CP may affect non-speech oral motor movements during vocalization
Verbal Communicative Means	Use of words and combinations to communicate	CP may affect speech subsystems including articulation, respiration, and phonation for speech
Social Reciprocity	Turn-taking and social engagement	Reduced speech, fine, and gross motor function may affect the ability to initiate or respond in social interactions
Social-Affective Signaling	Emotional expression during communication	Motor impairments may hinder expression of emotions via facial expressions or gestures
Symbolic Behavior	Pretend play and use of objects symbolically	Reduced fine motor function may limit object manipulation involved in symbolic and complex play

This will be the first study to apply the full CSBS to examine communication development in infants with CP, allowing us to generate detailed profiles of infant communication trajectories across multiple time points. Furthermore, we will use the long form CSBS to conduct the most detailed evaluation of infant communication performance and trajectories across multiple time points. While the short form (*CSBS-Developmental Profile*, CSBS-DP[21]) has been previously used with older children with CP,[5,15] it provides a more limited investigation. By using the full CSBS, this study will deliver unprecedented insights into early communication development in infants with CP, supporting our research aims comprehensively.

A certified speech-language pathologist (SLP) or trained, supervised graduate student clinician will administer the CSBS to each participant at all time points. To the extent possible, the same evaluator will be used for individual children at all time points to enhance fidelity. All assessments will be video- and audio-

recorded using high-quality recording equipment. To ensure scoring reliability, 20% of assessments will be reviewed by a secondary clinician. Discrepancies will be settled through consensus discussion.

Statistical Analysis

Aim 1: Characterize early communication profiles of CP and NT infants at 12 months.

- Hypothesis: We hypothesize that infants with CP will demonstrate significantly **lower scores** across the seven CSBS domains at 12 months compared to NT infants, reflecting early disruptions in communication and symbolic behaviors.
- Analysis: To examine group differences in early communication profiles, we will use **Mann-Whitney U tests** to compare scores across the seven CSBS domains between CP and NT infants at 12 months. This non-parametric approach is appropriate for our small sample sizes and accounts for the non-normal distribution often seen in clinical samples. We will quantify the magnitude of these group differences using **non-parametric effect sizes** (Cliff's delta), providing practical insights into the early impact of motor impairments on communication. Additionally, **bootstrapping** will be applied to construct robust confidence intervals around these estimates, enhancing the precision of findings despite the limited sample size.
- Potential Problems and Alternate Strategies: Given our small sample size, there is limited power to detect smaller effects that might otherwise be observed in a larger cohort. If needed, we will employ **Bayesian estimation methods** to refine parameter estimates and enhance result reliability, offering more nuanced insight into group differences. Bayesian approaches can further allow us to explore the likelihood of observed effects within a broader probabilistic framework, providing valuable pilot data for planning future studies.

Aim 2: Evaluate the Progression of Communication Profile Changes Over Time in CP and NT Infants.

- Hypothesis: We hypothesize that infants with CP will show significantly **slower gains** in communicative and symbolic behaviors across the three time points (12, 15, and 18 months) compared to NT infants, suggesting a cumulative impact of motor impairments on communication development over time.
- Analysis: We will calculate **summary change scores** for each communication domain on the CSBS across three time points to capture growth in each domain over time. **Mann-Whitney U tests** will then be used to compare these change scores between the CP and NT groups. This non-parametric test accommodates the non-linear and variable growth patterns typically observed in small clinical samples. By comparing relative growth trajectories, we aim to identify specific areas where communication development in CP diverges from typical development, providing preliminary evidence for developmental delays across these domains. Additionally, we will apply **bootstrapping** to improve the stability of change estimates and assess the consistency of growth differences.
- Potential Problems and Alternate Strategies: Small sample size limitations may reduce statistical power to detect developmental trajectory differences. To address this, we will apply **bootstrapping** to create more stable estimates and, if needed, implement **Bayesian methods** to model group-specific growth trajectories, allowing for a more flexible and refined assessment of differences across time points.

Power: This pilot study aims to provide foundational data on early communication profiles in infants with CP) compared to NT infants. With a sample size of 10 infants per group, we recognize that the study is underpowered to detect small effects, which would require a larger sample. Instead, this study is positioned to detect medium-to-large effects, with power levels lower than the conventional 80%. By focusing on larger effects, we aim to capture key trends and variability within this population, which will be essential for informing effect size estimates and guiding the design of a future, adequately powered study.

Justification for Pilot Design and Sample Size: Given the limited availability of infants with CP in this age range, a pilot design was selected to explore this research question in an initial sample of 20 infants (10 per group). This exploratory approach will generate essential preliminary data, offering initial effect size estimates and shaping the design of future studies. Though not powered for small effects, the study will detect medium-to-large effects, allowing us to assess communication patterns in CP infants at this early stage. The insights gained will support subsequent R21 to R01 funding applications, to secure the larger samples needed for more comprehensive longitudinal analysis and statistical rigor.

Feasibility and Timeline

This pilot study is designed with a focus on feasibility, supported by **recruitment partnerships** with local hospitals and community centers to access the target populations of infants with CP and NT infants. Regular communication with these partner facilities and scheduled follow-up meetings will be maintained to ensure recruitment milestones are met and to streamline the referral of eligible participants. Existing collaborations with these institutions provide a robust foundation for successful recruitment efforts in this project.

Retention strategies will include maintaining regular contact with participating families, providing reminders for upcoming sessions, and offering flexible scheduling options to reduce the likelihood of drop-out over the study period. **Equipment and materials required for the study are in place**; all video recording software has been installed, and the Communication and Symbolic Behavior Scales (CSBS) has been purchased, ensuring immediate readiness for data collection. Start-up funds allocated for **family compensation** will support recruitment and retention, and additional internal and external funding will be pursued as needed to expand project resources.

The project is structured over a 5-year period, with the **LRP award spanning the first two years**. Recruitment and data collection will occur in Years 1-3, allowing for complete data collection at all time points. Data analysis will begin in Year 3 and continue into Year 4, followed by manuscript preparation and dissemination of findings through Years 4-5 for Aims 1 and 2. The project timeline also includes the pursuit of additional funding to expand the study, including an early-career NIDCD R21 grant application to further develop this research (See **Table 2**), which will be used to transition into a future R01. Conference presentations will occur at multiple points throughout the study, ensuring timely dissemination of preliminary findings to strengthen the project's impact within the scientific community.

Table 2. Research Activities	**LRP Period**		**Post-LRP Period**		
	Y1	**Y2**	**Y3**	**Y4**	**Y5**
Recruitment & Enrollment					
- Recruit 10 CP and 10 NT infants with community partnerships	**X**	**X**			
Data Collection					
- Administer and score CSBS for 12-14 mo age band (Aims 1, 2)	**X**	**X**	**X**		
- Administer and score CSBS for 15-17 mo age band (Aims 2)	**X**	**X**	**X**		
- Administer and score CSBS for 18-21 mo age band (Aims 2)		**X**	**X**	**X**	
Aim 1: Characterize Early Communication in CP and NT infants					
- Analyze group differences at 12 mo			**X**		
- Manuscript preparation and submission				**X**	
Aim 2: Evaluate Communication Trajectories in CP and NT infants					
- Analyze group differences over time at 12, 15, 18 mo				**X**	
- Manuscript preparation and submission					**X**
Dissemination & Funding					
- Present preliminary findings at conferences		**X**		**X**	
- Submit and plan for potential resubmission of R21 application		**X**	**X**		

Scientific Career Goals

The long-term impact of this study lies in its **potential to set a new standard** for the early communication assessment of children with cerebral palsy (CP), establishing evidence-based guidelines for proactive identification and intervention in clinical practice. By generating foundational data on the cascading effects of motor impairments on early communication, this project will lay critical groundwork for larger, NIH-funded studies that expand research to broader age ranges and larger samples. The insights gained will enhance clinical understanding of how early motor impairments influence key domains of communication and symbolic behavior, which are essential in forming intervention strategies tailored to CP. Ultimately, this work aims to shift clinical practice **from reactive approaches to proactive intervention models,** reduce reliance on delayed compensatory interventions, and enhance long-term communication outcomes for children with CP.

This project directly supports my **long-term goal** to advance early identification and intervention strategies for communication impairments in CP. Findings from this project will contribute to the development of clinical tools for identifying communication challenges in infants with neuromotor disabilities, critical for timely and effective intervention. This pilot will provide the foundational baseline needed to extend the study of participants through age 5 in subsequent research, supported by future NIH R21 and R01 grants and private funding. Financial support from the LRP will allow me to fully dedicate time and resources to this research, accelerating progress toward a transformative shift in clinical practices for CP, ultimately enabling early, targeted interventions that improve lifelong communication outcomes.

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CAREER DEVELOPMENT PLAN

Research

My long-term research goals aim to advance the early identification and intervention of speech and communication needs in children with cerebral palsy (**CP**). I will investigate how motor delays in infancy impact communication trajectories, recognizing that motor and communication abilities are deeply interconnected. By studying infants with CP across early childhood, I plan to identify critical periods where motor impairments significantly affect communication to inform early intervention strategies. These findings will enable clinicians to address communication challenges sooner and more effectively to improve long-term outcomes.

Additionally, I aim to expand awareness within the medical community of the critical importance of early referrals to speech therapy, particularly during the critical period of communication development. By advocating for greater support for caregivers and speech therapy interventions such as augmentative and alternative communication (**AAC**), I hope to foster caregiver buy-in and empower families to advocate for their child's communication needs. This holistic approach will enhance both child outcomes and family well-being during the early diagnosis and intervention process.

Grants

Throughout my career, I plan to pursue a range of external and internal funding opportunities to support my longitudinal research. Externally, I am preparing an Early Career NIDCD R21 Grant to fund the pilot research project described in this application (beyond my start-up funds), with plans to transition into an NIDCD R01 Grant for larger-scale studies. Additionally, I will apply for grants from the American Academy of Cerebral Palsy and Developmental Medicine (**AACPDM**) and C-PROGRESS, both of which have current funding priorities in the early identification and intervention of rehabilitation needs for children with CP.

Internally, I will seek funding through Case Western Reserve University (**CWRU**) Early-career funding opportunities include the WP Jones Presidential Award which supports innovative research across my institution, and the Clinical and Translational Science Collaborative (**CTSC**) Pilot Program, which provides seed funding for early phase clinical and translational research. As my career progresses, I will pursue the Expanding Horizons Initiative, an internal mid-career grant for advancing established research programs. This combination of external and internal funding resources will allow me to impactful longitudinal studies on early communication needs in children with CP.

I will meet bi-weekly with my primary faculty mentor in Communication Sciences, Dr. Lauren Calandruccio and monthly with my secondary mentor in Developmental Psychology, Dr. Anastasia Dimitropoulos, to discuss my ongoing progress on data collection, analysis, and manuscript preparation. We will have quarterly full mentorship team meetings to review my progress toward research independence and tenure, and to discuss my grant application preparation for the NIDCD R21 and future transition to R01 funding.

Workshops & Seminars

I plan to participate in several professional development opportunities to expand my expertise in early communication development in CP. These include:

- CP Research Network (**CPRN**) Webinar Series: Monthly, 1-hour webinars where leading CP researchers present their findings and discuss critical topics such as early detection and communication development with other researchers, clinicians, and community members. Participating in these webinars will enhance my understanding of the latest research and foster collaboration with experts in the field.
- Early CP Intervention Training Courses: Available through the Early CP Detection Network, I will attend 3–4-hour training courses once a year focused on early detection and intervention in CP. I will learn practical skills to apply motor-focused interventions to the development of interventions to support communication development.
- Dissemination & Implementation Science (D&I) Short Course: I will participate in the University of Wisconsin-Madison's annual D&I Short Course every five years, which offers a two-day training in translating research into real-world clinical practice. This is particularly valuable for ensuring the practical impact of my research.
- Early Detection and Intervention (**EDI**) Workshop: I will attend this bi-annual, two-day international workshop focused on early detection and intervention for neurodevelopmental disorders, including CP.

This event offers an ideal platform to network with interdisciplinary experts and discuss the latest advances in diagnosis and early intervention.

Scientific Meetings

As part of my long-term career development, I plan to regularly attend and present at key conferences related to my area of research, including:

- American Speech-Language Hearing Association (**ASHA**): This annual conference hosts scientists and clinicians in the discipline of communication sciences and disorders, offering opportunities to present my work on early communication in CP and engage with researchers and clinicians on topics such as early speech development, AAC, and populations with diverse communication needs.
- American Academy of Cerebral Palsy and Developmental Medicine (**AACPDM**): This conference focuses on improving clinical care for people with CP and other developmental disabilities, providing an opportunity to share and discuss my findings with an interdisciplinary clinical audience and form collaborations with experts in CP.
- International Congress of Infant Studies (**ICIS**): I will present my research and attend sessions applying the developmental cascades framework in infancy at this bi-annual meeting, which connects international experts in infant behavioral research. This conference will allow me to contribute to the broader discourse on development in neuromotor disabilities such as CP and form international research collaborations.

Training in Responsible Conduct of Research

As part of my dedication to research integrity, I will maintain Responsible Conduct of Research (RCR) training through Case Western Reserve University's (CWRU) Continuing Research Education Credit (CREC) program. This training will be refreshed every three years, ensuring I remain up to date with NIH and institutional ethical standards. The CREC program covers critical topics like data management, peer review, conflict of interest, authorship, and human subject protections. I have already completed my initial RCR training and will continue to participate in both asynchronous online coursework via CITI Program modules and in-person workshops. Additionally, I will attend seminars on research ethics offered through CWRU's Office of Research Compliance, providing continuous professional development in ethical research practices. This structured education will help guarantee that my research adheres to the highest ethical standards, supporting the rigor and reproducibility of my work throughout my career.

Diverse, Equitable, Inclusive, and Accessible Research Practices

To ensure Diversity, Equity, Inclusion, and Accessibility (**DEIA**) are core principles in my research, I will engage in ongoing DEIA-focused seminars and workshops provided by CWRU. CWRU's Office of Research and Technology Management offers DEIA in Research training, ensuring that inclusive practices are applied throughout the research process, from recruitment to data interpretation. Additionally, I will participate in workshops offered by the Schubert Center for Child Studies that focus on DEIA principles relevant to child development and caregiver well-being. These sessions will equip me to better engage with underserved populations, ensuring my research on early communication in children with CP is both inclusive and accessible. I will also attend DEIA training through the CTSC, further enhancing my ability to conduct research that benefits all populations equitably. These ongoing training efforts will allow me to continuously apply DEIA practices in all aspects of my research.

Research Environment

Case Western Reserve University (CWRU)

As an R1 research institution, CWRU is renowned for its cutting-edge research and is consistently ranked among the top private research universities in the nation. In the 2022-2023 fiscal year, CWRU secured over $389 million in research funding across more than 1,200 research awards, including support from the U.S. Department of Health and Human Services and National Institutes of Health. The Communication Sciences Program at CWRU is housed within the Department of Psychological Sciences, a leading center for interdisciplinary research. The department integrates expertise in developmental psychology, early intervention, and communication sciences, making it an ideal environment to conduct this research project. The program's emphasis on evidence-based practice, medical speech-language pathology, and its strong commitment to community engagement aligns seamlessly with my research objectives centered on advancing the early identification and intervention of communication impairments in children with cerebral palsy (**CP**). My research will continue to benefit from the intellectual environment fostered through interdisciplinary seminars and workshops, facilitating collaborations across the communication sciences and psychological sciences.

Recruitment Resources

I will also benefit from CWRU's strong institutional and extensive clinical and research partnerships, including with institutions like University Hospitals Rainbow Babies Children's Hospital, the United Cerebral Palsy of Greater Cleveland, and the Cleveland Hearing and Speech Center. These partnerships offer access to diverse clinical populations, ensuring successful recruitment of infants for this study. Additionally, the Clinical and Translational Science Collaborative (**CTSC**) of Northeastern Ohio provides infrastructure for participant recruitment, statistical support, Redcap data management, and research collaboration, further enhancing the efficiency and feasibility of this research. The Schubert Center for Child Studies at CWRU is another key resource that will support this research. The center fosters interdisciplinary work aimed at improving the well-being of children through research, policy, and education. Its emphasis on translating research into practical applications and policy change will further support the continued clinical translation of my research.

Laboratory Space and Materials

My independent research laboratory, the Communication and Speech Emergence Lab, is equipped with state-of-the-art facilities and equipment, including a 12x10' video recording room, a 6x8' recording observation room with two-way mirror, an 8x8' lab manager office space, a 12x13' student workspace fitted for three computer workstations, a 6x6' waiting area, and a 4x4' storage room. I also have my own independent, 12x10' personal office space with printing, scanning, and wired internet access. Presently, I have two graduate student assistants to support data collection. I have acquired the Communication and Symbolic Behavior Scales assessment battery, including manuals, scoring sheets, and manipulatives to begin administering this tool to children throughout the project period.

Funding Support

Participation compensation for three laboratory visits for all 100 children is built into my start-up package. Additional funding for the final fourth visit at their 2nd birthday will be supplemented by internal and external research grants for which I am already in the process of applying. My start-up package also includes travel funds for myself and one student to present findings at three major conferences. As manuscripts will be shared publicly via post-print repositories, no additional funds for publication fees will be required.

This research environment, combined with the university's resources and interdisciplinary culture, will significantly enhance the probability of success for my research over the course of the LRP award and beyond.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Long, Helen L.

eRA COMMONS USER NAME (credential, e.g., agency login): hlong1

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
Indiana University, Bloomington, IN	BA	05/2010	Speech Language & Hearing Sciences; Slavic & Eastern European Languages & Cultures
Florida State University, Tallahassee, FL	MS	08/2012	Speech-Language Pathology
University of Memphis, Memphis, TN	PHD	12/2020	Communication Sciences & Disorders
University of Wisconsin, Madison, WI	Postdoctoral Fellow	07/2024	Communication Sciences & Disorders

A. Personal Statement

The long-term goal of my research is to advance the early and accurate identification of communication impairments in children with cerebral palsy (CP) to drive the development of targeted early interventions. My research questions are driven by my clinical experiences as a speech-language pathologist, where I encountered limited evidence to inform treatment decisions for this widely heterogeneous population to prioritize enhancing their speech and/or augmentative and alternative communication development. My doctoral training provided a strong theoretical foundation for studying vocal and speech development in typical and clinical populations. During my postdoctoral training, I gained extensive experience in studying longitudinal speech and communication development in children with CP. I applied the research methods from my doctoral program to begin to explore vocal predictors of speech impairments in infants at risk for CP. As a postdoctoral researcher, I was awarded two NIH T-grants through the NICHD (2021) and NCATS (2023), which provided broad training in clinical and translational research methods and intellectual and developmental disabilities. Additionally, I was awarded a prestigious ASHFoundation New Investigators Research Grant (2022) to conduct a preliminary study examining the relationship between infant vocal characteristics and speech-language outcomes in infants at risk for CP. These experiences equipped me with extensive skills in longitudinal data collection and analysis, project management, and manuscript writing which are essential for my independent research. As a new tenure-track Assistant Professor, I am writing an R21 award to collect pilot data using standardized methodologies to examine the communication profiles of infants with CP. This research aims to further inform the early identification of speech and communication needs in this population, supporting my long-term research goal. The initial Loan Repayment Program (LRP) award significantly reduced the burden of my student loan debt, allowing me to focus on my research aims. This financial relief enabled me to be highly productive during the LRP period (2022-2024), resulting in 15 published/submitted manuscripts (10 as first author) and 19 first-authored presentations at national and international conferences. As I begin my career as an independent research scientist and Assistant Professor, I require continued support from the LRP renewal to maintain this level of productivity and further my research endeavors.

1. **Long HL**, Ramsay G, Bene E, Su P, Yoo H, Klaiman C, Pulver S, Richardson S, Pileggi M, Brane N, Oller D. Canonical babbling trajectories across the first year of life in autism and typical development. Autism. 2024 May 17; DOI: 10.1177/13623613241253908

2. **Long HL**, Christensen L, Hayes S, Hustad KC. Vocal Characteristics of Infants at Risk for Speech Motor Involvement: A Scoping Review. J Speech Lang Hear Res. 2023 Nov 9;66(11):4432-4460. PubMed Central PMCID: PMC10715844.
3. **Long HL**, Hustad KC. Marginal and Canonical Babbling in 10 Infants at Risk for Cerebral Palsy. Am J Speech Lang Pathol. 2023 Aug 17;32(4S):1835-1849. PubMed Central PMCID: PMC10561958.
4. **Long HL**, Mahr TJ, Natzke P, Rathouz PJ, Hustad KC. Longitudinal change in speech classification between 4 and 10 years in children with cerebral palsy. Dev Med Child Neurol. 2022 Sep;64(9):1096-1105. PubMed Central PMCID: PMC9339470.

B. Positions, Scientific Appointments and Honors

Positions and Scientific Appointments

2024 -	Assistant Professor, Case Western Reserve University, Cleveland, OH
2023 - 2024	NCATS TL1 Postdoctoral Fellow, Institute of Clinical and Translational Research, University of Wisconsin-Madison, Madison, WI
2021 - 2023	NICHD T32 Postdoctoral Fellow, Waisman Center, University of Wisconsin, Madison, WI
2020 -	Co-founding collaborator, CSDisseminate and OpenCSD
2015 - 2020	Research Assistant, Origin of Language Laboratory, University of Memphis, Memphis, TN
2014 - 2021	Speech-Language Pathologist, Shelby County Schools, Invo-Progressus Therapy, Memphis, TN
2012 - 2014	Speech-Language Pathologist, Easter Seals Massachusetts, Worcester, MA
2010 - 2012	Research Assistant, Experimental Child Phonetics Laboratory, Florida State University, Tallahassee, FL
2008 - 2010	Research Assistant, Voice Physiology Laboratory, Indiana University, Bloomington, IN

Honors

2022 - 2024	Morse Society Scholar, Waisman Center, University of Wisconsin-Madison
2022 - 2024	Initial Loan Repayment Award, National Institute on Deafness and Communication Disorders (NIDCD)
2022 - 2023	ASHFoundation New Investigators Research Grant Recipient, American Speech-Language-Hearing Foundation
2023	Lessons for Success Fellow, American Speech-Language-Hearing Association (ASHA)
2021	Pathways Program Fellow, American Speech-Language-Hearing Association (ASHA)
2020	Graduate Student President Service Award, University of Memphis
2020	OrthoPediatrics Scholarship, American Academy for Cerebral Palsy & Developmental Medicine (AACPDM)
2019	S.P. Wong Award for Best Presentation in Statistical Application, Department of Mathematics, University of Memphis

C. Contribution to Science

1. **Vocal Predictors of Speech Impairments in Cerebral Palsy:** My primary line of research studies the early identification of speech impairments in children with cerebral palsy (CP). One longitudinal study of clinical speech classification showed that early speech performance predicts later abilities, highlighting the need for early detection and intervention. Two preliminary studies examining vocal characteristics of infants at risk for CP showed higher rates of marginal babbling and lower rates of canonical babbling than typical infants, suggesting early vocal differences. Our scoping review on this topic identified a need for standardized methodologies and larger sample sizes in this research. These studies suggest a need for additional research examining vocal characteristics as predictors of speech motor impairments to support early diagnosis and intervention.

    a. **Long HL**, Christensen L, Hayes S, Hustad KC. Vocal Characteristics of Infants at Risk for Speech Motor Involvement: A Scoping Review. J Speech Lang Hear Res. 2023 Nov 9;66(11):4432-4460. PubMed Central PMCID: PMC10715844.

b. **Long HL**, Hustad KC. Marginal and Canonical Babbling in 10 Infants at Risk for Cerebral Palsy. Am J Speech Lang Pathol. 2023 Aug 17;32(4S):1835-1849. PubMed Central PMCID: PMC10561958.

c. **Long HL**, Eichorn N, Oller DK. A Probe Study on Vocal Development in Two Infants at Risk for Cerebral Palsy. Dev Neurorehabil. 2023 Jan;26(1):44-51. PubMed Central PMCID: PMC9822870.

d. **Long HL**, Mahr TJ, Natzke P, Rathouz PJ, Hustad KC. Longitudinal change in speech classification between 4 and 10 years in children with cerebral palsy. Dev Med Child Neurol. 2022 Sep;64(9):1096-1105. PubMed Central PMCID: PMC9339470.

2. **Vocal Predictors of Language Differences in Neurodevelopmental Conditions:** This line of research investigated early vocal predictors of language differences in infants with neurodevelopmental conditions, including autism and tuberous sclerosis. These studies analyzed human-coding of infant vocal types produced during laboratory and home recordings and showed delayed canonical babbling onset and reduced volubility across these clinical groups compared to typically developing infants. These findings highlight the potential of early vocalizations as indicators of later social language differences to aid in early diagnosis and intervention for these populations.

   a. **Long HL**, Ramsay G, Bene E, Su P, Yoo H, Klaiman C, Pulver S, Richardson S, Pileggi M, Brane N, Oller D. Canonical babbling trajectories across the first year of life in autism and typical development. Autism. 2024 May 17; DOI: 10.1177/13623613241253908

   b. Su P, Yoo H, Ramsay G, **Long HL**, Bene E, Klaiman C, Pulver S, Richardson S, Pileggi M, Brane N, Oller D. Foundations of Vocal Category Development in Autistic Infants. Journal of Autism and Developmental Disorders. 2024 February 25; :-. Available from: https://link.springer.com/10.1007/s10803-024-06267-9 DOI: 10.1007/s10803-024-06267-9

   c. Gipson TT, Ramsay G, Ellison EE, Bene ER, **Long HL**, Oller DK. Early Vocal Development in Tuberous Sclerosis Complex. Pediatr Neurol. 2021 Dec;125:48-52. PubMed Central PMCID: PMC8557126.

3. **Evolutionary Origins of Speech and Development of Infant Vocalizations:** My doctoral dissertation investigated the role of nonsocial and social factors in the emergence of speech to understand how infants signal developmental progress through vocalizations. Using human coding of laboratory and home recordings of infant vocalizations, we found that infant vocal imitation is rare but salient, nonsocial vocalizations occur more frequently than social ones, and advanced vocalizations occur more frequently during interactions with caregivers than during independent vocal play. These findings underscore the dual motivations behind vocal development, highlighting the importance of both self-driven vocal exploration and social engagement in speech development.

   a. **Long HL**, Ramsay G, Griebel U, Bene ER, Bowman DD, Burkhardt-Reed MM, Oller DK. Perspectives on the origin of language: Infants vocalize most during independent vocal play but produce their most speech-like vocalizations during turn taking. PLoS One. 2022;17(12):e0279395. PubMed Central PMCID: PMC9803194.

   b. Oller DK, Ramsay G, Bene E, **Long HL**, Griebel U. Protophones, the precursors to speech, dominate the human infant vocal landscape. Philos Trans R Soc Lond B Biol Sci. 2021 Oct 25;376(1836):20200255. PubMed Central PMCID: PMC8419580.

   c. **Long HL**, Bowman DD, Yoo H, Burkhardt-Reed MM, Bene ER, Oller DK. Social and endogenous infant vocalizations. PLoS One. 2020;15(8):e0224956. PubMed Central PMCID: PMC7406057.

   d. **Long HL**, Oller DK, Bowman DA. Reliability of Listener Judgments of Infant Vocal Imitation. Front Psychol. 2019;10:1340. PubMed Central PMCID: PMC6579846.

4. **Open Science Practices in Communication Sciences and Disorders:** A secondary research area I have supported has studied the adoption and barriers of open science practices in the discipline of communication sciences and disorders. One survey study identified low levels of knowledge and implementation of open science practices such as preregistration and open data. Yet we found a strong desire among researchers to learn more and engage in these practices. Additionally, a separate study showed that fully open access articles receive significantly more citations and online attention than

paywalled articles. These findings highlight the importance of promoting open science practices to enhance clinical research reproducibility, transparency, and accessibility.

a. El Amin M, Borders JC, **Long HL**, Keller MA, Kearney E. Open Science Practices in Communication Sciences and Disorders: A Survey. J Speech Lang Hear Res. 2023 Jun 20;66(6):1928-1947. PubMed Central PMCID: PMC10554559.
b. **Long HL**, Drown L, El Amin M. The Effect of Open Access on Scholarly and Societal Metrics of Impact in the ASHA Journals. J Speech Lang Hear Res. 2023 Jun 20;66(6):1948-1957. PubMed Central PMCID: PMC10465153.

Complete List of Published Work in My Bibliography:
https://www.ncbi.nlm.nih.gov/myncbi/helen.long.1/bibliography/public/