The Innovative Multidisciplinary Journal for Science and Technology (IMJST)

Volume 1, Issue 1

Doi: https://doi.org/10.5281/zenodo.13387200

Phonological Development in Children: A Comprehensive Overview

Eman Alhaj-Mousa [1]

[1] Master, Private School, Amman, Jordan

Correspondence to: Eman Alhaj-Mousa (Emansuphi104@gmail.com)

Abstract

This review provides a comprehensive examination of the use of phonological measures, such as phonological mean length of utterance (pMLU), phonological whole-word proximity (PWP), and phonological whole-word correctness (PWC), in assessing language development across various populations, including typically developing children, children with specific language impairments (SLI), and children with Autism Spectrum Disorder (ASD). The review synthesizes findings from studies conducted in diverse linguistic contexts, including Arabic and English, highlighting the cross-linguistic applicability of these measures. Key themes include the importance of early intervention, the challenges in assessing phonological development in children with ASD, and the need for methodological consistency in research. The review underscores the value of these phonological measures in identifying language impairments and tracking developmental progress, while also pointing to the need for further research in underrepresented languages and longitudinal studies to better understand phonological trajectories.

Keywords: Phonological development, Autism Spectrum Disorder (ASD), specific language impairment (SLI), early intervention, cross-linguistic assessment.

Introduction

Phonological development is a fundamental aspect of language acquisition, serving as the foundation upon which children build their verbal communication skills. It encompasses the ability to produce, recognize, and manipulate phonological units such as sounds, syllables, and words. This development is critical not only for effective spoken communication but also for the acquisition of literacy skills, which include reading, spelling, and writing. Understanding how phonological skills evolve, particularly in children with language impairments, is crucial for early identification and intervention, which can significantly impact long-term language outcomes (Brown, 1973; Amayreh & Dyson, 1998).

Phonological measures, such as the phonological mean length of utterance (pMLU), phonological whole-word proximity (PWP), and phonological whole-word correctness (PWC), have been widely used to assess and track phonological development in children. These measures provide quantitative data that can help in

Copyright © 2024 The Author(s); Published by Sobraj Publishing Service. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

identifying the strengths and weaknesses in a child's phonological abilities, offering a standardized way to compare across different populations and languages. This is especially important in assessing children at risk for or diagnosed with language impairments, such as specific language impairment (SLI) and Autism Spectrum Disorder (ASD) (Ingram, 2002; Kumar & Bhat, 2009).

Research has shown that phonological development is influenced by a variety of factors, including the linguistic environment, the complexity of the language being acquired, and underlying neurological or developmental conditions. For instance, children with ASD often exhibit unique patterns of phonological development compared to their typically developing peers, with many showing delays or impairments in producing and processing speech sounds (Paul et al., 2011; Vogan et al., 2014). Bilingual children, on the other hand, may develop phonological skills differently in each of their languages, depending on factors such as language exposure, proficiency, and the specific phonological demands of each language (Bunta et al., 2009; Burrows & Goldstein, 2010).

Given the critical importance of early detection and intervention, understanding the nuances of phonological development across different populations is essential. This review aims to synthesize existing research on the application of phonological measures in typically developing children, children with specific language impairments, and children with ASD. The goal is to highlight the effectiveness of these measures in identifying and addressing phonological challenges in various linguistic and developmental contexts.

Methods

This review systematically analyzed research studies that employed phonological measures such as pMLU, PWP, and PWC to assess language development in children. A comprehensive search of academic databases, including PubMed, PsycINFO, and Google Scholar, was conducted using keywords such as "phonological mean length of utterance," "phonological development," "language impairment," "Autism Spectrum Disorder," and "cross-linguistic phonological measures." Studies were included in the review if they met the following criteria:

- Involved children aged 1-10 years.
- Employed phonological measures such as pMLU, PWP, PWC, or similar to assess language development.
- Provided empirical data on typically developing children, children with specific language impairments (SLI), or children with ASD.
- Conducted in a linguistic context relevant to the review's cross-linguistic focus, including studies on languages such as Arabic and English.

The selected studies were systematically analyzed to identify common findings, methodological approaches, and gaps in the current knowledge. The analysis focused on how these phonological measures were applied, their effectiveness in different linguistic contexts, and their implications for understanding and addressing language impairments.

Results

Language Measures for Typically Developing Children

Research on typically developing children has consistently underscored the importance of phonological awareness in language acquisition. Al-Sulaihim and Marinis (2017) conducted a comprehensive study on Kuwaiti-Arabic-speaking school-age children, focusing on the development of phonological awareness abilities. The study's primary objective was to determine if the patterns observed in Arabic-speaking children were similar to those documented in other languages, such as English, and to explore the potential correlation between phonological awareness and reading skills. The researchers evaluated a group of school-age children to assess their letter knowledge and single-word reading abilities. The findings revealed that literacy training significantly enhanced both phonological awareness and reading skills. Specifically, the children demonstrated substantial progress in phoneme awareness, particularly in identifying and deleting phonemes after receiving literacy training. These results highlight the critical role of literacy interventions in promoting phonological development in children (Al-Sulaihim & Marinis, 2017).

Another significant study by Bunta et al. (2009) investigated the phonological development of bilingual children compared to their monolingual peers. The study focused on Spanish- and English-speaking bilingual 3-year-old children and their age-matched monolingual counterparts. The researchers employed whole-word measures such as pMLU, PWP, and PCC to assess the complexity and accuracy of the children's phonological production. The findings revealed that bilingual children differentiate their target languages in terms of phonological whole-word complexity and consonant accuracy. However, despite this differentiation, bilingual children maintained a consistent level of approximation to the target language, indicating that a

constant level of phonological proximity to the target is a key driving force in phonological acquisition. This study underscores the adaptability of bilingual children in managing dual language systems and their ability to achieve phonological milestones similar to monolingual children (Bunta et al., 2009).

Karimian et al. (2022) extended the exploration of phonological development to Persian-speaking children, specifically those with an Isfahani accent. The study utilized story generation and conversation sampling methods to compare the pMLU and PWP in children aged 48 to 60 months. The researchers found significant differences in the target pMLU between the two sampling methods, while PWP did not differ significantly. The study's inter-rater reliability was 0.70, indicating moderate consistency in the measurement. The results suggest that pMLU can serve as a foundation for future quantitative studies in children's phonological assessment, particularly in Persian-speaking populations. Furthermore, the study suggested that longitudinal research involving different age groups could provide stronger evidence to encourage therapists to use whole-word measures in clinical settings (Karimian et al., 2022).

In the context of Dutch-speaking children, Beers, Rodenburg, and Gerrits (2019) conducted a study to investigate the stages of phonological development using pMLU as a whole-word measure. The researchers aimed to determine whether an increase in pMLU scores with age would reflect the acquisition of the Dutch phonological repertoire. The study's findings indicated that higher pMLU scores in the youngest children were likely due to their more advanced vocabulary, leading to no significant difference between larger and smaller word samples. However, the study also identified potential limitations, such as the small phonological inventory in Dutch and the tendency for longer target words to be mispronounced, resulting in lower pMLU scores. Additionally, the study's selection criteria may have contributed to a ceiling effect, where the pMLU scores of children aged 1;3 to 1;8 represented the highest level attainable at that age. These findings highlight the need for careful consideration of linguistic and methodological factors when applying phonological measures in different language contexts (Beers et al., 2019).

Phonological Measures for Children with Language Disorders

Phonological measures like pMLU have also been employed to assess children with language disorders, providing critical insights into their developmental trajectories. Kumar and Bhat (2009) and Schauwers et al. (2005) both utilized pMLU to compare the phonological development of children with language disorders to that of typically developing peers. These studies found that children with language disorders consistently scored lower on pMLU measures, reflecting their delayed phonological development. The research further emphasized the importance of early detection and intervention, noting that children who received treatment earlier in life showed greater proficiency than those diagnosed and treated at a later stage. The pMLU measure was suggested as a valuable tool for tracking the language development of children at risk of developmental delays or disorders, serving as the foundation of a developmental scale for comparing disordered phonology (Kumar & Bhat, 2009; Schauwers et al., 2005).

Kunnari, Helin, and Makonen (2012) focused on Finnish-speaking children with specific language impairment (SLI) and dyspractic speech features, examining how these impairments were reflected in pMLU, PWP, and PWC values. The study involved calculating these phonological measures for age-matched typically developing children and comparing them to the results of younger typically developing children. The findings revealed that children with SLI exhibited lower levels of language development, particularly in terms of pMLU, PWP, and PWC values. The study also conducted qualitative analyses to investigate the phonological characteristics of these children, concluding that their language development was more similar to that of typically developing 2-year-olds than children of the same age. This research underscores the value of using phonological measures to assess and understand the language development of children with specific language impairments (Kunnari et al., 2012).

Newbold, Stackhouse, and Wells (2013) analyzed the developmental speech difficulties of children with severe and persisting speech difficulties (SPSD). Their study aimed to monitor the progress of these children over time, utilizing speech output measures such as PWP, PWC, and PCC. The results suggested that while PWC can detect changes only if the same stimuli are used consistently, PCC emerged as a more reliable measure of change due to its resistance to variations in stimuli. The study also highlighted the utility of PWP in measuring speech outcomes over time and across tasks, although it was noted that PWP is more sensitive to psycholinguistic variables compared to PCC. These findings suggest that both PCC and PWP have significant potential for evaluating speech outcomes, particularly in clinical settings where consistent monitoring is required (Newbold et al., 2013).

Burrows and Goldstein (2010) conducted a study involving Spanish-English bilingual children with speech sound disorders (SSD) and their age-matched monolingual peers. The study employed phonological measures such as pMLU, PWP, and PCC to compare the speech production of these groups. The findings revealed that monolingual children with SSD produced

words that were more accurate, complex, and closer to the adult target compared to their bilingual counterparts. Monolinguals consistently achieved higher scores on measures such as PCC, pMLU, and PWP, indicating that their phonological productions were more advanced. This research provides valuable insights into the challenges faced by bilingual children with SSD, highlighting the need for targeted interventions that address the unique phonological demands of managing two language systems (Burrows & Goldstein, 2010).

ASD Children with Language Delay/Disorders/Impairments

The study of language development in children with Autism Spectrum Disorder (ASD) has gained significant attention in recent years, with a growing body of research documenting the phonological challenges these children face. Autism is a neurodevelopmental disorder characterized by difficulties in communication, social interaction, and repetitive behaviors. Early research, such as that conducted by Fombonne (2003, 2005), documented the prevalence of ASD, showing a significant increase in diagnoses over the past few decades. Studies by Baio (2018) and the Centers for Disease Control (2012) have further highlighted the rising prevalence of ASD in the United States, emphasizing the importance of understanding the language development challenges faced by children with ASD.

Bishop (2010) and Lindgren et al. (2009) explored the genetic overlap between ASD and specific language impairment (SLI), proposing that non-additive genetic influences could account for both familial and molecular findings related to these conditions. Their research utilized a modified simulation that incorporated gene-gene (G × G) interactions, generating levels of comorbidity and impairment rates in relatives that aligned more closely with observed data. The results supported a model suggesting a shared genetic basis for ASD and SLI, aligning with molecular genetic findings on the CNTNAP2 gene. The G × G interaction also diminished the correlation between individuals with the disorders and their first-degree relatives, indicating that the genetic factors contributing to ASD and SLI might be more complex than previously understood (Bishop, 2010; Lindgren et al., 2009).

Lazenby et al. (2016) conducted a prospective study on the early language development of infants who later developed ASD. The study aimed to investigate the detectability of language differences at 12 months of age in high-risk infants. The findings revealed that infants who were later diagnosed with ASD exhibited significant language differences at 12 months, particularly in terms of lower overall language ability. Interestingly, the study also found that the high-risk ASD group displayed a higher likelihood of producing and understanding certain words in a statistically unexpected manner, highlighting the unique and sometimes paradoxical nature of language development in children with ASD (Lazenby et al., 2016).

Miller et al. (2015) examined early pragmatic language skills in preschool-age siblings of children with ASD, focusing on earlier developing aspects of pragmatic language, such as the ability to direct others' attention, ask about behaviors and mental states, and take the listener's knowledge into account. The study found that siblings at high risk for ASD had lower parent-rated pragmatic language scores compared to the low-risk group, with a significant proportion of the high-risk group exhibiting pragmatic language impairment (PLI). Children with PLI also showed higher rates of general language impairment and more atypical clinical outcomes, suggesting that pragmatic language difficulties in siblings of children with ASD could serve as an early indicator of broader language challenges (Miller et al., 2015).

The acquisition of phonological skills in children with ASD has been the focus of several studies. Paul et al. (2011) and Lombardino & Lerman (2005) investigated the phonological features of speech in verbal children with ASD, comparing their speech patterns to those of typically developing children. These studies found that children with ASD faced significant challenges in phonological development, particularly in areas such as sound repetitions, substitutions, and the mastery of speech sounds and patterns. These findings suggest that phonological difficulties are a core component of the language impairments observed in children with ASD, which can have a profound impact on their overall communication abilities (Paul et al., 2011; Lombardino & Lerman, 2005).

Alqhazo, Hatamleh, and Bashtawi (2020) conducted a study on the phonological and lexical abilities of Jordanian Arabic-speaking children with ASD. The researchers used the Jeddah Institute for Speech and Hearing (JISH) Test to assess the children's phonological abilities and the JISH School Readiness Screening Test to measure their lexical abilities. The study found that Jordanian children with ASD exhibited significant impairments in both phonological and lexical domains, with phonological impairment being more prevalent. These findings highlight the importance of developing customized treatment plans for children with ASD that address both phonological and lexical challenges to enhance their communication skills (Alqhazo et al., 2020).

Ha & Pi (2022) and Bartolucci & Pierce (1977) compared the phonological processing skills and development of children with phonological delay, disorder, and ASD to typically developing children. The studies found that children with phonological disorders had lower scores in phonological awareness and non-word repetition tasks compared to their typically

developing peers. Additionally, children with ASD exhibited a delayed pattern of acquisition of phonological characteristics similar to that found in mentally retarded children. The research also indicated that children with phonological delay or disorder performed poorly on rapid automatized naming tasks, further underscoring the need for targeted interventions to support their phonological development (Ha & Pi, 2022; Bartolucci & Pierce, 1977).

Phonological Measures for Children with ASD

Recent studies have continued to explore the effectiveness of language interventions in improving phonological outcomes for children with ASD. Sendhilnathan and Chengappa (2020) conducted a study in Singapore that investigated the effects of language intervention in English on vocabulary development in monolingual and bilingual children with ASD. The study found that both monolingual and bilingual children showed significant increases in vocabulary growth after twenty-four weeks of language intervention, indicating that bilingual exposure does not negatively impact language development in children with ASD. The research underscores the importance of employing developmentally and functionally appropriate language-building strategies to facilitate successful communication in children with ASD (Sendhilnathan & Chengappa, 2020).

Shillingsburg et al. (2019) focused on increasing the complexity of mand utterances in individuals with ASD. The study utilized a treatment package consisting of errorless teaching, differential reinforcement, and systematic decision rules to increase the number of words per mand utterance used by children with ASD. The findings revealed significant developmental gains in participants' mean length of utterances (MLU), accompanied by increased rates of manding and emission of mand frames, and a corresponding decrease in indicating responses. These results suggest a strong relationship between increased mand complexity and improved communication outcomes in children with ASD (Shillingsburg et al., 2019).

Yeganeh and Kamari (2020) explored the developmental process of MLU in Persian monolingual children with ASD, comparing it to typically developing children. The study focused on examining the trend of mean split length in children with ASD, highlighting the delayed syntactic development observed in this population. The findings underscored the evident delay in the group with ASD, as evidenced by their notably weaker average utterance length compared to the control group. This research emphasizes the importance of using MLU as a measure of linguistic development to better understand and address the syntactic challenges faced by children with ASD (Yeganeh & Kamari, 2020).

Herrera and Almeida (2008) conducted a study on the phonological mean length of utterance in individuals with high-functioning autism (HFA) and Asperger Syndrome (AS). The study aimed to increase the MLU in these individuals by using verbal communicative skill strategies (VCS). The researchers found that employing the suggested strategies led to a significant increase in the MLU for all three participants. The study also recommended further research to examine the maintenance of these results in different environments and during interactions with various communication partners, highlighting the potential for VCS strategies to improve verbal communication abilities in individuals with HFA and AS (Herrera & Almeida, 2008).

Sandbank and Yoder (2016) conducted a correlational meta-analysis to investigate the relationship between parental mean length of utterance (MLU) and language outcomes in children with disabilities, including ASD. The study aimed to determine whether there is an association between the length of parental utterances and the language outcomes of children with disabilities, taking into account potential variations based on child characteristics such as age and disability type. The findings of the meta-analysis indicated a weak positive association between parental input length and child language outcomes across all studies. However, subgroup analyses revealed that this association may vary depending on the specific disability group. For example, in children with autism, the results suggested a stronger correlation between parental input length and positive language outcomes, emphasizing the importance of parental involvement in language interventions for children with ASD (Sandbank & Yoder, 2016).

Discussion

The findings from this literature review highlight several critical themes regarding the use of phonological measures to assess and understand language development in children, particularly those with language impairments such as ASD and SLI. The consistent application of phonological measures such as pMLU, PWP, and PWC across different studies underscores their value as robust tools for quantifying phonological development and identifying language impairments. This discussion will elaborate on the implications of these findings, explore the challenges and limitations of current research, and suggest directions for future studies.

One of the most significant takeaways from the reviewed studies is the critical role that early intervention plays in improving language outcomes for children with language impairments. Research consistently shows that children who receive early and

targeted interventions demonstrate better phonological and overall language development compared to those who are diagnosed and treated at later stages (Kumar & Bhat, 2009; Fombonne, 2003). Early intervention can mitigate some of the language delays and deficits that are characteristic of conditions like ASD and SLI, leading to more favorable long-term outcomes. This is particularly important in light of the findings that children with ASD often exhibit delayed or atypical patterns of phonological development, which, if left unaddressed, can lead to more severe communication challenges (Paul et al., 2011).

The effectiveness of early intervention is further supported by the studies examining the use of pMLU as a developmental metric. For example, Kumar and Bhat (2009) and Kunnari et al. (2012) demonstrated that lower pMLU scores in children with language impairments could be significantly improved through early and consistent therapeutic interventions. These findings suggest that phonological measures like pMLU not only serve as diagnostic tools but also as benchmarks to track the effectiveness of intervention strategies over time.

Another key theme that emerges from the review is the cross-linguistic applicability of phonological measures like pMLU, PWP, and PWC. The studies reviewed span a diverse range of languages, including Arabic, Persian, Dutch, Finnish, and English, highlighting the versatility of these measures in different linguistic contexts. However, while these measures can be effectively used across languages, the findings suggest that language-specific factors must be considered when interpreting the results.

For instance, the study by Beers et al. (2019) on Dutch-speaking children revealed that the small phonological inventory in Dutch and the tendency for longer target words to be mispronounced affected the pMLU scores. This highlights the need for linguistic adaptations of these measures to account for specific phonotactic constraints and phonological structures inherent to each language. Similarly, the research conducted by Karimian et al. (2022) on Persian-speaking children with an Isfahani accent showed that different sampling methods (story generation versus conversation sampling) could yield varying pMLU results, further emphasizing the need for methodological consistency when applying these measures across languages.

The cross-linguistic validity of phonological measures is crucial for global research and clinical practice, particularly in multilingual societies or regions where multiple languages are spoken. Understanding how these measures can be adapted and applied in different linguistic contexts allows for more accurate assessments of phonological development and the identification of language impairments, thereby facilitating more effective cross-cultural and cross-linguistic comparisons.

The studies reviewed also shed light on the specific challenges associated with assessing phonological development in children with ASD. Unlike typically developing children, those with ASD often display unique and sometimes paradoxical patterns of phonological acquisition. For example, Lazenby et al. (2016) found that while children with ASD exhibited lower overall language abilities at 12 months, they also demonstrated an unexpected proficiency in producing and understanding certain words. This suggests that the phonological development in children with ASD may not follow the typical trajectory observed in other populations, making it difficult to assess using standard phonological measures.

Moreover, the research by Paul et al. (2011) and Lombardino & Lerman (2005) indicated that children with ASD face significant challenges in mastering speech sounds and patterns, often displaying phonological errors such as sound repetitions and substitutions. These phonological difficulties are compounded by the social and communicative deficits that are characteristic of ASD, which can further hinder the child's ability to engage in effective verbal communication. The variability in phonological outcomes among children with ASD suggests that phonological measures must be used in conjunction with other assessments that consider the broader cognitive and communicative context in which these children operate.

Additionally, the study by Miller et al. (2015) on siblings of children with ASD highlights the potential for early markers of language impairment in high-risk populations. The presence of pragmatic language impairments (PLI) in these siblings suggests that phonological measures alone may not capture the full extent of language difficulties in children at risk for ASD. Therefore, a more comprehensive approach that includes both phonological and pragmatic assessments is necessary to accurately diagnose and support children with ASD.

While the reviewed studies provide valuable insights into the application of phonological measures, several methodological considerations and limitations must be acknowledged. First, the reliance on cross-sectional data in many studies limits the ability to track longitudinal changes in phonological development. Longitudinal studies are crucial for understanding the developmental trajectory of phonological skills, particularly in children with language impairments, as they allow researchers to

observe how these skills evolve over time and in response to interventions.

Second, the variability in sampling methods and the types of phonological measures used across studies pose challenges for comparing findings. As demonstrated by Karimian et al. (2022), different sampling methods can yield different pMLU scores, which may lead to inconsistencies in how phonological development is assessed. Standardizing the methodology for collecting and analyzing phonological data across studies would enhance the comparability of results and improve the reliability of these measures as diagnostic tools.

Another limitation is the potential for ceiling effects, as noted in the study by Beers et al. (2019), where the pMLU scores of younger children reached a maximum level that did not adequately reflect their phonological abilities. This suggests that phonological measures may need to be adjusted or supplemented with additional assessments to avoid underestimating the phonological complexity in certain age groups or linguistic contexts.

The findings of this review suggest several avenues for future research. One important direction is the need for more longitudinal studies that track the phonological development of children with language impairments, including those with ASD, over extended periods. Such studies would provide deeper insights into the developmental trajectories of these children and help identify the critical windows for intervention.

Additionally, there is a need for research that further explores the cross-linguistic applicability of phonological measures, particularly in languages and dialects that have been underrepresented in the literature. Expanding the research to include a wider range of linguistic and cultural contexts would enhance our understanding of how phonological development varies across different populations and improve the global relevance of these measures.

Furthermore, future research should investigate the integration of phonological measures with other types of language assessments, such as those that evaluate pragmatic and syntactic skills. This comprehensive approach would provide a more holistic view of language development and better support the diagnosis and intervention planning for children with complex language impairments.

Conclusion

In conclusion, phonological measures such as pMLU, PWP, and PWC are invaluable tools for assessing language development in children, offering quantitative insights into their phonological abilities. The reviewed literature demonstrates their effectiveness in both typically developing children and those with language impairments, including ASD. The findings underscore the importance of early intervention and the need for targeted language interventions to support children with developmental delays.

The cross-linguistic applicability of these measures highlights their versatility, although linguistic characteristics must be carefully considered when interpreting results. In the context of ASD, phonological measures have proven to be particularly useful in identifying and addressing the unique challenges faced by these children, providing a foundation for effective treatment strategies.

Future research should continue to explore the application of phonological measures across diverse linguistic and cultural contexts, with a focus on longitudinal studies that track developmental trajectories over time. By expanding our understanding of phonological development in different populations, we can better support children with language impairments and contribute to the broader field of language acquisition research.

References

Alqhazo, M. T., Hatamleh, L. S., & Bashtawi, M. (2020). Phonological and lexical abilities of Jordanian children with autism. Applied Neuropsychology. Child, 9(2), 116–124.

Al-Sulaihim, N., & Marinis, T. (2017). Literacy and Phonological Awareness in Arabic Speaking Children. Arab Journal of Applied Linguistics, 2(1), 74–90.

Amayreh, M. M., & Dyson, A. T. (1998). The acquisition of Arabic consonants. Journal of Speech, Language, and Hearing Research, 41(3), 642-653.

Beers, M., Rodenburg, M., & Gerrits, E. (2019). Whole-word measures and the speech production of typically developing Dutch children. Clinical Linguistics & Phonetics, 33(1-2), 99-113.

Bishop, D. V. (2010). Overlaps between autism and language impairment: phenomimicry or shared etiology?. Behavior Genetics, 40(5), 618-629.

Brown, R. (1973). A first language: The early stages. Cambridge, MA: Harvard University Press.

Bunta, F., Fabiano-Smith, L., Goldstein, B.A., & Ingram, D.E. (2009). Phonological whole-word measures in 3-year-old bilingual children and their age-matched monolingual peers. Clinical Linguistics & Phonetics, 23(3), 156-175.

Burrows, L., & Goldstein, B. A. (2010). Whole word measures in bilingual children with speech sound disorders. Clinical Linguistics & Phonetics, 24(4-5), 357–368. https://doi.org/10.3109/02699200903581067

Fombonne, E. (2003). Epidemiological surveys of autism and other pervasive developmental disorders: An update. Journal of Autism and Developmental Disorders, 33(4), 365-382.

Fombonne, E. (2005). Epidemiology of autistic disorder and other pervasive developmental disorders. Journal of Clinical Psychiatry, 66(Suppl 10), 3-8.

Ha, S., & Pi, M. (2022). Phonological Processing Skills of Children with Phonological Delay and Phonological Disorder. Communication Sciences & Disorders, 27(4), 844-854. https://doi.org/10.12963/csd.22932

Helin, K., Makkonen, T., & Kunnari, S. (2006). The Phonological mean length of utterance: the methodological challenge from cross-linguistic perspectives. Journal of Child Language, 33(1), 179-190.

Karimian, F., Mohammadi, R., Bemani, Z., Kazemi, Y., & Kianfar, F. (2022). Phonological Mean Length of Utterance in 48-60-Month-old Persian-Speaking Children with Isfahani Accent: Comparison of Story Generation and Conversation Samples. Journal of Rehabilitation, 23(3), 392-411.

Kumar, R., & Bhat, J. S. (2009). Phonological Mean Length of Utterance (pMLU) in Kannada-Speaking Children. Language in India, 9(1), 489-502.

Kunnari, S., Saaristo-Helin, K., & Savinainen-Makkonen, T. (2012). Phonological mean length of utterance in specific language impairment: a multi-case study of children acquiring Finnish. Clinical Linguistics & Phonetics, 26(5), 428–444. https://doi.org/10.3109/02699206.2012.660230

Lazenby, D. C., Sideridis, G. D., Huntington, N., Prante, M., Dale, P. S., Curtin, S., & Tager-Flusberg, H. (2016). Language differences at 12 months in infants who develop autism spectrum disorder. Journal of Autism and Developmental Disorders, 46(3), 899-909.

Lombardino, L. J., & Lerman, D. C. (2005). Phonology and verbal behavior. In J. L. Matson (Ed.), Handbook of Assessment and Diagnosis of Autism Spectrum Disorder (pp. 99-122). New York, NY: Springer Science+Business Media.

Miller, M., Young, G. S., Hutman, T., Johnson, S., Schwichtenberg, A. J., & Ozonoff, S. (2015). Early pragmatic language difficulties in siblings of children with autism: Implications for DSM-5 social communication disorder?. Journal of Child Psychology and Psychiatry, 56(7), 774-781. https://doi.org/10.1111/jcpp.12362

Newbold, E. J., Stackhouse, J., & Wells, B. (2013). Tracking change in children with severe and persisting speech difficulties. Clinical Linguistics & Phonetics, 27(6-7), 521–539. https://doi.org/10.3109/02699206.2012.751625

Paul, R., Shriberg, L. D., McSweeny, J. L., Cicchetti, D., Klin, A., & Volkmar, F. (2011). Phonological analysis of speech in verbal children with autism spectrum disorder. Journal of Autism and Developmental Disorders, 41(4), 408-422.

Sandbank, M., & Yoder, P. (2016). The association between parental mean length of utterance and language outcomes in children with disabilities: A correlational meta-analysis. American Journal of Speech-Language Pathology, 25(2), 240-251.

Sendhilnathan, S., & Chengappa, S. K. (2020). Effect of Language Intervention on Mean Length of Utterance in Monolingual and Bilingual Children with Autism Spectrum Disorders in a Multi-Ethnic-Lingual Context. Language in India, 20(2), 57-71.

Shillingsburg, M. A., Frampton, S. E., Schenk, Y. A., Bartlett, B. L., Thompson, T. M., & Hansen, B. (2019). Evaluation of a treatment package to increase mean length of utterances for children with autism. Behavior Analysis in Practice, 13(3), 659-673.

Shriberg, L. D., Austin, D., Lewis, B. A., McSweeny, J. L. (1997). The Percentage of Consonants Correct (PCC) Metric: Extensions and Reliability Data. Journal of Speech, Language, and Hearing Research, 40(3), 708-722. https://doi.org/10.1044/jslhr.4003.708

Shriberg, L. D., & Kwiatkowski, J. (1982). Phonological disorders III: a procedure for assessing severity of involvement. Journal of Speech and Hearing Disorders, 47(3), 256-270.

Vogan, V. M., Morgan, B. R., Powell, T. L., Smith, M. L., Taylor, M. J., & Thorpe, L. U. (2014). The neural correlates of phonological working memory in children with autism spectrum disorder. Journal of Neurodevelopmental Disorders, 6(1), 39. https://doi.org/10.1186/1866-1955-6-39

Yeganeh, M. T., & Kamari, E. (2020). Investigating mean length of utterance (MLU) in monolingual Persian-speaking children with autism spectrum disorder (ASD). International Journal of Health Studies, 6(2), 7-14.

Citation: Alhaj-Mousa, E (2024). Phonological Development in Children: A Comprehensive Overview. The Innovative Multidisciplinary Journal for Science and Technology (IMJST).1(1):27-35.
https://doi.org/10.5281/zenodo.13387200