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Phonological Process Patterns in Children with Phonological Disorder: A Psycholinguistic Perspective

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ABSTRACT: *This study examines the phonological processes produced by two seven-year-old children with phonological disorder, interpreted from a psycholinguistic perspective. The purpose of this research was to identify the types of phonological processes used by the two participants and to explain the differences in their speech production patterns. This study employed a qualitative case study design. Data were obtained through speech elicitation tasks and recordings of the participants' word productions, which were transcribed phonetically and analyzed using Ingram's (1976) phonological process framework. The findings revealed that both participants demonstrated systematic phonological simplification strategies, but the patterns differed between them. Participant 1 predominantly produced substitution processes, particularly stopping and gliding, indicating that the child generally maintained the syllable structure of words while replacing more complex phonemes with simpler sounds. Participant 2 produced phonological processes primarily related to syllable structure modification, including cluster reduction, final consonant deletion, syllable reduction, and initial syllable deletion. From a psycholinguistic perspective informed by Stackhouse and Wells' (1997) processing framework and Levelt's (1989) model of speech production, these differing patterns suggest that phonological difficulty may originate at different levels of the speech production system — phonemic representation for Participant 1, and phonological planning/sequencing for Participant 2. Given the case-study design and limited sample, these interpretations are offered as hypotheses for further investigation rather than generalizable conclusions. The study underscores the heterogeneous nature of phonological disorder and the value of phonological process analysis for informing individualized assessment and intervention.*

KEYWORDS: Children's Phonological Development, Phonological Disorder, Phonological Process, Psycholinguistics, Speech Production.

Introduction

Language acquisition is a complex developmental process involving the interaction of cognitive, linguistic, and social factors. One of the earliest aspects of language development in children is the acquisition of sound systems, commonly referred to as phonological development. From a psycholinguistic perspective, phonological development is understood as the process by which children build, organize, and retrieve mental representations of speech sounds in order to produce intelligible spoken language; this view draws on models of phonological representation and processing such as the psycholinguistic framework of Stackhouse & Wells (1997) and Levelt (1989) model of speech production, both of which describe phonological development as the gradual refinement of stored representations that are accessed and assembled during speech planning. The development of phonology plays a crucial role in children's overall language competence because accurate speech production supports effective communication and later literacy development. Recent studies emphasize that phonological development is closely related to children's cognitive and linguistic processing abilities, making it a central topic in psycholinguistic research (Tambyraja SR et al., 2023).

During the early stages of language acquisition, children frequently simplify adult speech patterns as part of their developmental process. These simplifications are known as phonological processes, systematic strategies used by children to produce speech sounds that are easier to articulate. Within the natural phonology tradition that underlies much of this research, such processes are understood as innate simplifying strategies that children gradually suppress as their articulatory and phonological systems mature (Hegde, 2021; Ingram, 1976). Specifically, Ingram's (1976) framework and the broader natural phonology account from which it derives propose that processes such as stopping, fronting, and cluster reduction reflect universal articulatory constraints rather than idiosyncratic errors, and that these processes recede in a roughly predictable order as children's motor and phonological systems become more refined (Bernhardt & Stoel-Gammon, 1994; Hegde, 2021).

Previous studies indicate that most phonological processes gradually disappear as children approach school age, and typically developing children are expected to produce speech that closely resembles adult pronunciation by the age of six or seven (Mcleod & Crowe, 2018). When these phonological processes persist beyond the expected developmental period, they may instead indicate the presence of a speech sound disorder or phonological disorder. Persistent phonological errors can affect speech intelligibility and may also influence children's communication effectiveness in academic and social contexts (Mcleod & Crowe, 2018).

Phonological disorder is a contested construct that has been operationalized differently across clinical and psycholinguistic traditions, and the present study adopts the following working definition situated within that literature. Following Dodd (2014) differential diagnosis model, phonological disorder is defined here as a developmental condition in which a child produces speech errors that are inconsistent with or that persist beyond the typical developmental timetable for their age and that reflect difficulty organizing the phonological system of the language rather than a peripheral motor-execution problem. This is distinguished from an articulation disorder, which involves difficulty producing specific sounds because of motor constraints, and from childhood apraxia of speech, which reflects a deficit in motor planning and programming (Dodd, 2014; Geytenbeek, 2019). Children with phonological disorder substitute, omit, or restructure sounds according to identifiable rule-governed patterns, for example stopping, cluster reduction, final consonant deletion, or gliding, that affect speech clarity (Ingram, 1976). A complementary view comes from the psycholinguistic framework of

Stackhouse & Wells (1997), which conceptualizes phonological disorder not as a single unitary deficit but as a breakdown that can occur at one or more stages of speech processing, including input perception, lexical phonological representation, or output production, and which therefore requires profiling at the level of the individual child rather than assuming a uniform underlying cause.

From a psycholinguistic perspective, then, phonological disorders are not merely problems of articulation but may also involve difficulties in phonological representation and processing. Children with phonological disorders may struggle to establish stable mental representations of phonemes or to apply phonological rules accurately during speech production. Studies have shown that children with speech sound disorders often demonstrate weaknesses in phonological processing, reflecting underlying difficulties in how speech sounds are mentally represented and manipulated during language production (Rvachew, 2007). Furthermore, recent longitudinal research indicates that limitations in phonological processing and speech production skills place school-age children with speech sound disorder at measurably increased risk for literacy difficulties: in a sample of children receiving school-based speech therapy, Tambyraja et al. (2023) found that approximately one in four exhibited concurrent deficits in word-level decoding, and that phonological awareness and speech production ability predicted later reading risk even after accounting for age, language comprehension, and socioeconomic status. Similarly, Hayiou-Thomas et al. (2017) reported that children with disordered (as opposed to merely delayed) speech error patterns were at particular risk for weaker phonological awareness and poorer word-level reading and spelling outcomes. These findings indicate that the academic impact of persistent phonological processes is most clearly documented in the domains of phonological awareness and word-level reading/decoding, rather than academic achievement in general. Other research highlights that phonological awareness and speech perception are closely associated with vocabulary growth and reading-related skills in children with speech sound disorders, reinforcing the importance of examining phonological patterns in children's speech from a psycholinguistic perspective (Benway et al., 2021).

One theoretical framework widely used to analyze children's speech patterns is the phonological process framework proposed by David Ingram. Ingram (1976) explains that children simplify adult speech through systematic phonological strategies that can be categorized into several major groups, generally including substitution processes, assimilation processes, and syllable structure processes. This framework remains widely used in speech-language research because it allows researchers to identify and classify systematic speech errors produced by children (Ingram, 1976).

Subsequent scholarship has both extended and critiqued this framework. Bernhardt & Stoel-Gammon (1994) argue that while linear phonological process analysis is useful as a descriptive starting point, it treats each error in isolation and does not capture the hierarchical relationships among phonological units (e.g., syllable, foot, word); they propose nonlinear/constraint-based phonological models as a way of providing a more explanatory account of why particular processes co-occur in a child's system and of generating more targeted intervention goals. In a more recent critical review, Hegde (2021) similarly observes that natural-phonology-based process analysis, although clinically convenient and widely used for organizing assessment and treatment targets, has been criticized for “process proliferation” and imprecise definitions, and notes that some clinical researchers now prefer the more theoretically neutral term phonological pattern over phonological process. Despite these critiques, phonological process analysis continues to be used because, unlike feature-geometric or

optimality-theoretic alternatives, it remains accessible for descriptive clinical and research purposes and provides a common vocabulary for comparing error patterns across children (Hegde, 2021). The present study uses Ingram's framework for this descriptive purpose, while drawing on Stackhouse & Wells (1997) and Levelt (1989) for the explanatory, psycholinguistic interpretation of why these patterns might arise.

Several disciplinary lenses could, in principle, be applied to children's phonological errors: a purely articulatory/motor account would explain errors in terms of speech-motor coordination; a purely linguistic-descriptive account (e.g., Ingram's original framework, or Dodd's classification system) would describe error patterns without specifying their cognitive origin; and a clinical account would prioritize diagnostic categorization for intervention planning. A psycholinguistic perspective is adopted in this study because it is specifically designed to explain why a given error pattern occurs by locating it within a model of the speech-processing system. Stackhouse & Wells (1997) psycholinguistic framework, for example, distinguishes between difficulties in auditory input processing, in the storage and organization of phonological representations in the lexicon, and in the planning and motor output of speech allowing the same surface error (e.g., a substitution) to be traced to different underlying loci depending on the child. Levelt (1989) model of speech production similarly specifies discrete stages of phonological encoding, in which lexical items are retrieved and assembled into articulatory programs; breakdowns at different stages of this process predict different error profiles. Because the persistence of phonological processes in seven-year-old children an age at which most processes are expected to have resolved (Mcleod & Crowe, 2018). It raises questions not just about what errors occur but about where in the processing system the difficulty originates, a psycholinguistic approach is particularly well suited to this study's aims, compared with frameworks that describe error patterns without modeling their underlying mechanism.

Research on phonological development has been widely conducted (Namasivayam et al., 2025); however, studies specifically examining phonological processes in seven-year-old children with phonological disorder, analyzed through this kind of psycholinguistic lens, remain relatively limited. Most previous studies have focused either on younger preschool children or on clinical intervention approaches rather than detailed phonological process analysis. Therefore, this study aims to analyze the phonological processes produced by two seven-year-old children with phonological disorder using a psycholinguistic framework informed by Ingram (1976), Stackhouse & Wells (1997) and Levelt (1989). By identifying the types and patterns of phonological processes present in children's speech, this research is intended as an exploratory case study contributing descriptive, hypothesis-generating evidence toward a deeper understanding of phonological development and speech production mechanisms in children with phonological disorder.

Method of Research

Design

This study employed a qualitative case study design to analyze the phonological processes produced by two seven-year-old children. A case study approach was selected because the aim of the study was not to generalize findings to a larger population, but to provide an in-depth, detailed, and context-sensitive description of individual phonological systems. The selection of only two participants is consistent with the logic of exploratory case study research, which prioritizes depth of analysis over breadth of sampling. According to Yin (2018), case studies are appropriate when the research seeks to investigate a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly separable. In this study, phonological processes are interpreted not only as linguistic outputs but also as reflections of individual cognitive-linguistic development. Therefore, this study is positioned as an exploratory qualitative investigation intended to generate hypotheses regarding differing phonological profiles rather than to produce statistically generalizable findings. The limited sample size is acknowledged as a constraint on transferability; however, it is justified by the intensive phonetic and psycholinguistic analysis applied to each participant.

Participants and Context

The participants consisted of two seven-year-old children who exhibited persistent phonological error patterns beyond the expected age of phonological development. The participants were recruited through a school-based referral process at a primary school in Indonesia, where teachers identified children with speech intelligibility difficulties and recommended them for further observation. Participation was voluntary and based on parental agreement. Regarding diagnostic status, both children had previously been reported by school staff and parents as having characteristics consistent with Autism Spectrum Disorder and speech delay. However, no standardized phonological assessment was administered prior to this study. Therefore, the classification of phonological disorder in this study is based on observed speech performance during elicitation tasks and developmental expectations documented in the literature (McLeod & Crowe, 2018). This is acknowledged as a limitation of the study. Both participants were Indonesian-speaking children. One participant was monolingual Indonesian, while the other was exposed to a local regional language at home in addition to Indonesian. This multilingual exposure was considered in the interpretation of phonological patterns, particularly in distinguishing between disorder-related processes and potential language transfer effects. In terms of educational background, both children were enrolled in formal primary education at the time of data collection. No detailed socioeconomic data were collected beyond general school context information, in order to maintain participant anonymity.

Research Setting and Recruitment Procedure

Data collection took place in a quiet room at the participants' school to ensure minimal background noise and to create a familiar environment for the children. Participants were selected using purposive sampling based on the following criteria: (1) age of seven years, (2) observable persistent phonological error patterns in spontaneous and elicited speech, and (3) absence of reported hearing impairment or structural speech impairments.

Data Collection Procedures

Data were collected using two methods: structured speech elicitation and naturalistic speech observation. In the elicitation task, each participant was asked to produce 20 target words presented through picture naming activities. The word list was designed to include a range of phonological structures in Indonesian, including simple syllables, multisyllabic words, final consonants, and consonant clusters. The elicitation was conducted entirely in Indonesian, as it is the primary language of schooling and communication for both participants. Indonesian was selected to ensure consistency in linguistic input and to minimize variability caused by dialectal or multilingual switching during the task. In addition to elicitation, short spontaneous speech samples were collected through informal conversation to complement the structured data. All speech productions were recorded using a digital audio recorder for subsequent phonetic analysis.

Transcription and Data Analysis

The recorded speech data were transcribed using the International Phonetic Alphabet (IPA). Transcription involved repeated listening to recordings to ensure accuracy and reliability. Data were analyzed using Ingram's (1976) phonological process framework, which categorizes children's speech patterns into substitution processes, assimilation processes, and syllable structure processes. Analysis proceeded in four stages: (1) identification of target and produced forms, (2) phonetic comparison between adult and child productions, (3) classification of phonological processes, and (4) identification of dominant patterns for each participant. Although Ingram's framework is used as a descriptive tool, the interpretation of results is informed by psycholinguistic models of speech production, particularly Stackhouse & Wells (1997) and Levelt (1989), to provide insight into possible underlying processing mechanisms.

Ethical Considerations

Ethical procedures were implemented to ensure the protection of participant rights. Informed consent was obtained from the parents or legal guardians of both participants prior to data collection. In addition, assent was sought from the children in an age-appropriate manner. Confidentiality was maintained by assigning pseudonyms (Participant 1 and Participant 2) and removing all identifying information from transcripts and reports. Audio recordings and data files were stored securely and accessed only by the researcher for analysis purposes. Although formal institutional ethical committee approval was not obtained, the study followed general ethical principles for research involving human participants, including voluntary participation, confidentiality, and minimal risk procedures. This limitation is acknowledged.

Result Finding

This study analyzed the phonological processes produced by two children with phonological disorder, drawing on the phonological process classification described above. The analysis focused on identifying the types of phonological simplification strategies used by the participants when producing everyday Indonesian words. The results indicate that both participants demonstrated systematic phonological processes; however, the patterns and dominant processes differed between the two participants. Consistent with the case-study design, the interpretations offered below are intended as analytic readings of these two children's data rather than claims about phonological disorder in general.

Types of Phonological Processes

The analysis of the participants' speech revealed distinct types of phonological processes for each child. Participant 1 primarily exhibited substitution processes, particularly stopping and gliding. Stopping occurred when the fricative */s/* was replaced with the stop consonant */t/*, as seen in productions such as */susu/* produced as */tutu/*, */sapi/* as */tapi/*, and */sirup/* as */tirup/*, as well as */səpatu/* as */təpatu/*, */səndok/* as */təndok/*, and */sabun/* as */tabun/*. This substitution is consistent with the general observation in phonological development research that fricatives, which require precise airflow control and tongue positioning, are typically acquired later than stops (Hegde, 2021; Ingram, 1976). Gliding involved replacing the liquid consonant */r/* with */l/*, for example */rumah/* produced as */lumah/*, */roda/* as */loda/*, */merah/* as */mɛlah/*, */biru/* as */bilu/*, */garam/* as */galam/*, and */rambut/* as */lambut/*.

The predominance of substitution processes indicates that, on the data examined here, Participant 1 tended to simplify speech primarily at the phonemic level, generally maintaining the overall syllable structure while replacing individual phonemes with articulatorily simpler ones. One psycholinguistic account that could explain this pattern is the proposal, associated with Stackhouse & Wells (1997) processing framework, that children may initially store phonological representations with less fine-grained phonemic detail than adults, refining these representations gradually with exposure and practice; under this account, a child's substitution pattern would reflect the current state of refinement of a stored representation rather than solely a motor limitation. It should be emphasized that this is an interpretive lens applied to the observed pattern rather than a conclusion that follows directly from the data alone, since the same surface substitutions could equally be explained by articulatory difficulty with the specific consonants involved, by typical developmental sequencing of these particular sounds, or by characteristics of the Indonesian fricative/liquid inventory; the data in this study cannot, on their own, distinguish among these explanations. The full data on Participant 1's word productions and identified phonological processes are presented in Table 1.

Table 1. Participant 1 Word Productions and Phonological Processes

No	Word	Target (IPA)	Child Production	Process
1	sepatu	*/səpatu/*	*/təpatu/*	Stopping
2	susu	*/susu/*	*/tutu/*	Stopping
3	rumah	*/rumah/*	*/lumah/*	Gliding
4	roda	*/roda/*	*/loda/*	Gliding
5	sapi	*/sapi/*	*/tapi/*	Stopping
6	sendok	*/səndok/*	*/təndok/*	Stopping
7	merah	*/mɛrah/*	*/mɛlah/*	Gliding
8	biru	*/biru/*	*/bilu/*	Gliding
9	garam	*/garam/*	*/galam/*	Gliding
10	kursi	*/kursi/*	*/kulsi/*	Gliding
11	sabun	*/sabun/*	*/tabun/*	Stopping
12	pisang	*/pisaŋ/*	*/pitaŋ/*	Stopping

No	Word	Target (IPA)	Child Production	Process
13	nasi	*/nasi/*	*/nati/*	Stopping
14	sirup	*/sirup/*	*/tirup/*	Stopping
15	rambut	*/rambut/*	*/lambut/*	Gliding
16	roti	*/roti/*	*/loti/*	Gliding
17	soto	*/soto/*	*/toto/*	Stopping
18	rusak	*/rusak/*	*/lusak/*	Gliding
19	sapu	*/sapu/*	*/tapu/*	Stopping
20	sore	*/sore/*	*/tole/*	Stopping

In contrast, Participant 2 demonstrated phonological processes dominated by syllable structure modification, including final consonant deletion, cluster reduction, initial syllable deletion, syllable reduction, and initial consonant deletion. Final consonant deletion appeared in words such as */tas/* produced as */ta/*, */mobil/* as */mobi/*, */kərtas/* as */kəta/*, */makan/* as */maka/*, */gambar/* as */gamba/*, */tidur/* as */tidu/*, */təlur/* as */telu/*, and */sabuk/* as */sabu/*. Cluster reduction was evident in */pramuka/* produced as */pamuka/*, */lampu/* as */lapu/*, */pintu/* as */pitu/*, */buŋga/* as */buŋa/*, and */kantoŋ/* as */katoŋ/*. Other structural simplifications included initial syllable deletion in */səkolah/* as */kola/*, */səpeda/* as */peda/*, and */pərgi/* as */gi/*; syllable reduction in */buku/* as */bu/* and */bərmain/* as */main/*; and initial consonant deletion in */k͡utiŋ/* as */uciŋ/*.

These processes suggest that, in this case, Participant 2 tended to simplify speech primarily at the syllabic level. One psycholinguistic interpretation, consistent with models of phonological planning that emphasize working-memory demands in sequencing multi-syllabic forms, is that the child's omissions may function as a strategy for reducing articulatory and processing load when producing longer or more structurally complex words (Keshavarzi et al., 2024; Mettler et al., 2024). As with Participant 1's pattern, this representational/processing-load interpretation is an inference drawn from established psycholinguistic theory applied to the observed pattern, rather than something the data demonstrate directly; alternative, non-mutually-exclusive explanations including developmental variation in syllable structure acquisition, articulatory-motor constraints specific to consonant sequences, the phonotactic complexity of the Indonesian target words themselves, or effects of the picture-naming task format cannot be ruled out on the basis of this dataset and would require converging evidence (e.g., from nonword repetition or working-memory tasks) to adjudicate. The full data on Participant 2's word productions and identified phonological processes are presented in Table 2.

Table 2. Participant 2 Word Productions and Phonological Processes

No	Word	Target (IPA)	Child Production	Process
1	pramuka	/pramuka/	/pamuka/	Cluster Reduction
2	tas	/tas/	/ta/	Final Consonant Deletion
3	mobil	/mobil/	/mobi/	Final Consonant Deletion
4	bunga	/buŋga/	/buŋa/	Cluster Reduction
5	sekolah	/səkolah/	/kola/	Initial Syllable Deletion
6	kertas	/kərtas/	/kəta/	Final Consonant Deletion
7	makan	/makan/	/maka/	Final Consonant Deletion
8	gambar	/gambar/	/gamba/	Final Consonant Deletion
9	lampu	/lampu/	/lapu/	Cluster Reduction
10	pintu	/pintu/	/pitu/	Cluster Reduction
11	kantong	/kantoŋ/	/katoŋ/	Cluster Reduction
12	dokter	/doktər/	/dokə/	Final Consonant Deletion
13	buku	/buku/	/bu/	Syllable Reduction
14	kucing	/kut͡ʃiŋ/	/uciŋ/	Initial Consonant Deletion
15	sepeda	/səpeda/	/peda/	Initial Syllable Deletion
16	bermain	/bərmain/	/main/	Syllable Reduction
17	pergi	/pərgi/	/gi/	Initial Syllable Deletion
18	tidur	/tidur/	/tidu/	Final Consonant Deletion
19	telur	/təlur/	/telu/	Final Consonant Deletion
20	sabuk	/sabuk/	/sabu/	Final Consonant Deletion

Patterns of Phonological Processes

The findings also reveal contrasting patterns between the two participants. Participant 1 consistently used substitution strategies, systematically replacing fricatives with stops and liquids with glides while preserving the overall syllable framework. Within the psycholinguistic framework adopted in this study, this pattern is consistent with though not proof of a difficulty located primarily at the level of phonemic specification, in Stackhouse & Wells (1997) terms, rather than at the level of syllable/word-structure planning.

Participant 2, by contrast, showed a systematic tendency toward syllable structure simplification, frequently deleting consonants or entire syllables. Within the same framework, this pattern is consistent with difficulty located more at the level of phonological planning and sequencing that is, in Levelt's (1989) terms, in the stage at which phonological material is

organized into a structured articulatory plan though again, the present data describe the pattern without being able to confirm this specific locus directly. The difference in patterns between the two participants is consistent with the broader claim in the literature that phonological disorder is not a single, uniform condition but can arise from difficulty at different points in the speech-processing system (Dodd, 2014; Stackhouse & Wells, 1997). Returning to the framework introduced in the Introduction, this distinction difficulty with phonemic specification (Participant 1) versus difficulty with syllable/word-level planning (Participant 2) illustrates precisely the kind of differentiation that a psycholinguistic, processing-based framework is designed to capture, in contrast to a purely descriptive phonological-process count, which would simply report "more substitutions" versus "more structural changes" without locating these in a model of the production system.

These two participants' contrasting profiles also illustrate, at the level of an individual case comparison, why assessment and intervention recommendations in the literature emphasize profiling each child's speech system individually rather than assuming a single intervention approach will suit all children with persistent phonological processes (Stackhouse & Wells, 1997).

Discussion

From a psycholinguistic perspective, speech production involves several stages, including conceptual preparation, phonological encoding, and articulatory execution. According to Levelt's (1989) model of speech production, phonological encoding is the stage at which phonological representations stored in the mental lexicon are activated and organized into an articulatory plan before output occurs. Difficulties arising at different stages of this process may, in principle, produce different types of phonological errors. The contrast observed between the two participants in this study is interpreted here, within Levelt's framework, as consistent with difficulty arising at different points along this production sequence, as noted above, this study's design (speech-output data from two children) cannot directly test which specific stage is implicated; it can only show that the resulting error patterns are differentiable in a way that the framework would predict if such a difference in locus existed.

For Participant 1, the most prominent processes were stopping and gliding. Stopping occurred when fricative sounds, particularly */s/*, were replaced with stop consonants such as */t/*, as in */susu/* realized as */tutu/* and */sapi/* realized as */tapi/*. Stopping is commonly classified in the literature as a substitution process in which continuant sounds are replaced by stop consonants, plausibly because stops require less precise articulatory coordination than fricatives (Kumar & Mubeen, 2024; Namasivayam et al., 2025). Within Stackhouse & Wells (1997) framework, one way of interpreting this pattern is that the phonological representation of fricative sounds may not yet be fully specified in the child's lexicon, such that, during phonological encoding, the production system substitutes an articulatorily simpler sound sharing some phonological features with the target. This remains an interpretation consistent with the framework rather than a finding the data establish on their own.

In addition to stopping, Participant 1 frequently demonstrated gliding, particularly the replacement of the liquid consonant */r/* with */l/*, as in */rumah/* pronounced as */lumah/* and */roda/* pronounced as */loda/*. Gliding reflects reliance on an articulatorily simpler sound while preserving word structure, and is reported elsewhere as a common phonological process in children's speech, including in cross-linguistic work on monolingual and bilingual development (Kehoe, 2025; Wang et al., 2021). Liquid consonants are generally acquired later in

phonological development because they require precise tongue movement and coordination (Babatsouli & Geronikou, 2025; Hutauruk et al., 2023; Saleh et al., 2023). Within the psycholinguistic account adopted here, such substitutions are interpreted as indicating that the phonemic category for the liquid sound has not yet been fully stabilized in the child's phonological system specifically, in Stackhouse & Wells (1997) terms, a representational-level account, as with stopping, this is the framework's interpretive lens applied to the pattern, and a purely articulatory account (precise tongue-tip coordination for */r/* not yet mastered) would predict the same surface pattern and cannot be excluded by these data alone.

Unlike Participant 1, Participant 2 demonstrated phonological processes that primarily involved changes in syllable structure rather than substitution of individual phonemes. One of the most prominent processes was cluster reduction, in which consonant clusters were simplified by deleting one consonant, as in */pramuka/* pronounced as */pamuka/* and */lampu/* pronounced as */lapu/*. Producing a consonant cluster requires coordinating multiple phonological segments during phonological encoding and articulation (Levelt, 1989); within this framework, a child who has difficulty organizing these sequences may simplify clusters to reduce the planning and articulatory demand involved (Ranjitha & Sreedevi, 2024).

Another prominent process in Participant 2's data was final consonant deletion, in which the coda consonant was omitted, as in */tas/* pronounced as */ta/* and */mobil/* produced as */mobi/*. Syllables with codas are structurally more complex than open syllables; within the psycholinguistic framework adopted here, frequent deletion of final consonants is interpreted as a preference for simpler syllable structures during phonological planning, consistent with a system that is, at this stage, prioritizing ease of articulation and reduced processing load (Ingram, 1976; Levelt, 1989). Participant 2 also showed syllable reduction in multisyllabic words, such as */buku/* produced as */bu/* and */bərmain/* pronounced as */main/*, a pattern that may be related by analogy with research on phonological working memory in word and sentence production to limitations in the capacity to maintain and sequence phonological units during speech planning (Keshavarzi et al., 2024; Mettler et al., 2024).As elsewhere in this study, this working-memory account is offered as one plausible explanatory hypothesis grounded in the broader literature rather than a claim directly verified by the present data, since no independent working-memory measure was administered to either participant.

The contrast between the two participants' patterns is consistent with the idea, central to Stackhouse and Wells' (1997) psycholinguistic framework, that the same broad diagnostic label phonological disorder can mask difficulty originating at different levels of the speech-processing system: a more phonemic-level difficulty for Participant 1, and a more structural/sequencing-level difficulty for Participant 2. This individual variation is consistent with the framework's central claim that children's phonological systems should be profiled individually rather than assumed to share a single underlying deficit (Dodd, 2014; Stackhouse & Wells, 1997).

It is important to be cautious about how far this individual-case interpretation can be extended. The present study did not collect independent data on either participant's linguistic environment, language exposure, or socioeconomic background; consequently, while the broader literature does establish links between the quantity and quality of language exposure and the pace of phonological development (Hoff, 2006), this study's data cannot be used to attribute the observed difference between Participant 1's predominance of substitutions and Participant 2's predominance of structural reductions to differences in linguistic experience or environmental exposure, since no such exposure-related information was gathered. A more

defensible and theoretically grounded reading of the contrast is the processing-locus account developed above namely, that the two profiles are consistent with difficulty at different levels of the speech-production system as modeled by Levelt (1989) and Stackhouse & Wells (1997) together with the acknowledgment that other explanations (developmental variation, articulatory-motor factors specific to the sounds involved, or task-related effects) cannot be excluded. Future research that collects systematic information on participants' language exposure and background would be needed to test the environmental-exposure hypothesis directly.

A detailed analysis of the types of phonological processes nonetheless provides potentially useful diagnostic information, to be tested in future work with larger samples. Distinguishing whether a child's errors are dominated by phoneme-level substitutions or by syllable-structure reductions as operationalized through Ingram's (1976) descriptive framework and interpreted through Stackhouse & Wells (1997) and Levelt's (1989) processing models could in principle help practitioners orient intervention: for example, toward phoneme discrimination and production practice for representational-level difficulty, or toward practice with complex consonant sequences and syllable structures for structural/sequencing-level difficulty. This remains a hypothesis arising from the present case comparison rather than an established clinical recommendation, and would need to be evaluated through intervention studies.

Overall, this case comparison illustrates how a psycholinguistic approach anchored in Ingram's (1976) descriptive process framework together with Stackhouse & Wells (1997) and Levelt's (1989) processing models can help frame hypotheses about the cognitive mechanisms that may underlie individual children's speech production difficulties, while underscoring that two children of the same age can show markedly different error profiles. Understanding such individual differences may, in time, contribute to more individualized assessment and intervention planning, though this study's small, purposively sampled case base means its conclusions should be treated as exploratory.

Conclusion

This study investigated the phonological processes produced by two seven-year-old children with phonological disorder, interpreted through a psycholinguistic framework drawing on Ingram (1976), Stackhouse & Wells (1997), and Levelt (1989). The findings showed that both participants displayed systematic phonological simplification strategies, but the dominant pattern of these processes differed considerably between them. Participant 1 primarily produced substitution processes, particularly stopping and gliding, while generally maintaining syllable structure; within the adopted framework, this pattern is consistent with difficulty primarily at the level of phonemic representation. Participant 2 showed phonological processes dominated by syllable structure modification, including cluster reduction, final consonant deletion, syllable reduction, and initial syllable deletion; this pattern is consistent with difficulty primarily at the level of phonological planning and sequencing.

These differences illustrate the heterogeneous nature of phonological disorder: even among children of the same age, difficulty may emerge at different levels of phonological processing. Because this study examined only two purposively sampled children using a case-study design, its findings should be understood as exploratory and hypothesis-generating rather than generalizable. Future research with larger and more diverse samples including systematic

documentation of participants' language background, socioeconomic and educational context, and independent diagnostic confirmation of phonological disorder is needed to test whether the processing-locus distinction observed here holds across a broader population of children, and to clarify the relative contributions of representational, sequencing, articulatory-motor, and environmental factors to children's phonological error patterns.

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