When liquids and fricatives outrank stops: A Kuwaiti Arabic-speaking child with Down syndrome and protracted phonological development

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ABSTRACT
This paper describes the phonological system of a monolingual Kuwaiti Arabic-speaking 9-year-old girl with Down Syndrome (DS) as part of a special crosslinguistic issue presenting individual profiles of children with protracted phonological development within the framework of constraints-based nonlinear phonology. Her responses to a 100-word speech test were audio-recorded and transcribed narrowly by two native speakers. Analyses showed low accuracy for word shapes (CV sequences), primarily because of expected deletion patterns in initial weak syllables and clusters, but also reflecting inaccuracies in segment length. Vowel match was also relatively low. For consonants, she unexpectedly showed lower accuracy for stops than typically later-developing liquids and fricatives. This case study provides researchers and speech-language pathologists with broader information about expected and unexpected patterns in children with DS and protracted phonological development in general.

Introduction

This paper describes the phonological profile of a monolingual Kuwaiti Arabic-speaking 9-year-old girl with Down Syndrome (DS: ‘Jury’) as a contribution to a special crosslinguistic issue of case profiles in protracted phonological development (PPD).\textsuperscript{1} Jury’s data were selected for this issue because her stops were less accurate than more articulatorily complex liquids and fricatives. This is an uncommon developmental pattern in both typically developing (TD) children (Bernhardt & Stemberger, 1998) and those with DS (Bleile & Schwarz, 1984), and distinguished her from peers with DS in a previous group study (Ayyad et al., 2021). This issue provides an opportunity to expand the analysis of her phonology beyond the group analysis in Ayyad et al. (2021). In accordance with this special issue, the analyses are grounded in constraints-based nonlinear phonological theory (Bernhardt & Stemberger, 1998), taking into account patterns for word structure (length, word shape, syllable timing and structure), segments (consonants and vowels; phonological features) and their interactions. The analysis identifies positive constraints (strengths) that

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\textsuperscript{1}PPD is alternatively called e.g. ‘developmental phonological disorder’, ‘speech sound disorder’. We use the term PPD (following Bernhardt & Stemberger, 1998) because it is inclusive and provides hope that the PPD may eventually resolve.

\textsuperscript{b}Supplemental data for this article can be accessed on the publisher’s website

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promote production of phonological elements, and also negative constraints (needs) that inhibit production. Readers are directed to the introduction to this issue (Stemberger & Bernhardt, 202X) for background on the framework. The following sections provide an overview of Kuwaiti Arabic phonology and phonological acquisition.

Kuwaiti Arabic phonology

Word structure
Kuwaiti Arabic words vary from one to four syllables (or more in borrowings). Syllables can have simple or complex onsets and nuclei, with length distinctions for vowels and word-medial (WM) consonants. Syllables may have from one to three moras, or syllable-timing units (Ayyad, 2011), i.e. there are light, heavy, and super-heavy syllables. Epenthesis is sometimes used to break up clusters in adult speech.

Segments
Kuwaiti Arabic has a diverse consonant inventory across word positions (27 consonants), with all manner and both voicing categories; place extends from labial to pharyngeal/glottal (Al-Qenaie, 2011). As any other Arabic dialect, Kuwaiti Arabic has ‘guttural’ consonants: uvulars, pharyngeals, glottals, and emphatics (consonants with secondary uvularization: the tongue root rises against the pharyngeal wall, whereas the front of the tongue is against the hard palate.) Inventory gaps (sounds that are not in Arabic) include /p/ and /w/. Some Kuwaiti Arabic consonants do not occur across word positions, e.g. /h/ and /w/ (not word-final, WF) (see Table 1).

Vowels include /i/, /a/, /u/ (both short and long), /e:/ and /o:/ plus diphthongs /ai/, /ou/, and /ei/, similar to those of Modern Standard Arabic (Ayyad & Bernhardt, 2009).

Table 1. Consonant-feature correspondence for Kuwaiti Arabic (Ayyad et al., 2016).

| Features               | Consonants |
|------------------------|------------|
| **Manner**             |            |
| [+consonantal]         | m n η (η not word-initial) b t t’ d d’ k (k’) ʃ ʒ q q’ f s s’ z η ə δ ʒ ʃ ʒ ʒ χ η h ℓ r l |
| [-consonantal]         | jʰ wʰ h (not word-final) η |
| [+nasal]               |            |
| [-continuant] [-nasal] | b t t’ d d’ k (k’) ʃ ʒ q q’ |
| [-continuant] [and]    | f s s’ z η ə δ ʒ ʃ χ η h ℓ r |
| [-sonorant] [-continuant] | ʃ ʒ |
| Place                  |            |
| Labial                 | m b f w   |
| Coronal [+anterior]    | n t t’ d d’ η ə δ ʒ ʃ ʒ ʃ ʒ s s’ z ℓ r |
| Coronal [-anterior]    | ʃ ʒ c ʒ |
| Coronal [+grooved]     | s s’ z f ʃ ʒ |
| Coronal [-grooved]     | θ ə δ ʒ (coronal stops, sonorants) |
| Dorsal                 | [+high]: k k’ ʃ ʒ (δ) w j (η not word-initial); [+low] χ η |
| Pharyngeal             | χ η h ℓ h |
| Laryngeal              |            |
| [+voiced] obstruents   | b d d’ q (q’ ) z η δ ʒ ʃ ʒ χ η |
| [-voiced]              | t t’ k k’ q q’ f s s’ η ʃ ʒ χ η h |
| [+spread glottis]      | f s s’ η ʃ ʃ χ η h |

/j/ and /w/ are considered glides syllable finally. [grooved] refers to the central grooving of the tongue for strident sibilants.
**Phonological development: Kuwaiti Arabic**

This section begins with general background on phonological development in children with DS and then reports global phonological measures and consonant acquisition data for Kuwaiti Arabic-speaking TD children and those with DS in order to provide a context and comparison for Jury’s data.

The TD Kuwaiti data are from 80 monolingual 4-year-olds (Ayyad, 2011; Ayyad et al., 2016), recruited from kindergartens in six school districts in Kuwait, and referred to the project as children with no perceptible developmental concerns. A bimodal distribution for Whole Word Match\(^2\) (WWM) in that dataset led to post-hoc categorisation of a sub-group of eight children as at risk of PPD: whereas the overall group mean for WWM was 80.7% (SD 14.6%), the mean of the sub-group was 48.5% (SD 5.9%), i.e. more than two standard deviations below the overall group mean. Where relevant for comparison with the current analysis, data for the TD 4-year-olds are noted for younger and older age groups (3;10–4;5; 4;6–5;2).

The Kuwaiti Arabic data for monolingual children with DS are from Ayyad et al. (2021). The study included six participants aged 5–12 years, recruited through mainstream integration public schools. Because many children with DS between the ages of 4 and 5 years were not verbal, the Ayyad et al. study selected older verbal children (5;10–12;5). Confidentiality concerns preclude information on their cognitive and educational status but recent audiological tests had found no hearing concerns for that group. Jury participated in that study, but her data are excluded from the group data below.

**Phonological development in children with DS: general**

Down Syndrome, a genetic neurodevelopmental disorder, is often associated with delays in speech-language development (Roberts et al., 2007). Cognitive factors such as limitations on processing and memory (Frenkel & Bourdin, 2009) can lead to difficulties forming lexical, morphosyntactic and phonological representations. Hearing loss can occur (conductive and/or sensorineural), affecting speech perception and consequently, speech production (Roizen, 2007). Oral mechanism differences can affect speech output, e.g. hypotonicity, vocal fold anomalies, a small oral cavity for the size of the tongue (and dental and sometimes palatal anomalies: Stoel-Gammon, 2001). Studies on English-speaking children with DS have found similar speech patterns to those of TD children but at a delayed rate, and with more mismatches (errors; Dodd, 1976; Stoel-Gammon, 2001).

**Global measures: TD children and those with DS**

Two global measures are reported for comparative purposes with Jury’s data: WWM and word shape match (accuracy of CV sequences such as CVC, CVCC, etc.) (see the TD WWM data in Table 2). In contrast, Kuwaiti children with DS in Ayyad et al. (2021) revealed a WWM ranging from 2% to 16.7% (mean 8.8%), far below the mean for the TD children,

\(^2\)Whole Word Match indicates that all segments in the child’s production match the adult targets, with small details of voicing or slight place changes ignored.
Table 2. Global phonological measures for Jury and comparative groups.

| Percent match | TD age 4a | At risk of PPD, age 4b | 5 children with DS5 | Mean (Range) | Jury 9:2 |
|---------------|-----------|------------------------|---------------------|--------------|----------|
| Whole Word    | 80.7 (SD 14.6) | 48.5 (SD 5.9) | 7.9 (2–17) | 13.0 |
| Word length   | –         | –                     | –                   | 79.0 |
| Word shape (CV sequences) | 90        | 90                    | 50.7 (31–66) | 33.0 |
| Consonants    | 90        | –                     | 42.7 (31–54) | 47.4 |

Hypermnasality and breathy voice quality ignored as mismatch.
*Typically developing children: 80 four-year-olds (Ayyad, 2011).
†At risk group for PPD (protracted phonological development: Eight 4-year-olds (Ayyad, 2011).
‡Five Kuwaiti Children with Down Syndrome (Ayyad et al., 2021).

but comparable to the WWM scores for children with PPD (aged 3–6 years) in this crosslinguistic issue (mean 14.8%, SD, 13.5%, Jury excluded: Stemberger & Bernhardt, 202X).

With respect to word shape match, the TD 4-year-olds in Ayyad (2011) had greater than 90% match across word lengths, although the younger age group was still acquiring multisyllabic words. For the children with DS in Ayyad et al. (2021: excluding Jury), Word Shape Match ranged from 31% to 65% (mean 47.8%, SD 15.1%), notably lower than the TD mean, but again comparable to the level for children in this special issue (excluding Jury): 45.7 (SD 22.9: Stemberger & Bernhardt, 202X).

**Consonants**

The TD 4-year-olds in Ayyad (2011, 2016) had a high overall consonant match. Thus, in order to see any inter-phonemic differences, a very high mastery criterion was applied, resulting in three categories: (a) mastery: 90% of the children with 100% match for a consonant (87.5% for the at-risk group, i.e. 7/8 children); (b) near-mastery: 75–89% of the children with 100% match for a consonant; (c) still developing: fewer than 75% of the children with 100% match. The TD 4-year-olds showed mastery for all but eight consonants (see Table 3). Three fricatives and one affricate showed near-mastery: interdentals /θ/ and /ð/, the pharyngeal /ʃ/ and voiced affricate /ʤ/. Four segments were still developing: grooved coronal fricatives /s/, /z/, uveicularized /ʃ/ and trilled /ɾ/. The at-risk group were less advanced, showing: (a) mastery for glides, nasals, /ʃ/, /ɾ/ and stops except coronals; and (b) near-mastery for coronal stops only.

Overall Percent Consonant Match for the comparative group with DS was 42.7% (range 31–54%), lower than the TD 4-year-olds but comparable with the mean for the other children in this special issue (mean 46.1%, SD 23.6%). Because the small group of children with DS in Ayyad et al. (2021) had identifiable PPD, a more liberal mastery criterion was applied for mastery: 75+ % match for a consonant indicated (near-)mastery for each consonant for each child: (Ayyad et al., 2021); Table 3. (Near-)mastery was observed for at least one child out of five for all stops (except emphatic /ɾ/), nasal /n/, glides, /l/, fricatives /ʃ/, /s/, /z/, /χ/, /ɾ/ and affricate /ʤ/. The strongest consonants across children were non-dorsal stops, nasal /n/, fricatives /ʃ/ and /ɾ/, lateral /l/ and glides (at least three children). We return to the data in Table 3 when discussing Jury’s results. Comparing the two groups, then expectations for Jury were that she would show acquisition of stops, a nasal, fricatives (possibly /ʃ/ and /ɾ/), /l/ and glides; affricates, /ɾ/, coronal fricatives and other pharyngeals were expected to be still developing.
Method

Participant

Following an ethics review, permission was granted by the school board in the Ministry of Education in the State of Kuwait in 2017, and the research department at Kuwait University for collection of speech samples from children with DS in Kuwait for purposes of research in PPD. The study was conducted with the informed written consent of the parents for research and publication of anonymised data.
The child of this research case study is a Kuwaiti female child ‘Jury’ (pseudonym) with DS (aged 9;2), a student at an integrated public mainstream school, and a participant in an afore-mentioned group study (Ayyad et al., 2021). Her data were selected for the current paper because her phonological patterns were somewhat different from those of the other children in the group study (Ayyad et al., 2021) and merited an in-depth analysis that could not be provided in the group study.

Jury talked in short sentences and was able to complete simple tasks as well as having some early literacy skills. An oral mechanism examination by the first author revealed symmetrical lip seal at rest, and a high narrow palate with enlarged tongue (macroglossia). Her current hearing was normal based on family and school report. No information was available about her earlier hearing status. ‘The school reported her to be in the upper mild range of cognitive delay, but further specific information concerning her IQ and other factors, including sub-type of DS, were simply not available.

Speech sample

The speech sample was collected by the first author and senior speech-language pathology (SLP) students in Kuwait using the Kuwaiti Arabic Articulation and Phonology Test (KAAP-T: Ayyad & Bernhardt, 2017). The KAAP-T is the only test available for Kuwaiti Arabic and varies just slightly from the test used in Ayyad (2011), which was normed on TD 4-year-olds. The test is comprehensive in terms of Kuwaiti Arabic consonants and word structures and allows evaluation of all consonants, vowels and word structures. Pictures were presented on a computer screen. An audio-recording was made with a Sennheiser wireless clip-on lapel microphone and Marantz professional Solid State Audio-Recorder PMD661MKII.

The sample consisted of 100 words with different word lengths and shapes: 21 monosyllabic words, 56 disyllabic words, 19 trisyllabic words, and 4 words with 4 syllables, including 228 consonant singletons across word positions and 35 consonant sequences. Although spontaneous productions were encouraged, 75 out of 100 words were elicited through delayed imitation due in part to Jury’s shyness during the session.

The first author calibrated at the outset with an international expert in phonetic transcription regarding the level of narrowness, and then trained a senior Kuwaiti speech-language pathology student to transcribe Jury’s sample phonetically, including diacritics of nasality, distortion (exact placement), devoicing and inaudible release. The first author confirmed the transcription of each word in the sample. (Supplemental File 1 includes full transcriptions.) Phon 3.1 (Hedlund & Rose,) provided a basis for quantitative analysis.

Case profile

The first part of the profile gives global measures and then consonants are discussed in detail. Both the strengths and developmental gaps are noted in each section, beginning with the strengths. Developmental gaps are discussed in terms of more typical mismatch patterns and then less common ones.
Global measures (Table 2)

Thirteen words matched the adult target almost exactly (nasalisation on vowels, slight phonetic deviations ignored), and showed a variety of consonants and vowels: fricatives, including pharyngeals; coronal [+anterior]; and dorsal stops; nasals; trilled /r/; front and back, short and long vowels. Word shapes included: CVCV, CV:C, CV:CV, CCV:C, and CVCCVC (examples #1–4 below).

|       | Adult | Child | English   | Notes               |
|-------|-------|-------|-----------|---------------------|
| (1)   | /ˈhɛlu/ | [ˈhɛlʊ] | ‘sweet’   | WI pharyngeal [h], WM lateral [l] |
| (2)   | /ˈfi:l/ | [ˈfi:l] | ‘elephant’ | WI labiodental [f]; WF lateral [l] |
| (3)   | /ˈɡʌ:ri/ | [ˈɡʌ:ri] | ‘bicycle’ | WI dorsal stop [ɡ]; WM trilled [r] |
| (4)   | /ˈfoːɡ/ | [ˈfoːkʰ] | ‘upstairs’ | WI fricative [f]; devoiced WF stop |

Jury’s Whole Word Match was 13%, the second highest among the comparative DS group, yet much lower than the 4-year-old at-risk group’s WWM scores.

Word Structure

Word structure match was relatively low for this child (see Table 2: 33%), with several mismatch types: 13 initial weak syllable deletions (#5, 8), 9 consonant deletions (#6, 7, especially in consonant sequences or in the initial unstressed syllable), 8 epentheses (two consonant, e.g. #6), and 16 length mismatches (#8). Jury had higher proportions of syllable deletions, syllable additions and consonant length mismatches than other children with DS in the comparison group.

|       |       |       |       |       |
|-------|-------|-------|-------|-------|
| (5)   | /riˈuːl/ | [ˈluːl] | ‘feet’ |
| (6)   | /ˈdʒɒntə__/ | [ˈse_təh] | ‘purse’ |
| (7)   | /ˈlɔwz/ | [ˈloːs] | ‘puzzle’ |
| (8)   | /bərtəˈqala/ | [ka:lbʰ] | ‘orange’ |

Vowels

Vowel match was low: 43.8% (see Table 2). Several vowel mismatch types were observed (#5, 6, 7). For example, she reduced a vowel sequence /iːu:/ to [uː] and lengthened and mismatched vowel place: [a] > [oː] (rounding). Vowels were occasionally nasalised (#6, 9).

|       |       |       |       |       |
|-------|-------|-------|-------|-------|
| (9)   | /ˈrawðə/ | [nebdeʰ] | ‘kindergarten’ |
**Consonant singletons**

Jury’s consonant singleton match was 47.4% match, which was within the range of the peer group with DS, and equivalent to that of 4-year-olds at-risk for PPD (see Tables 3 and 4). For individual consonants, Jury showed equivalent or higher scores in some instances (Table 3) than the three groups in Ayyad et al. (2016). By word position (see Table 4), Jury’s highest consonant match was WF (69.2%), followed by WM (51.3%) and WI (40.7%) for stressed syllables, 18.9% in un stressing syllables, the latter reflecting the word structure constraints prohibiting initial weak syllables as noted in the section on word structure). The higher proportion of WF matches in comparison with WI consonants in stressed syllables was unexpected developmentally (Bernhardt & Stemberger, 1998).

There was another somewhat surprising pattern, as noted earlier: her total match proportion for the often later-acquired liquids (70.6%: 24/34) and fricatives (53.3%: 24/45) surpassed the match level for stops (33.8%: 22/65). The [-voiced] dorsal /k/ and glottal stop were most advanced at 50% match. The least advanced stop was emphatic /tʰ/, often losing secondary articulation (although retaining manner). In contrast, she showed mastery of fricatives /ʃ/ (100%, e.g. #2, 4), /s/ (88.9%, e.g. #10, 11), and /h/ (88.9%, #1).

Also high were lateral /l/ and trilled /ɾ/ (78.9%, 60% respectively) and glides /j/ and /w/ (77.8%, 60%).

Some often later-developing fricatives showed no matches, however, as predicted from the comparative developmental data: the interdentals (#9, 12), /z/ (minor degrooving and devoicing), and the voiced uvular /k/ (#10). Furthermore, the palatoalveolars /ʃ/ and the affricates showed only one match each.

**Consonant feature mismatches**

Table 4 shows consonant mismatch patterns. Jury showed manner, place, and voicing mismatches with some targets showing multiple mismatches. For example, in /ʔɪˈʔaːnːi/ (#12) the weak initial syllable deleted, moving the WM consonant into WI position. The uvular rhotic changed in place ([Pharyngeal] > [Dorsal]), manner ([+continuant] > [-continuant]) and voicing:

Glottals [h] and [ʔ] were fairly frequent substitutions and also often were a result of multiple feature mismatches. They replaced oral stops (e.g. /q/, /ɡ/: #13), nasals /m/ and /n/ (#14), /l/ and fricatives /ʃ/, /h/ and /ɾ/. When replacing uvulars and pharyngeals, [h] maintained [Pharyngeal] place and sometimes [+continuant], and when replacing /l/, [+continuant], but in the other cases, [h] appeared to be a default substitution (consonant place-holder) similar to the glottal stop, which also appeared for a number of consonants, especially word initially (including other stops, nasals, fricatives).
Table 4. Jury’s singleton consonant matches and mismatches*.  

| Word-initial stressed | Word-initial unstressed | Word-medial | Word-final | Total match % |
|-----------------------|-------------------------|-------------|------------|---------------|
| **C** | /\ targets | Mismatches | /\ targets | Mismatches | /\ targets | Mismatches | /\ targets | Mismatches | C |
| **b** | 2/4 | p-1, bdγ-1 (M) | 1/5 | m-2 (C-1), ʔ-1, Syl del-1 | 3/4 | p-1 | 1/2 | f-1 | 43.8 |

| **t** | 1/1 | 0/2 | Del-2 | 0/3 | t-1, d'-1, d-1 | 0/1 | t-1, Del-1, f-1 | 0/2 | t-1, t'-1 | 33.3 |

| **d** | 0/1 | t-1 | 1/2 | Del-1 | 0/3 | t-1, d'-1, d-1 | 0/2 | t-1, t'-1 | 11.1 |

| **t'** | 0/1 | t'-1 | 1/4 | t-1, Del-1, f-1 | 0/2 | t-1, t'-1 | 0/2 | t-1, t'-1 | 0 |

| **k** | 1/2 | tf-1 | 0/1 | k-1 | 1/1 | 50.0 |

| **g** | 1/3 | h-1, ʔ-1 | 1/1 | 0/2 | k-1, k'-1 | 1/1 | k'-1 | 37.5 |

| **q** | 0/1 | h-1 (R) | 0/1 | ʔ-1 | 0/1 | k-1 | 0/1 | k'-1 | 0 |

| **ʔ** | 2/2 | 0/4 | Syl del-4 | 1/1 | 1/1 | 50.0 |

| **m** | 1/3 | hβ-1, b-1 | 2/8 | n-1, ʔ-2, h-1(A), Syl del-2 | 2/2 | 2/2 | 46.7 |

| **n** | 1/1 | 0/2 | h-1, Syl del-1 | 3/4 | m-1 (C) | 4/4 | 75.0 |

| **f** | 3/3 | 3/3 | 3/3 | 100 |

| **s** | 2/3 | ʕf-1 | 3/3 | 3/3 | 88.9 |

| **sγ** | 0/4 | s-2, s-1, s-1 | 0/1 | s-1 | 0/1 | ʔγ-1(A) | 0/1 | s-1 | 0 |

| **sγ'** | 0/2 | s-2 | 0/2 | s-2 | 0/2 | s-2 | 0/2 | s-2 | 0 |

| **θ** | 0/1 | ʔ-1 | 0/2 | s-1, ʔθ-1 | 0/1 | tsθ-1 | 0/1 | s-1 | 0 |

| **δ** | 0/1 | ʔ-1 | 0/3 | t-1, k-1, s-1 | 0/1 | s-1 | 0/1 | s-1 | 0 |

| **z** | 0/1 | ʔz-1 | 0/1 | Syldel-1 (M?) | 0/1 | ʔzθ-1 | 0/1 | ʔzθ-1 | 0 |

| **zγ** | 0/1 | ʔz-1 | 0/1 | ʔz-1 | 0/1 | ʔzθ-1 | 0/1 | ʔzθ-1 | 0 |

| **f** | 0/3 | θ-1, tf-1, ʔes-1 | 1/1 | 0/3 | ʔθ-1, ʔs-1, ʔ-1 | 0/1 | ʔθ-1, ʔs-1, ʔ-1 | 14.3 |

| **χ** | 0/2 | h-2 | 0/1 | h-1 | 1/2 | ʔh-1 | 1/1 | 42.9 |

| **X** | 0/1 | 0/1 | 1/1 | 1/1 | 1/1 | 50.0 |

| **ʕ** | 1/3 | ʔ-2 | 1/2 | ʔh-1 | 1/1 | 1/1 | 66.7 |

| **h** | 2/3 | h-1 | 4/4 | 4/4 | 88.9 |

| **h** | 0/1 | (ʔe)h-1 | 1/1 | 1/1 | 50.0 |

| **ʧ** | 0/2 | ʔ-1, (ʔe) | 1/1 | 1/1 | 25.0 |

| **ʤ** | 1/5 | s-1, t-1(A), h-1, hef-1 | 0/1 | (ʔe)θ-1 | 0/1 | ʔf-1 | 0/1 | ʔ-1 | 14.3 |

| **r** | 1/2 | n-1 | 0/1 | l-1 (R) | 2/4 | ʔ-2 | 0/1 | l-1 | 60.0 |

| **r** | 3/4 | n-1 (A) | 0/1 | h-1 | 6/6 | 6/6 | 4/6 | n-1(A), l-1 | 78.9 |

| **l** | 0/2 | (ʔ-2) | 0/2 | (ʔ-2) | 0/2 | (ʔ-2) | 0/2 | (ʔ-2) | 0 |

| **w** | 1/3 | b-1 | 2/2 | 2/2 | 60.0 |

| **j** | 0/1 | ʔ-1 | 0/1 | 0/1 | j-1 | 0/1 | j-1 | 77.8 |

| **j** | 0/1 | 0/1 | 0/1 | 0/1 | j-1 | 0/1 | j-1 | 0/1 | 0/1 |

| **Total** | 24/59 | 7/37 | 41/80 | 36/52 | 108/228 |

| **R** = reduplication; **M** = metathesis or migration; **C** = coalescence; **A** = Assimilation (colour-coded in purple online); **Del** = deletion; **SyDel** = syllable deletion.  

*For the totals, the long consonants are counted in with the short consonants with length mismatches ignored.

\[\text{نطیف} \quad /\text{ناً}di:f/ \quad \text{‘clean’} \quad \text{Reversing feature order of [-continuant]_[-continuant]}\]

\[\text{ففشة} \quad /\text{ɡαʃʃ}/ \quad \text{‘spoon’} \quad \text{Reversing feature order mismatched place [-continuant]_[-continuant]}\]
Looking only at manner of articulation, the least stable feature was [continuant]: e.g. [-continuant] stops or nasals sometimes appeared as [+continuant] fricatives (#13, 15) or [-continuant,+continuant] affricates (/k/ > [ɡ]); fricatives sometimes appeared as stops (#9, 12, 13) or affricates (/ʃ/ > [ʂ]); and affricates often appeared as fricatives (losing the [-continuant] portion of the [continuant] sequence, #6).

\[\text{(15)} /\text{dæ}\text{lə}:/ [\text{dæ}kʰ] \quad \text{‘sock’} \quad \text{d}.l > [\text{ð}]; /\text{ʃ}/ > [k] \]

Manner feature metathesis also was observed, e.g. reversal of [-continuant] (nasal)_ [+continuant] (e.g. #13, 14, 16):

\[\text{(16)} /\text{də'bə:a}nə/ [\text{ʔəvə:nəʰ}] \quad \text{‘fly’} \quad \text{Reversing feature order of} \quad \text{[continuant]occurred} \]

Although manner features for liquids were relatively strong (particularly for /l/), sonorant nasal [n] appeared occasionally for /l/ (possibly through assimilation) and /ɾ/ (#9); [ɾ] also substituted for /ɾ/ (#5: reduplication), as did non-Arabic rhotic [ɾ] (and as noted previously, [ɾ] replaced /l/ once).

Place mismatches were reflected in the glottal substitutions described above (de-buccalization), but also in terms of minor place changes, i.e.: (a) loss of [Coronal,-anterior] for palatoalveolars, with production of a [Coronal,+anterior] dentoalveolar (as in #6); (b) contrastign loss of [+grooved] for /ʃ/ but of [-grooved] for the interdentals; and (c) loss of [+low] for uvulars resulting in, e.g. [Dorsal,+high] [k] for /ʃ/ and /ʒ/. Secondary place usually did not appear (emphatics surfaced as plain consonants: #6). In addition, exact place was not always maintained for coronals, with slight advancement or retraction (partway between an alveolar and palatoalveolar).

Voicing was also an issue for Jury. She tended to switch voiced consonants for voiceless and vice versa (#12-14).

**Discussion**

**Theoretical and developmental implications**

In summary, Jury had a low Word Shape Match (33%) and Whole Word Match (13%) compared with TD 4-year-olds but within the range of peers with DS and many younger children with PPD in this special issue (without DS). Initial unstressed syllables and consonant sequences (clusters) were particularly challenging. Jury also showed many needs in terms of manner, place and laryngeal features, not just for the features themselves but (a) by word position; and (b) in sequences, because she showed several examples of assimilation/reduplication/metathesis/coalescence. Secondary place and minor coronal place were still a challenge for Jury. Children with PPD in general and in this issue (Stemberger & Bernhardt 2022) often show constraints such as Jury showed for complexities in word structure and feature combinations including secondary articulation (emphatics). Thus, Jury ‘fits’ PPD as instantiated in this crosslinguistic issue.

Jury’s system was less usual in showing: (a) a higher match for liquids and fricatives than stops; (b) a higher match for WF versus WI consonants; and (c) a reduced match level for vowels. At least one other child with PPD in this issue (e.g.
Chung, Bernhardt & Stemberger, 2022) had more accurate WF than WI consonants along with a reduced vowel match. Thus, she is not unique, but rather following a less common developmental path. We can only speculate as to the possible perceptual, attentional or articulatory sources for these less common patterns. Certainly, the loss or changes for WI consonants in unstressed syllables is well-attested (Bernhardt & Stemberger, 1998) but generally, WI consonants develop earlier in stress-initial words, possibly because they are more salient in that position as part of the basic stressed CV syllable. However, if vowels are less accurate in those stressed syllables, perhaps the initiating onset consonant also loses contrastiveness and/or salience as part of that neutralised syllable. Additionally, or alternatively, WF consonants may be more easily retained in memory (a recency effect) when children have working memory constraints, as has been noted for children with DS (Frenkel & Bourdin, 2009). Finally, although stops are generally considered easier to articulate than fricatives and liquids, her hypotonicity perhaps predisposed her to less firm articulatory contact, and thus [+continuant] rather than [-continuant] consonants.

**Clinical implications**

Table 5 suggests potential goals and strategies for the next intervention period for Jury. The first priority is mastery of stops to bring her system more in line with typical development. Following the perspective of constraints-based nonlinear phonology and utilising strengths (positive constraints) to address needs, stops would first be addressed in her strongest word position (WF) in basic VC syllables, thereby circumventing possible interference from WI position (as in CVC), then in WI and WM positions and longer words with initial unstressed syllables. Contrast-based activities in perception and production are suggested to demonstrate the difference between [+continuant] and [-continuant] segments. Firm brief articulator contact may need to be facilitated for stops. Later needs include maintenance of the initial weak syllable and production of consonants in sequences, plus the remaining fricatives and affricates and vowels, if they do not improve independently.

| Form                  | New                                                                 | Old form in new ways or places                                      | Treatment strategy ideas                                                                 |
|-----------------------|----------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Word structure        | #4. Multisyllabic words with initial unstressed syllables            | Feature-structure interactions                                     | Start with WF and WM consonants in sequence (VCV, CVCV) with the stop and fricative in separate syllables. Gradually increase speed to join the syllables and maintain the sequence. |
| Features and segments | #1. [-continuant] vs [+continuant] (voiceless stops)                  | Feature combinations: #3. [+voiced] & [-continuant] (voiced stops)  | • Speech sounds in isolation and in VC syllables (WF)                                    |
|                       |                                                                     |                                                                    | • Phonological contrast focus in perception                                                |
|                       |                                                                     |                                                                    | • and production (stop/fricative)                                                          |
|                       |                                                                     |                                                                    | • Firm brief articulator contact (stop) versus slow approximation (fricative)              |

**Table 5. Proposed goals and treatment strategies for the next treatment period.**
**Limitations and directions for future research**

Research on Kuwaiti Arabic phonological development is limited. Many more studies are required in order to develop research methods, train researchers and clinicians and establish databases across groups by age and with various conditions. For this particular study, it was not possible to obtain more detailed information on Jury’s hearing history, cognitive skills or IQ, which limits generalisability of the results both for Arabic-speaking children with DS, and children with DS speaking other languages. Additionally, Jury needed to imitate a fairly large number of words of the KAAP-Test (Ayyad & Bernhardt, 2016) either because of unfamiliarity with vocabulary items or difficulty interpreting the picture stimuli. Although she did imitate unfamiliar words, the imitations may have over- or under-represented her customary phonological skills. The KAAP-T (Ayyad & Bernhardt, 2016) thus likely needs further norming and possible adaptation for less verbal children.

**Conclusion**

Jury’s data expand the horizons of researchers and SLPs with respect to clients with PPD, especially with genetic aetiologies such as DS. Her data are a reminder that it is always important to look at each child as an individual to see what their strengths and needs might be. Future research is vital to expand the knowledge base on acquisition in general and for Kuwaiti Arabic in particular, and to provide support for the development of the SLP profession.

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