Acquisition of Tok Pisin phonology in the multilingual highlands of Papua New Guinea

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Abstract

Purpose: Papua New Guinea (PNG) has extreme linguistic diversity reflected in its three national languages and sociolinguistic diversity comprising over 380 vernaculars or Tokples, English and the lingua francas, which include Tok Pisin (TP). This first clinical cross-sectional study of consonant acquisition in TP-speaking children sought to identify universal features and the impact of age on phonological development.

Method: A local picture naming task was developed and used to elicit a speech sample from 80 children (aged 3;0–6;11). Phonetic and phonemic inventories and developmental phonological processes were analysed across the sample and also in 12-month age groups.

Result: Statistically significant differences were found between the Percentage Consonants Correct (PCC) of the 3YO and other age groups. Mean PCC increased with age, but high variation within age groups meant differences were not statistically significant. Universal features observed included the early acquisition of plosives and late mastery of /r/. Language-specific features included processes such as fricatisation and earlier acquisition of /ð/ before /s/. Creolisation was seen in morphophonemic condensation and the influence of loanwords.

Conclusion: This study demonstrates both universal and language-specific features amidst wide diversity influencing phonological acquisition in creolising TP. This first phonological study of TP consonant development will inform future clinical speech-language pathology practice in PNG.

Keywords: phonological development; PNG; Tok Pisin; creole

Introduction

Papua New Guinea (PNG), Australia’s nearest northern neighbour, is the world’s most linguistically diverse nation (Simons & Fennig, 2018). Despite a wealth of linguistic research, PNG has no recorded history of speech-language pathology (SLP) services or research. This first cross-sectional clinical study provides preliminary information about PNG children’s phonological consonant development in Tok Pisin (TP), the major lingua franca. Tok Pisin translates as ‘talk pidgin’ and began life as a pidgin trade language. Now it is the native language for many urban PNG speakers and thus may be considered to be changing into a creole language (Mühlhäusler, Dutton, & Romaine, 2003). Throughout this paper, pidgin refers to the pure contact language, but creole to where the pidgin is being used as a primary or native language.

PNG’s linguistic complexity is due both to its over 800 vernacular languages or Tokples and the interplay between its three language types in a trilingual mix (Smith, 2002). The Tokples, English, and the Melanesian pidgin lingua franca, Tok Pisin (TP) each have generally specific domain use (Nidue, 1990). Sociolinguistic factors influence this trilingual mix. Every PNG speaker has at least one identifying Tokples used in home life, family life, village activities and all traditional events. English is used in the domains of education, government, and international relations. English usage and fluency are more common in professional, educated families. English has been the language of education for a number of generations. Although there has been some vernacular primary education in the late twentieth century, and TP has had a valuable role in elementary literacy (Siegel, 2005), English has dominated education from grade three onwards since 2013. English is spoken in less than 10% of PNG homes (Temple, Ezebilo, Hane-Nou, & Kamene, 2017). Lingua Francas allow communication between different language groups. TP is the most widely spoken lingua
franca both geographically and by the domain (Smith, 2002). It is widely used in journalism, PNG’s many churches and early education. There is a TP New Testament that provides an unofficial standard for orthography (Siegel, 2005). A national education goal is literacy in one of the national languages, which includes Tok Pisin (Siegel, 2005).

Multilingual urban squatter settlements have a greater dependence on TP due to the mixing of Tokples speakers. This has led to TP becoming the primary language of many urban speakers (Sankoff & Laberge, 1973). Urban children frequently have TP as their mother tongue (Rumsey, 2014), and are changing it in a process known as creolisation (Smith, 2002). Frequent code mixing and code-shifting between English, TP and various Tokples have increased with growing access to mobile phones and social media (King, 2014).

**Complexity in phonological development**

We can expect that Tok Pisin phonological development will reflect the high level of sociolinguistic complexity present in PNG. Davis and Bedore’s (2013) emergence approach to language development allows consideration of the impact both of intrinsic capacities such as production, perception, and cognition, but also extrinsic factors such as the ambient phonologies and language inputs, all of which contribute to the complexity of phonological acquisition (Hua & Dodd, 2006a). In examining phonological acquisition, it is crucial to consider both phonetic inventory – all the sounds a child can produce – as well as phonological inventory, which measures the children’s ability to use phonological contrasts. Both these skillsets increase in complexity when children are required to differentiate multiple ambient phonologies, with their differences in inventories, phonotactics and functional load for segments (Amayreh & Dyson, 2000). Cross-linguistic studies have sought evidence of language universals in the content and age of phonetic and phonemic repertoire completion and the priority of specific features and segments. Further complexity is added if pidgin languages become the mother tongue and are creolised, causing accelerated language change and variation (Romaine, 1992).

Extensive studies have investigated cross-linguistic phonological development, looking for universal features and testing theories of phonological development. Jakobson’s seminal work (1968), discussed the concept of distinctive features of phonemes: how children learn to articulate and contrast sounds beginning with maximally contrasted sound pairs. Unmarked sounds like /m/ and /p/ were proposed as more universally present cross-lingually in phonological inventories and earliest in the sequence of developmental acquisition of segmental phonology (Hua & Dodd, 2006a). Some sounds, like /θ/ have combinations of articulatory features identified as marked. They are considered to have greater articulatory difficulty and are more likely to be subject to simplifications such as deletion or substitution, in patterns referred to as developmental phonological processes (Miccio & Scarpino, 2009). Unmarked phonemes such as /m/ are less complex, as they have fewer marked features. Unmarked phonemes will have priority in the order of acquisition over more marked phonemes.

Children acquiring their phonology must balance a preference for an unmarked sound or a markedness constraint where the universal pressure holds sway, against faithfulness constraints that favour marked sounds found in the child’s ambient language environment. Many theories of speech acquisition suggest maturing children begin to be less influenced by universal phonological rules and begin to apply faithfulness constraints (Kehoe, 2011). This study allowed observation of how children acquiring multiple phonologies balance multiple faithfulness constraints, one of which is to a changing, creolising language, with markedness constraints.

**Current study**

This current study examined consonant development in the sociolinguistic fragment of Tok Pisin spoken by children of Tokples Melpa background, the regional vernacular of the Western Highlands province of PNG. Most participants also had exposure to English. Melpa, a large highlands Tokples, is the second biggest vernacular in PNG with over 100 000 speakers (Stewart & Strathern, 2018).

**Language of focus, Tok Pisin**

TP is one dialect of Melanesian Pidgin English (Smith & Siegel, 2013). Pidgins are simplified languages that emerge in situations where speakers have no language in common. Although simplified languages, pidgins nevertheless have consistent rules and vocabulary which must be learnt (Velupillai, 2015).

It is thought that Melanesian Pidgin emerged in contact situations of Melanesian ports and the plantations of the Pacific region (Mühlhäuser, 1985). TP stabilised within PNG into a uniquely PNG language. Despite its humble beginnings and sometimes derided status, TP is a language expanding in complexity, valued and used by most Papua New Guinean speakers (Mühlhäuser, 1985), and was therefore considered by the researcher as an appropriate language for preliminary SLP research.

**Pidgin languages**

Pidgin languages are comprised of features of each of their contact languages. For example, the dominant language is usually the lexifier language, meaning it contributes most of the new language’s vocabulary. Vernacular languages have a critical role in the syntax, phonology and suprasegmentals of pidgins. Pidgin
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phonology typically has fewer phonemes than the lexifier language (Velupillai, 2015). Phonemic inventories generally substitute marked sounds in the lexifier language with unmarked sounds (Romaine, 1992). TP, as a form of Melanesian Pidgin, is mainly an English lexified language, with some Melanesian Tokples and German vocabulary and phonotactics (Mihalic, 1989). A creole language develops when a pidgin language becomes the native language of urbanised child speakers (Romaine, 1992).

Variation in TP phonology means the literature discusses core consonants and core vowels (Romaine, 1992), around which variation can occur due to vernacular Tokples influence. Core phonemes are found in all versions of TP, but additional phonemes may be added regionally and with different sociolects and registers. Whilst being intelligible throughout PNG, TP shows variation both over time (diachronic) and geographically (synchronic) (Mühlhäusler, 1985). TP, like other creole languages, is impacted by change processes such as extensive code shifting and loan word adoption (Smith, 2002). TP has the status both of an expanded pidgin with many more functions as an ‘everyday lingua franca’ (Siegel, 2005, p. 143) and as a creole, when it is the native language of urban dwellers (Mühlhäusler, 1985). In this paper, we have referred to our speakers as creole speakers because in their frequent and dominant use of TP they are changing it in a typically creolising manner. Rapid speech rates of young creole speakers elide segments and syllables in morphophonemic condensation (Romaine, 1992). The trialling and adoption of new phonemes within loan words mean that the creolising phonology is a shifting target and, with other features of creole speech, greatly adds to variation between TP creole speakers (Smith, 2002).

Local TP phonology

Prior to the main developmental study, an adult pilot study sampled the phonology of 12 adult speakers in the target area, to confirm the adult phonology described in the literature (Smith & Siegel, 2013). This study provided the phonology targets for relational measures (Table I). Our adult pilot study (Boer & Williams, 2017) identified the following consonants: six plosives /p, b, t, d, k, g/, three nasals; /n, m, \&, three fricatives, two approximants /w, l/ and the trill /r/. In addition, we found that there was an expansion of the phonology emerging in this population, for example, the /j/ phoneme in new loanwords like /dfj/ ‘dish’. There were also changes in the phonotactics, for example in the use of /v/ and /\&/ in coda positions (Boer & Williams, 2017). New developments were therefore monitored in our child study.

There are significant differences between Melpa and TP phonology, although English and TP are similar. The Melpa phonological inventory is very different from English and TP and includes the velar lateral /L/ (Ladefoged, 2001). As well as differences in inventories, Melpa's skills in coarticulation mean that alveolar fricatives may be velarised (Ladefoged, 2001, p. 197). Dentalisation of alveolar stops is contrastive in Melpa and pre-nasalisation of stops, lateralisation of stops and fricatisation of laterals occur (Ruby, Stucky, & Stucky, 1990). Melpa is not one of the vernacular languages that shaped the original TP phonology. However, TP phonotactics reflect the influence of Tokples Tolai and German in features such as the rule excluding voiced coda segments (Mihalic, 1989). For further details regarding TP phonotactics, see supplementary item 2.

Four questions were addressed in this current study: (1) Are there differences in phonetic and phonotactic inventories between the age groups? (2) Are there differences in phonological inventories between the age groups? (3) Are there differences in the phonological processes used by children between the age groups? (4) Are the universal principles of phonological acquisition demonstrated by phonological processes and the precedence of unmarked phonemes and processes?

It was hypothesised that phonetic, phonotactic and phonological inventories would expand with age, that phonetic and phonemic acquisition would reflect universal principles and that developmental processes would decline with age. The research questions were addressed using both independent and relational measures (Baker, 2004).

Method

The study was a cross-sectional observational phonological development study of TP children between the age of three and seven years old.

Ethical approval was obtained through Curtin University Human Research Ethics Committee (HREC) prior to the commencement of the pilot studies (approval number RDHS-85-15). In addition

Table I. New adult TP phonological inventory (Boer & Williams 2017).

| | Bilateral | Labio-dental | Alveolar | Post alveolar | Palatal | Velar | Glottal |
|---|---|---|---|---|---|---|---|
| Stop | p, b | t, d | | | k, g | | |
| Nasal | m | n | | | | | |
| Affricate | f, v | s, (\&) | | | (j), \& | | |
| Trill or flap | | | | | | | |
| Lateral | l | | | | | j | |
| Approximant | w | | | | | | |

Note: Occurrence in > 50% of participants (<50% bracketed).
to HREC approval, a police clearance certificate was sought in May 2015 from the PNG Royal Constabulary. Elders of the Melpa community and a native speaker assistant acted as cultural and language consultants.

**Materials**

A Word Naming Test (WNT) appropriate to this population was developed using locally obtained photographs. This task was developed and refined with the support of a local research assistant. The final WNT (supplementary item 1) consisted of 67 pictures, which enabled each phoneme to be elicited on a minimum of two occasions.

**Participants**

For this preliminary study, an age-stratified convenience sample of 80 participants was sourced to complete four twelve-month age groups (3;0–3;11, 4;0–4;11, 5;0–5;11, 6;0–6;11) of 20 participants each. PNG does not place the same value on dates of birth, as in minority world countries; therefore, at times, it was difficult to be certain of a child’s age or date of birth. This prevented breaking participants down into smaller age brackets.

Chase and Johnston (2013) suggest that valuable data can be obtained from small samples of up to 20 subjects. This was supported by a power analysis which revealed that a sample size of 76 was sufficient for large effect size. Inclusion criteria included TP/ Melpa language use, valid date of birth and typical neurological development. Typical neurological and sensory function was based on parent and teacher reports. We included all children satisfying this criterion in order to describe the population’s typical range (Dodd, Holm, Hua, Crosbie, & Broomfield, 2006). Children experiencing severe Upper Respiratory Tract Infections (URTI) symptoms on the day were not included in the 20 participants for their age group.

**Recruitment of participants**

Speakers generally lived in villages on the fringe of Mt Hagen, although some attended Mt Hagen schools. Participant recruitment began with researchers providing information about the project at local community events. Information about the project was provided in either TP or Melpa and informed consent documents were also provided in the relevant language. Demographic information is provided in Table II.

Questionnaire data gathered from each family at the time participants were recruited and families met with the researcher were analysed with the research assistant to describe the range of family language use (Table II), education, and occupation. Education level and occupation ranged from primary educated subsistence farmers (17 families) to those with both tertiary education and professional roles (14). The largest group were those described as ‘primary or secondary education, farming, and small business’ (32 families). The largest language-use group was ‘mixed Melpa and TP, English TV’ (Table II). Each family had a strong element of TP use, thus satisfying the inclusion criterion but the sociolinguistic diversity was apparent in the varied distribution between English, TP and Melpa (Table II).

**Procedure**

**Data collection**

Data was collected between June 2015 and March 2018 at six school and community sites near the city of Mt Hagen. For each participant, picture naming data were recorded at a single point in time. The procedure was explained to the children either in Melpa or TP, by the local research assistant. To familiarise children with the naming task the researcher had provided in-class activities where naming was modelled and incorporated into a story-telling activity. The research assistant presented the pictorial WNT to the child participants. The 67 target words for every child’s dataset were identical, although elicitation rates varied. Modelling, a culturally acceptable practice (Rumsey, 2014), supported the children. When a child was unable to produce the target word spontaneously, it was modelled for them. Spontaneous elicitation in the child study increased with age. Each child’s responses for each word were noted as elicited spontaneously, modelled, or not elicited at all. The researcher audio-recorded and transcribed responses in IPA at the time of collection. Recordings were subsequently re-transcribed by syllabic position with a narrow IPA transcription in four syllabic positions to allow fuller preliminary data: SIWI (syllable initial, word initial), SIWW (syllable initial within word), SFWW (syllable final within word) and SFWF (syllable final word final). Transcription was re-checked at least once by the local research assistant and the researcher alone or in cooperation. Independent transcription for intra-rater reliability in IPA of 10% of samples was completed by an Australian speech-language pathologist in PNG who spoke fluent TP. The agreement rate for inter-rater reliability was 97%.

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**Table II. Participant demographics: gender, and language use**

| Gender | 3YO | 4YO | 5YO | 6YO | Total |
|---|---|---|---|---|---|
| Male | 11 | 13 | 8 | 10 | 42 |
| Female | 9 | 7 | 12 | 10 | 38 |
| Mainly English | 2 | 6 | 3 | 3 | 14 |
| Mixed English and TP | 7 | 5 | 3 | 5 | 20 |
| Mixed Melpa and TP | 10 | 9 | 12 | 10 | 41 |
| English TV | | | | | |
| TP and Melpa only | 1 | 0 | 2 | 2 | 5 |

*CYO: Year old. Language use surveyed media, written language and conversation.*
Data analysis

Independent analyses

Phonetic inventories. The criterion for inclusion in a child’s phonetic inventory required sounds to be produced at least twice in any syllabic position (Stoel-Gammon, 1989) and 75% of the group producing the sound for inclusion in a 12-month age group (Hua & Dodd, 2000). Percentages of phones produced by each 12-month age group were then tallied in the four syllabic positions: SIWI, SIWW, SFWW and SFWF with attention to segmental features of voicing, place, and manner.

Phonotactic structure. Analysis of phonotactic structures examined the syllable structure of words in each participant’s single word data (Robb & Bauer, 1991). The phonotactic structures recorded for each 12-month age group were tallied. A participant was credited with a structure used once, and the age group was considered to have mastered the structure when it was used by 85% (Mahuralala, Pascoe, & Smouse, 2014). Target words included two variant forms for analysis. These variants were /faɪpla/ and /faɪv/, ‘five’ and /skɪræptm/ and /skɪreɪpm/ ‘to scrape’. The sequencing of phonemes and placement within the word according to voicing and manner were noted in the phonological data.

Relational measures

Phonological inventories. The second and fourth research questions examined phonological acquisition with age and universal features of that acquisition. Children’s phonological productions of phonemes in target words in relation to the adult phonological targets were compiled into phonemic inventories. The broad transcription of target phonetic data was entered for each participant into a 67-line Excel data set. The criterion for inclusion of a phoneme in a phonological inventory was the two out of three (67%) correct metric for the individual acquisition of a phoneme, which has been used in studies in less researched languages (Mahuralala & Pascoe, 2016). When there were less than three opportunities to use a phoneme, we credited participants with a phoneme when it was 100% correct, and when three or more opportunities, when it was at least 67% correct. Some variants, such as aspiration, were allowed. Distortions that were infrequent in the adult population, for example with the [l] substitution for [r] or [s], were noted as a phonological process but may reflect cross-linguistic transfer. Group phonological inventories were obtained for mastery by 90% of the age group (Hua & Dodd, 2006b). Group phonological inventories were tabulated according to the group criterion by the four syllabic positions (SIWI, SIWW, SFWW, SFWF). Phonemes correct in every targeted syllabic position for each 12-month age group were noted. Results for the combined positions of each sound, by month, across all age groups were also graphed in Excel. These data were used to identify the month each sound entered customary use (50% of cohort) until it was mastered (90%) (Sander, 1972).

Percentage consonants correct (PCC). The number of target consonants produced correctly in relation to the adult targets by each child was divided by the total attempts and this number was converted to a percentage of consonants correct (PCC) (Shriberg & Kwiatkowski, 1982).

Each child’s phoneme and PCC scores were incorporated into a single line of data per participant for entry into SPSS (Version 25. 2017), in order to generate further descriptive and inferential statistics. Descriptive measures of PCC were obtained for the group as a whole and for each 12-month age group. The assumptions of independence, normal distribution, and homogeneity for one-way between groups analysis of variance (ANOVA) were tested. Participant data were independent. The normal distribution of the PCC was examined with the Shapiro-Wilk test, descriptive statistics, histograms, and boxplots. Homogeneity of variance was examined with Levene’s test. An ANOVA was used to investigate the impact the age group had on mean PCC. Post hoc Tukey’s HSD tested the significance of individual 12-month age group comparisons. A univariate analysis of ANOVA was used to calculate an omnibus measure of effect size ($\eta^2 = .27$).

Phonological processes. An audit of processes seen at least once formed the basis of the processes subjected to analysis in Excel and revealed the many conflicting phonological influences in the children’s language environment. When multiple processes were evident in a word, all were counted (Grunwell, 1987). Criteria for a process being present were five occurrences in a child’s word sample (Cohen & Anderson, 2011) and 10% in an age group (Hua & Dodd, 2000). This stringent criterion was to reflect processes rather than ephemeral events caused by the multiple phonologies available to children learning TP.

Result

Independent analyses

Phonetic inventories

The phonetic inventories (Table III) affirmed that children’s phonetic skills increased with age. Although all the target phones were present by the 6YO group, and each successive group was larger, not all phones appeared in every syllabic position in each subsequent group. Some sounds present in younger age groups were not present in all positions in later age groups. Affricate [dr], for
example, was present in all positions for the 3YO and 4YO groups but absent in some positions for the 5YO group, which acquired the fricative [s]. All nasals were present in every position for the 4YO group, but not elsewhere. It was of interest to observe that several forms of /r/ were recorded, but the flap [r] alone satisfied our criterion and only ever in one syllabic position for each age group. There were larger inventories of phones in the SIWI position, with the smallest phonetic inventory observed for the SFWF position. Onset syllabic positions were the only place the voice stops bilabial [b] and fricative [f] were seen in the 3YO group. The SFWF velar nasal /ŋ/ was seen only in the 3YO and 4YO groups, in contrast to the wide distribution of the bilabial and coronal nasals in the 3YO age group onward.

All manners but fricatives were represented from the 3YO group in all positions. These included front plosive /d/, continuants, nasals, and affricate [ð].

### Relational analyses

Relational analyses addressed questions two, three and four and assessed whether phonological development would change with age and reflect universal features. These included phonological inventories, phonological developmental process inventories and statistical analysis of PCC.

### Phonological inventories

Phonological inventories based on the 67% correct criterion were prepared for each age group (Table IV). Phonemes correct in all syllabic positions by the 3YO group were plosives /d/, /k/, the bilabial and alveolar nasals and approximant /w/. The fricative /f/ was mastered in all positions by 48 months as was affricative /ð/ and lastly the voiceless alveolar /s/ in the 6YO group in all positions.

Differences were seen between syllabic positions in numbers and which phonemes were acquired. More phonemes were mastered early in onset positions. Linear consistency was seen in plosives /d/ and /k/, fricative /f/ and approximant /w/ which appeared in all positions from the age first mastered onwards. Voiced plosive /g/ was mastered from the 3YO onward, but only in SIWI. Approximant /l/ failed to achieve mastery for SFWF, so was never seen in all positions. The /r/ phoneme appeared in SIWW from the 4YO group but was never mastered in all positions. However, there were reversals at 90% with the affricate /ð/ (see Supplementary Item No. 1 for word opportunities), which was mastered by the 3YO in all positions, but absent in SIWW for the 4YO, 5YO and 6YO groups. Once the velar nasal was added to bilabial and alveolar nasals in the 4YO group they remained.

The Sander style compilation (1972) (Figure 1) is a compilation of each pheme for all participants. It shows the range from customary production (50%) to mastery (90%) also demonstrating clear increases with age. There were some minor sequential differences in this compilation of all syllabic positions to the tallies of phonemes correct in each available syllabic position from the phonological inventories. By age 48

### Table III. Consonant phonetic inventories by 12-month age groups.

| Age group | Total phones | SIWI | SIWW | SFWW | SFWF | All available positions |
|-----------|--------------|------|------|------|------|-------------------------|
| 3YO       | 13           | p, b, t, d, k | s | b, d | d |                      |
| 4YO       | 15           | p, b, t, d, k | m, n | t, d | s |                      |
| 5YO       | 17           | p, b, t, d, k | m, n | t, d | s |                      |
| 6YO       | 18           | p, b, t, d, k | m, n | t, d | s |                      |

Note: Seen twice in 75% of the age group (Stoel-Gammon, 1989, Hua & Dodd, 2000).
months the compilation of all positions showed 90% of the participants had mastered /p, b, t, d, k, l, f, m, n/. At 65 months /j/ was added and at 83 months a late group of /v, g, s/. The /r/ phoneme was only mastered in the SIWW position and did not reach 90% overall by 83 months.

PCC descriptive and inferential statistics
Descriptive statistics (Table V) for the mean PCC of each age group confirm that phonological skills increase with age. With the presence of outliers in the 3YO and 5YO groups, this was clearer with the median than the mean. Assumption testing of normality prior to performing the ANOVA found large ranges, with confidence intervals overlapping between all groups except the 3YO age group. There were larger standard deviations and 95% confidence interval ranges in both the 3YO ($M=83.46$, range 30.8, SD 7.81) and 5YO groups ($M=89.93$, range 26.8, SD 5.90) which both had outliers. Levene’s statistic was significant for the mean $F(3.76) = 3.58(p < 0.02)$, but not violated for the median ($p = 0.61$). The Shapiro-Wilk test indicated the assumption of normality was supported for each group ($p < 0.05$) except the 5YO group. ANOVA is robust with respect to minor violations of the assumption of normality, particularly in the presence of equal sample sizes, so was used to analyse mean PCC. The ANOVA was statistically significant, confirming that children’s PCC scores were influenced by their ages $F(3,76) = 9.12$, $p < 0.05$, $\eta^2 = 0.27$. However, this calculation must be considered in light of the heterogeneity of variances around the mean.

### Table IV. Phonotactic development: phonotactic structures mastered* by age group*

| Phonotactic structure | Syllables | Sample words | Gloss | Percentage correctly used by age group. | 3YO | 4YO | 5YO | 6YO |
|----------------------|-----------|--------------|-------|----------------------------------------|-----|-----|-----|-----|
| CVC                  | 1         | kar          | Car   | 100 100 100 100                       |     |     |     |     |
| CCVC                 | 1         | blikk        | Black | 100 100 100 100                       |     |     |     |     |
| CV CV                 | 2         | diwai        | Tree  | 100 100 100 100                       |     |     |     |     |
| CV CVC               | 2         | wasmr        | Wash  | 100 100 100 100                       |     |     |     |     |
| CV CVC CV            | 2         | kundu        | Drum  | 100 100 100 100                       |     |     |     |     |
| CV CCV               | 2         | janpla       | Young | 95 100 100 100                        |     |     |     |     |
| CV CCV CV            | 2         | tupla        | Two   | 75 100 100 90                         |     |     |     |     |
| CV CCV CV CV         | 3         | piendji      | PNG   | 90 90 100 95                         |     |     |     |     |
| CV CCV CV CV         | 3         | banana       | Banana| 95 100 100 100                       |     |     |     |     |
| CV CCV CV CV CV      | 3         | solwarar     | Sea   | 85 95 90 95                          |     |     |     |     |
| CV CCV CV CV CV CV   | 3         | kokonas      | Coconut| 100 100 100 100                  |     |     |     |     |
| VC V CVC             | 3         | onjon        | Onion | 95 95 100 100                       |     |     |     |     |
| CV CV CV CV CV CV    | 3         | pdfimin      | Child | 50 70 75 75                         |     |     |     |     |
| CV CV CV CV CV CV    | 3         | sskarapim    | Scrape| 55 75 65 80                         |     |     |     |     |
|                      |           |              |       | *Mastered* means a child used this phonotactic structure at least once. |     |     |     |     |
|                      |           |              |       | *Mastered* by an age group when 85% of the age group used |     |     |     |     |
|                      |           |              |       | the word shape. |     |     |     |     |

Figure 1. Range of ages of TP phoneme acquisition from Customary usage (50%) to Mastery (90%) (Sander 1972).
Post hoc analysis using Tukey’s HSD ($\alpha = .05$) revealed that the only significant differences between mean PCCs were between the 3YO group and each of the other age groups. Univariate analysis of ANOVA was used to calculate an omnibus measure of effect size ($g^2 = .27$). According to Cohen (1988) this is a large effect size for Cohen’s $F$. We can attribute 27% of the difference in PCC between age groups to age differences. Effect sizes for the three comparisons between the 3YO and 4YO groups ($D = 0.72$), 3YO and 5YO groups ($D = 0.84$), 3YO and 6YO groups ($D = 1.16$) ranged from medium to large. Comparisons not involving the 3YO group were not significant at the $p = .05$ level.

**Developmental phonological processes**

The developmental processes found in the children’s speech were examined for developmental changes and evidence of universal patterns. The processes found at least once were three syllable structure processes: vowel deletion, consonant deletion, and cluster reduction and twelve substitution processes: voicing or de-aspiration, stopping, dentalisation, palatisation, fricatisation, lateralisation, deaffrication, liquid confusion, glottal replacement, backing, fronting and de-voicing. Fewer processes were present in every age band when subjected to our criterion of five instances in 10% or more of the age band. Vowel deletion was a syllable structure process seen in members of the 3YO, 4YO and 5YO groups, but only at 10% in the 4YO group. Substitution processes were more frequent overall and were dominated by errors in voicing and aspiration. The next most frequent substitution processes were lateralisation (14), fricatisation (11), de-affrication (9), de-voicing (8) and liquid confusion (8). In TP, the liquid confusion manifests as an /l/ for /r/ substitution. Although the 3YO group had the most participants demonstrating processes (54), the 5YO group had more active categories of processes than any other group (11). The 6YO group had declined to a total of 10 instances including three of the largest process groups seen: fricatisation, de-voicing and voicing or aspiration.

**Discussion**

This project has provided preliminary data on TP phonological development in a sociolinguistically diverse population in the PNG highlands. Phonetic, phonotactic, phonemic and phonological process inventories all showed changes with age, as anticipated. The hypothesis that universal principles of language development would be seen in each of the measured inventories was not proved unequivocally. Universal features were seen, but details of the data showed language-specific aspects of phonological development. Within this multilingual group, the impact of their Melpa tokples and creolisation forces such as morphophonemic condensation and the impact of loan word phonological templates from the English lexifier were evident. Processes observed may have often been due to these factors.

**Phonetic development**

By the 3YO group, all manners of phones were represented. The phonetic inventories showed an increase in phones with each age group, but the inventory development was not linear, with some regressions. The most consistently present phones were continuant [w] and nasals [m, n] seen in all available
The early appearance of [dʒ], along with SIWI /f/, before any other fricative forms, in the 3YO and 4YO groups did not continue in all positions for the 5YO and 6YO groups. The older groups did however acquire consistent use of [s].

Although the flap [ɾ] was the most consistent form of the /ɾ/ phoneme the presence of the trill and English [t] in numbers under our criterion may have contributed to its lack of appearance in all available positions at any age group. It is our opinion that the use of the rhotic allophone of /ɾ/ was stylistic. Examination of the data showed that the younger children used a more even distribution of all three of the possible allophones of /ɾ/ used in this population, the flap, the trill, and the English approximant. English loanwords which were the targets for voiced consonants SFWF [v] ‘five, dive’ and [g] ‘flag’ were not produced by 75% of children either voiced or unvoiced in any age group but SIWW [v] was seen in 100% of participants once. This suggests that children had mastered [v] articulation but were not uniformly using it as a phoneme in all syllabic positions but rather allophonically as dictated by the influence of loanwords. It therefore may be of value in early studies of children acquiring multiple phonologies to choose the ‘once only’ criterion and examine instances smaller than 75% of an age group.

Universal features were seen in the strength of onset position plosives, the strength of the front continuants and the bilabial and alveolar nasals. A recent cross-linguistic survey of the results of monolingual developmental phonological research in 27 languages listed sounds mastered (90% criterion) by the end of the third year (McLeod & Crowe, 2018). These are: plosives [p, t, b, d, tʰ, k, kʰ, g], fricatives and affricates [f, v, ʃ], approximants [w, l, j] and nasals [m, n, n̑]. Our multilingual children, compared to this survey, are later with aspiration, which is not a TP feature, but appeared with the 5YO and 6YO groups. The TP phonotactic rule excluding final voiced consonants appears to be a feature that varies in our population with exposure to English and creole forms. The increase in aspiration in older children with more exposure to English may be due to a possible conflict between TP’s rule excluding voiced plosives and fricatives in coda syllable positions and their presence in English loanwords.

Phonotactic structures clearly showed development with age, with only more complex multisyllabic word structures such as /stkretpim/ (scrape) causing difficulty. The influence of creolisation forces was seen in the introduction of English phonetic templates, seen in most of the older children, through count nouns such as five /fiːv/ and three /triː/ for the usually longer TP forms /fiapela/ and /tripela/. A preference for CV and CCV structures was overturned by the English loanword ‘onion’ which has three syllables in TP as /onijon/ (VC V CVC), and which was mastered by all age groups. Some apparent errors in phonotactics such as /stkretpim/ for /stkarapim/ (scrape) may have been due to the creolisation process of morphophonemic condensation (Smith, 2002). Others like /skreipm/ for ‘scrape’ showed the influence of the English form. Thus, creolisation clouded the developmental picture and contributed to language-specific features in this population.

**Phonological**

The Phonological inventories of the 3YO age group showed mastery (90%) by 39 months of /d, k, f, dʒ, w, m, n/. When all syllabic positions of consonants correct were combined, these early phonemes also included /p, b, t/. By the 6YO group, however, all but /g/, /l/ and /ɾ/ were seen according to the mastery criteria (90%) in all positions.

Universal features were seen in the early acquisition of /d/, /k/, /m/, /n/ and /ɾ/ (McLeod & Crowe, 2018). The late acquisition of /ɾ/, which was not mastered even by the 6YO group, is also a universal feature. Fricative /ʃ/ and affricate /dʒ/ did start earlier in inventories and total phonemes correct but took longer to reach 90% than plosives and approximants. There were reversals at 90% with the affricate /dʒ/, which was mastered by the 3YO in all positions, but absent in SIWW for the 4YO, 5YO and 6YO groups. Once the velar nasal was added to the bilabial and alveolar nasals at the 4YO group they remained. Melpa speakers’ wide use of the fricative manner as well as the impact of English word templates such as /dɪm/, ‘ginger’, adopted by creole speakers, may have influenced this difference.

The failure of some sounds to be used in coda positions may be the result of an interaction between faithfulness and markedness constraints. TP rules do not allow voiced plosives in coda positions, but the unvoiced plosives such as /t/, which was never seen in more than 75% of an age group in SFWF, were sometimes voiced in words such as /klaut/, ‘cloud’ and /rot/, ‘road’. Surprisingly, both the phonetic and phonological inventories showed earlier phonological mastery of affricate /dʒ/ by the 3YO age group along with SIWI fricative /ʃ/, earlier than /s/.

The analysis of PCC by the ANOVA also confirmed the development with age. The wide range and overlapping confidence intervals meant that the difference between the 3YO group’s mean PCC and the other age groups was the only statistically significant difference. This is possibly a reflection of the sociolinguistic diversity within each age group, which is difficult to control.

**Phonological processes**

The inventories of processes were better able to reveal possible language-specific Tokples influences during phonological development. Processes seen in smaller
numbers, such as stopping of fricatives, are universally familiar. Nevertheless, the larger groups of developmental processes seen in this population show the language-specific influences of TP and Melpa phonology or the ongoing creolisation process in this population. The high level of variation in voicing and aspiration options, seen in the phonetic inventories and also in the voicing and de-aspiration processes, is a possible reflection of the children's conflicting phonologies. The influence of Melpa and TP preference for unaspirated and coda unvoiced plosives, conflicts with the English use of both aspiration and coda-voiced plosives.

The frequent substitution of [l] for fricatives and laterals – 35% in the 3YO group, with declining numbers in the later age groups – showed up in the developmental process analysis, where fricatisation and lateralisation featured strongly. Even though 18 out of 20 3YO children used [l], there was only one child who was unable to articulate the target [s], [l] or [ð] replaced by [l]. There is a possible link between [l] and the Melpa phonetic inventory. Fricatisation is a frequent variant of Melpa laterals in dental, alveolar and velar positions, particularly in SFWF where laterals de-voice and become lateral fricatives (Ladefoged, 2001). It was our opinion that the one child unable to articulate [s], [l] or [ð], was also the only one with an articulatory disorder. The other children were possibly still differentiating their realisations of phonemic targets for each of their three languages.

Limitations

This was a preliminary study, and there is much more to be done in studies of the TP phonological development of younger children and other Tokples. In addition, this study has hinted at the influence of language on phonological development. Important other elements such as comparison between typical and atypical development, have not been possible at this stage. Studies of larger cohorts and younger age bands, possibly at six-month intervals, may clarify the earliest ages of articulatory and phonological acquisition.

A potential confounder is that the participants’ language inputs and output opportunities are, of necessity, extremely variable in a multilingual PNG population, even when there is only one Tokples in the sociolinguistic mix. Specific research is required to identify accurate language use surveys which can be conducted in culturally appropriate and effective ways. SLP would benefit from the partnership with ethnologists and anthropologists to measure and clarify language used in each sociolinguistic fragment.

Vocabulary studies are needed for every sociolect surveyed. This would maximise the possible readily eligible word samples, allowing multiple opportunities in a variety of syllabic positions for each of the target phonemes. Further study is also required to identify loanwords and words which have been changed by morphophonemic condensation, and which have begun to enter mainstream TP vocabulary. These may not be regarded as ‘correct’ but are nevertheless present in typical TP usage, impacting phonology and phonotactics.

Conclusions

In summary, this study of TP phonological acquisition reinforces many universal patterns seen in phonological development in other languages. Language-specific features and diversity within age groups appear to reflect the influence of sociolinguistic diversity and the impact of both the Tokples Melpa phonology and creolisation processes operating in this population. When clinical decisions are being made about speech development, it will be crucial for consideration to be given to all the linguistic influences impacting children in this and similar populations.

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