

# Pacifiers, Thumb Sucking, Breastfeeding, and Bottle Use: Oral Sucking Habits of Children with and without Phonological Impairment

Elise Baker<sup>a</sup> Sarah Masso<sup>a, b</sup> Sharynne McLeod<sup>b</sup> Yvonne Wren<sup>c, d</sup>

<sup>a</sup>Discipline of Speech Pathology, The University of Sydney, Sydney, NSW, Australia; <sup>b</sup>School of Teacher Education, Charles Sturt University, Bathurst, NSW, Australia; <sup>c</sup>Bristol Speech and Language Therapy Research Unit, North Bristol NHS Trust, Bristol, UK; <sup>d</sup>University of Bristol, Bristol, UK

## Keywords

Pacifiers · Breastfeeding · Thumb sucking · Speech sound disorders · Children

## Abstract

**Aims:** The aim of this study was to describe the nutritive and non-nutritive oral sucking habits (breastfeeding, bottle use, pacifier/dummy/soother use, thumb/finger sucking) of preschoolers with and without phonological impairment, and to determine whether oral sucking habits are associated with the presence and severity of phonological impairment.

**Methods:** We conducted a cross-sectional study of 199 Australian English-speaking preschoolers with and without phonological impairment. Preschoolers' speech was directly assessed, and parents/caregivers completed a questionnaire. Chi-square ( $\chi^2$ ) tests were used to examine relationships between oral sucking habits and the presence and severity of phonological impairment. **Results:** Based on caregiver reports, 79.9% of participants had been breastfed (33.3% for >12 months), 58.3% had used a pacifier (74.2% for  $\geq$ 12 months), 83.9% had used a bottle (73.4% for >12 months), and 15.1% sucked their thumb/fingers. There was no association between a history of oral sucking and the presence

and severity of phonological impairment. **Conclusion:** The majority of preschoolers had been breastfed and bottle-fed, and more than half had used a pacifier. The findings support an understanding that phonological impairment is not associated with a history of nutritive and non-nutritive sucking habits. Research is needed to examine the association between oral sucking habits and other types of speech sound disorders.

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## Introduction

During the early years of speech development, children may engage in nutritive (breast/bottle-feeding) and non-nutritive oral sucking (pacifier/dummy/soother use and digit sucking). Breastfeeding is considered the most ideal form of nutritive sucking because of the nutritional and immunological benefits in breast milk [1]. Breastfeeding for longer than 9 months has also been identified as a protective factor against speech and language problems in children [2]. By contrast, bottle-feeding and non-nutritive sucking, particularly pacifier use, are common practices associated with a range of advantages and dis-

advantages. For instance, pacifier use has been associated with accelerated maturation of oral sucking in preterm infants [3, 4], reduction in infants' pain during medical procedures [5], reduction in a child's risk of developing allergies [6], and a reduction in the risk of sudden infant death syndrome [7]; however, evidence from randomised controlled trials is lacking to unequivocally support or refute the effect of use of pacifiers for risk of sudden infant death syndrome [8]. By contrast, pacifier use during infancy has been associated with increased occurrence of gastrointestinal infections, diarrhoea, and oral candida [9, 10], an increased risk of ear infections and malocclusion [11–13], a case of bowel obstruction [14], poorer emotional competence in boys and young adult males [15], and shorter duration of breastfeeding [16]; however, other research has not supported this latter association [17].

Speech problems in children, broadly referred to as speech sound disorders (SSD), can be divided into five different types [18] including phonological impairment (PI) (i.e., a cognitive-linguistic difficulty associated with pattern-based speech errors), inconsistent speech (phonological) disorder (i.e., difficulty selecting and sequencing speech sounds resulting in the same word being pronounced in different ways), articulation impairment (i.e., difficulty with the physical articulation of specific speech sounds, particularly rhotics and sibilants), childhood apraxia of speech (CAS) (i.e., motor speech disorder associated with difficulty planning and programming speech movement sequences), and childhood dysarthria (i.e., motor speech disorder associated with impaired sensorimotor control processes needed to program and execute muscle movements needed for speech) [19]. Of these five types, PI is the most common [20] and is the focus of the current investigation. The pattern-based errors that characterise PI may be delayed for a child's age (i.e., an error pattern evident in young children) or disordered (i.e., atypical error patterns not routinely evident in typically developing children's speech).

Across the relatively small body of research examining the relationship between nutritive/ non-nutritive sucking and PI in children, results have been equivocal. Barbosa et al. [21] conducted a study of 128 Patagonian children between the ages of 37 and 70 months with below normal (<1 standard deviation) and normal or above normal speech production skills, based on the occurrence of phonological processes using a validated single-word picture naming task. It was unclear if errors involving /s/, particularly interdental substitutions, were considered phonological error patterns or articulation errors. It was also

not reported whether any of the children had received intervention from a speech-language pathologist. Given that the broad term "speech disorder" was used rather than PI, and that exclusion criteria were not mentioned, it was unclear if any of the participants had articulation or motor speech difficulties rather than or in addition to PI characterised by the presence of age-inappropriate phonological processes. Barbosa et al. [21] reported that among the 128 participants 96.5% had been breastfed (with 30% breastfed for more than 12 months), 41.7% had used or were still using a pacifier, and 18.3% had engaged in finger sucking. The children who were reported to have sucked their fingers and/or have prolonged pacifier use (i.e., used a pacifier for more than 36 months) were 3 times more likely to score below the normal range on the speech assessment measuring occurrence of phonological processes. Whether or not this performance equated to a diagnosis of PI-only was unclear. By contrast, the children who did not start using a bottle until the age of 9 months were more likely to score within the normal range on the speech assessment.

In a sample of 65 English-speaking children with SSD and 48 children with typically developing speech, Fox et al. [22] examined risk factors (including oral sucking history) associated with SSD. Of the 65 children with SSD, 56 had PI (41 = delayed; 15 = disordered), and 9 children had inconsistent speech (phonological) disorder. Children with articulation impairment were excluded. One child with phonological difficulties had mild symptoms of CAS; however, the authors noted that the symptoms did not warrant the diagnosis of CAS. Children with "organic motor disorder" were also excluded, suggesting that children with childhood dysarthria associated with organic causes such as cerebral palsy were excluded. However, it was unclear if any of the children with PI also had symptoms associated with childhood dysarthria or had PI-only. Oral sucking habits, including duration of habit, were based on parent reports. Of note, Fox et al. [22] grouped pacifier use at night only with no pacifier use. If a bottle or pacifier was used, or thumb sucking present, duration of use was classified as either greater or less than 24 months. The authors reported that their cohort of children with PI were more likely to have used a pacifier, a bottle as a pacifier or sucked their thumb for more than 24 months; however, only the use of a bottle as a pacifier (i.e., non-nutritive sucking on a bottle outside feeding times) was significantly different between the children with PI compared to their control group. The relationship between the duration of bottle use and severity of PI, in addition to nutritive sucking and PI, was not considered.

In contrast, Shotts et al. [23] reported no difference in performance on a speech production test for three groups of children (mean age = 45.5 months): group 1 included 30 children with a history of no or limited pacifier use, group 2 consisted of 16 children who had routinely used a pacifier for up to 15 months, and group 3 was composed of 22 children who used a pacifier beyond 18 months of age. Although the mean standard scores for speech production accuracy (based on the Goldman-Fristoe Test of Articulation – Second Edition [24]) were in the normal range for each group (group 1: 100.47, group 2: 103.31, and group 3: 105.59), it was unknown how many children in each group may have had SSD, and whether any of these children had PI, given that the minimum standard scores in groups 1, 2, and 3 were 55, 67, and 67, respectively. Standard scores between 85 and 115 are considered within the normal range as they fall within 1 standard deviation of the standardised mean of 100. It was also unknown whether any of the children across the groups had a history of speech-language pathology intervention, as this was not reported. Thus, it was unclear if children with PI would have differed in their history of pacifier use compared to children without PI.

Collectively, the findings of the limited research on oral sucking habits and PI to date are mixed. Although some findings suggest a negative association between prolonged non-nutritive sucking and speech accuracy [21, 22], and protective benefits of prolonged nutritive sucking against PI [21], explanations for these possible associations are uncertain. As Tomblin et al. [25, p. 339] suggest for language impairment, it is possible that the “critical nutrients, immunologic protection, or early maternal language exposures during” breastfeeding may serve as protective factors against PI. Conversely, the presence of a pacifier may increase a child’s risk for PI, given the increased risk of factors that have been associated with both pacifier use and children’s speech acquisition, such as ear infections [2]. These suggestions are of course speculative. Synthesis of the limited research is also constrained due to methodological differences and/or insufficient details. For example, apart from Fox et al. [22], criteria for including/excluding participants with PI have been unclear. Definitions of pacifier use and prolonged use have varied. Moreover, the relationship between the severity of PI and duration of oral sucking habits has not been considered.

Pacifier use is a controversial practice. Beyond empirical research, parenting websites, blogs, and social media sites include opinions and ideas about the advantages and disadvantages of non-nutritive sucking [26]. For parents to

make an informed decision about nutritive and non-nutritive sucking, including the potential for prolonged pacifier use to be associated with PI, more research is needed.

The purpose of this study was (1) to examine the history of nutritive and non-nutritive sucking habits of children with and without PI, and (2) to determine whether prolonged breastfeeding might be advantageous to, and non-nutritive sucking might be detrimental to, developing clear, intelligible speech. The specific research questions of interest included:

1. What proportion of Australian preschoolers, with and without PI, have engaged in breastfeeding, bottle-feeding, pacifier sucking, and thumb/finger sucking?
2. What is the duration of breastfeeding, bottle-feeding, pacifier, and thumb/finger sucking in Australian preschoolers, with and without PI?
3. Is there an association between (a) breastfeeding duration and presence/severity of PI, and (b) pacifier use and presence/severity of PI?

In light of the extant literature, it was predicted that significantly more children without PI would have been breastfed compared to children with PI, and that for the children with PI, longer breastfeeding duration would be associated with less severe PI. By contrast, significantly more children without PI would not have used a pacifier, and of the children with PI, longer pacifier use would be associated with more severe PI.

## Materials and Method

Charles Sturt University Ethics Committee evaluated this research and granted ethics approval (Approval No. 2013/070) in addition to the NSW Department of Education and Communities State Education Research Applications Process (SERAP) (Approval No. 2013267). Informed consent was obtained from all parents/caregivers of children involved in the study. Assent was also obtained from each child who participated in the study.

### Participants

#### Recruitment of Participants

Participants were recruited as a part of the Sound Start Study, a 3-year randomised controlled trial for children with PI [27]. The data for the current study were collected before intervention started. Parents of 1,205 preschool-age children at early childhood centres in Sydney (NSW, Australia) completed a screening questionnaire that included the Parent Evaluation of Developmental Status [28]. A total of 327 (27.1%) parents/carers expressed concerns about their child’s speech. Children were not eligible to participate if their parents/carers were not concerned about their speech, or if they had a diagnosed developmental delay, hearing loss, cleft lip and/or palate, an articulation impairment only (e.g., lisp), CAS, or childhood dysarthria previously diagnosed by a speech-language pathologist. All children were reported by their parents to speak English as well as

**Table 1.** Nutritive and non-nutritive sucking history of children with and without phonological impairment ( $n = 199$ )

Sucking history	No identified impairment ( $n = 65$ )	Phonological impairment only ( $n = 134$ )	Total ( $N = 199$ )
<i>Breastfed</i>			
No	7 (10.8)	32 (23.9)	39 (19.6)
Not reported <sup>a</sup>	0 (0.0)	1 (0.7)	1 (0.5)
Yes	<b>58 (89.2)</b>	<b>101 (75.4)</b>	<b>159 (79.9)</b>
Time breastfed <sup>b</sup>			
Not reported <sup>a</sup>	1 (1.7)	2 (2.0)	3 (1.9)
<6 months	24 (41.4)	53 (52.5)	77 (48.4)
6–12 months	11 (19.0)	15 (14.9)	26 (16.4)
>12 months	22 (37.9)	31 (30.7)	53 (33.3)
<i>Bottle-fed</i>			
No	11 (16.9)	15 (11.2)	26 (13.1)
Not reported <sup>a</sup>	0 (0.0)	6 (4.5)	6 (3.0)
Yes	<b>54 (83.1)</b>	<b>113 (84.3)</b>	<b>167 (83.9)</b>
Time bottle-fed <sup>b</sup>			
Not reported <sup>a</sup>	1 (1.9)	4 (3.5)	5 (2.5)
<6 months	5 (9.3)	4 (3.5)	9 (4.5)
6–12 months	3 (5.6)	4 (3.5)	7 (3.5)
>12 months	45 (83.3)	101 (89.4)	146 (73.4)
<i>Use of pacifier</i>			
No	27 (41.5)	50 (37.3)	77 (38.7)
Not reported <sup>a</sup>	2 (3.1)	4 (3.1)	6 (3.0)
Yes	<b>36 (55.4)</b>	<b>80 (59.7)</b>	<b>116 (58.3)</b>
Time with pacifier <sup>b</sup>			
Not reported <sup>a</sup>	1 (2.8)	3 (3.8)	4 (3.4)
1–11 months	7 (19.4)	19 (23.8)	26 (22.4)
12–23 months	13 (36.1)	14 (17.5)	27 (23.3)
24–35 months	7 (19.4)	25 (31.3)	32 (27.6)
36 months or more	8 (22.2)	19 (23.8)	27 (23.3)
<i>Thumb/finger sucking</i>			
No	46 (70.8)	107 (79.9)	153 (76.9)
Not reported <sup>a</sup>	7 (10.8)	9 (6.7)	16 (8.0)
Yes	<b>12 (18.5)</b>	<b>18 (13.4)</b>	<b>30 (15.1)</b>
Time thumb/finger sucking <sup>b</sup>			
Not reported <sup>a</sup>	0 (0.0)	1 (5.6)	1 (3.3)
<6 months	2 (16.7)	2 (11.1)	4 (13.3)
6–12 months	0 (0.0)	0 (0.0)	0 (0.0)
>12 months	10 (83.3)	15 (83.3)	25 (83.3)

Values are  $n$  (%). The participants represent 90.5% of the total number of children who were assessed during stage 2 of the Sound Start Study ( $n = 199$ ). These data refer to children whose caregiver/s returned the stage 2 questionnaire and children who were identified as having a phonological impairment based on their performance on the DEAP phonology assessment (phonological impairment only) and those who did not present with speech sound disorder on this same test (no identified impairment). No data were available for those children whose caregiver/s did not complete the questionnaire.

<sup>a</sup> “Not reported” includes children whose caregiver/s indicated that they did not know whether the child was exposed to this sucking behaviour or that they missed this question on the questionnaire. <sup>b</sup> Data on time use are based on the children whose caregiver/s reported the duration of sucking behaviour.

or better than any other languages spoken at home. A total of 275 children were eligible to receive a speech and language screening assessment as a part of the Sound Start Study. At the time of the screening assessment, the parents of these children were asked to complete a comprehensive questionnaire that included items on oral sucking habits; 249 (90.5%) were returned. Children were further excluded from participation in the current study based on their performance on the Diagnostic Evaluation of Articulation and Phonology (DEAP) phonology assessment [29]. Based on children's performance on the DEAP, four groups of children were identified: (1) *No identified impairment* (NI): obtained DEAP standard score of 7 or more based on percentage of consonants correct (PCC); (2) *Phonological impairment only* (PI-only): obtained DEAP standard score of 6 or less with one or more age-inappropriate common phonological error patterns present including cluster reduction, final consonant deletion, gliding, velar fronting, stopping of fricatives and/or affricates, context sensitive voicing, and deaffrication, but no evidence of motor speech involvement; (3) *Phonological impairment plus lisp* (PI+Lisp): met criteria for a PI but also demonstrated an interdental lisp; and (4) *Speech sound disorder-other* (SSD-other): obtained DEAP standard score of 6 or less and demonstrated none of the listed common phonological error patterns. Due to the interest in the relationship between PI and history of nutritional and non-nutritional sucking behaviours, children who did not meet the criteria for PI-only (i.e., children in the PI+Lisp [ $n = 13$ ] and SSD-other [ $n = 37$ ]) were excluded from the current study. Only children with NI ( $n = 65$ ) and children with PI-only ( $n = 134$ ) were included in the current study. The total samples size for this investigation was therefore 199 children.

#### Participant Characteristics

Participants for this study included more male ( $n = 121$ ) than female ( $n = 78$ ) children, aged between 48 and 66 months (mean = 54.07, SD = 4.11) – a typical ratio for children with PI. Participants demonstrated varied performance on the DEAP [29] with a mean PCC of 72.52 (range = 29.1–98.6, SD = 15.3). Oromuscular structure and function testing [30] indicated that 160 (80.4%) had structure within the typical range but only 32 (16.1%) had function within the typical range. Structural problems were minor (e.g., missing tooth); no participant had a major structural problem impacting speech (e.g., ankyloglossia, atrophy of the tongue, cleft palate). Function problems were associated with poor speech production accuracy, rather than non-speech function. Hearing was assessed via pure-tone audiometry for 186 (93.5%) of the participants; 169 (84.9%) passed the hearing screening at 40 dB and 17 (8.5%) did not pass and were referred for follow-up hearing assessment. Thirteen (6.5%) participants did not complete the hearing screening due to being unable to complete the task ( $n = 2$ , 1.0%) or the task being missed in the assessment battery ( $n = 11$ , 5.5%). No child demonstrated overt signs of dysarthria or CAS (verbal and/or oral). Questionnaires were completed by 176 (88.4%) mothers, 19 (9.5%) fathers, and 4 (2.0%) other family members or caregivers.

#### Procedure

Eligible children were directly assessed by one of two speech-language pathologists using a range of assessments including the DEAP [29], the Robbins and Klee oromuscular structure and function protocol [30], and a hearing screening assessment. Participants' parents completed the comprehensive questionnaire that included items related to oral sucking habits.

#### Reliability

Intra- and inter-judge transcription reliability of the DEAP phonology assessments were completed by two speech-language pathologists on 10% of the participant samples, obtaining agreement scores of 89.4 and 88.7%, respectively, indicating acceptable agreement for broad transcription [31].

#### Analysis

Descriptive statistics were used to determine the presence and duration of nutritive and non-nutritive sucking behaviours. Children with PI were identified based on performance on the DEAP phonology assessment as measured by the PCC score and associated standard score plus the presence or absence of the common phonological error patterns that could be targeted with the computer-based program Phoneme Factory [32]. A  $\chi^2$  test of independence was used to examine a possible association between the duration of participants' oral sucking habits and the presence and severity of PI-only.

## Results

Of the 199 participants who completed the DEAP phonology assessment, 65 (32.7%) scored within normal limits. The remaining participants ( $n = 134$ , 67.3%) were identified to have PI-only based on their performance on the DEAP phonology assessment.

#### Description of Oral Sucking Habits

Of the whole group, 159 (79.9%) were breastfed, 167 (83.9%) were bottle-fed, 116 (58.3%) used pacifiers, and 30 (15.1%) engaged in thumb/finger sucking. Table 1 lists the duration of nutritive/non-nutritive sucking for the children in each group and the extent of missing data: breastfeeding ( $n = 1$ , 0.5%), bottle use ( $n = 6$ , 3.0%), pacifier use ( $n = 6$ , 3.0%), and thumb/finger sucking ( $n = 16$ , 8.0%).

The combined sucking history was considered in terms of breastfeeding and pacifier use. Of the children with complete data ( $n = 186$ ), 82 (44.1%) were breastfed and used a pacifier, 28 (15.1%) only used a pacifier, 66 (35.5%) were breastfed but did not use a pacifier, and only 10 (5.4%) children did not use a pacifier and were not breastfed. Table 2 describes the combined sucking history, considering breastfeeding and pacifier use, for the children in each group.

#### Oral Sucking Habits and the Presence and Severity of PI

The duration of oral sucking habits (breastfeeding and pacifier use) was categorised into three groups: no use, minimal use (<12 months), and prolonged use (>12 months), for the participants in each group (see Table 3).

**Table 2.** Combined sucking history (breastfeeding and pacifier use) of children with and without phonological impairment ( $n = 186$ )

Sucking history	No identified impairment ( $n = 61$ )	Phonological impairment only ( $n = 125$ )	Total ( $N = 186$ )
Breastfed only (no pacifier used)	24 (39.3)	42 (33.6)	66 (35.5)
Not breastfed (no pacifier used)	2 (3.3)	8 (6.4)	10 (5.4)
Breastfed and pacifier used	30 (49.2)	52 (41.6)	82 (44.1)
Pacifier only (not breastfed)	5 (8.2)	23 (18.4)	28 (15.1)

Values are  $n$  (%). Valid percentages reported.

**Table 3.** Nutritive and non-nutritive sucking history of children with no identified impairment and those with a phonological impairment only

Sucking behaviour and duration	No identified impairment	Phonological impairment only	Total
<i>Breastfed (<math>n = 195</math>)</i>			
No	7 (3.6)	32 (16.4)	39 (20.0)
<12 months	35 (17.9)	68 (34.9)	103 (52.8)
>12 months	22 (11.3)	31 (15.9)	53 (27.2)
Total	64 (32.8)	131 (67.2)	195 (100)
<i>Pacifier use (<math>n = 189</math>)</i>			
No	27 (14.3)	50 (26.5)	77 (40.7)
<12 months	7 (3.7)	19 (10.1)	26 (13.8)
>12 months	28 (14.8)	58 (30.7)	86 (45.5)
Total	62 (32.8)	127 (67.2)	189 (100)

Values are  $n$  (%).

An investigation of the association between the duration of oral sucking habits and the presence of PI was conducted by comparing participants classified as NI ( $n = 65$ ) with those with PI-only ( $n = 134$ ). An investigation of the association between the duration of oral sucking habits (nutritive and non-nutritive) and the severity of PI was conducted by comparing participants based on a standard score of  $\leq 3$  (severe) or a standard score of 4, 5, or 6 (mild/moderate) from the DEAP manual [29]. Figure 1 presents the mean PCC for participants in each of the nutritive (Fig. 1a) and non-nutritive (Fig. 1b) duration categories.

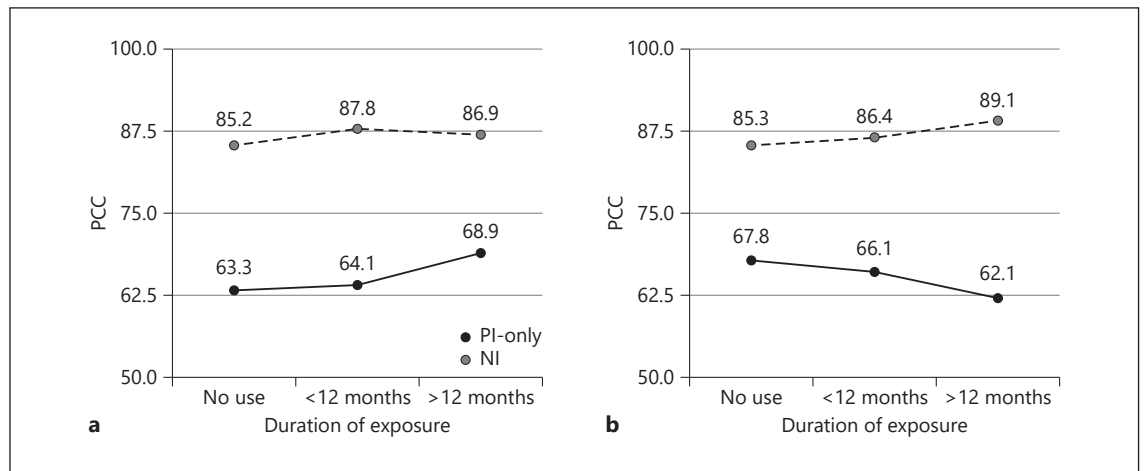
#### Nutritive Sucking

A non-significant interaction was found between the duration of breastfeeding and the presence of a PI,  $\chi^2(2, n = 195) = 5.79, p = 0.055$  (see Table 3), and the severity

of participants' PI,  $\chi^2(2, n = 131) = 1.85, p = 0.396$  (see Table 4). Although the relationship was non-significant, there was a trend that participants with PI who breastfed for longer demonstrated, on average, a higher mean PCC than those who were not breastfed for as long (see Fig. 1a).

#### Non-Nutritive Sucking

A non-significant interaction was found between the duration of pacifier use and the presence of PI,  $\chi^2(2, n = 189) = 0.589, p = 0.745$  (see Table 3), and the severity of participants' PI,  $\chi^2(2, n = 127) = 4.48, p = 0.106$  (see Table 4). Although the relationship was non-significant, there was a trend that participants with PI who used a pacifier for longer demonstrated, on average, a lower mean PCC than those who did not use a pacifier for as long (see Fig. 1b).



**Fig. 1.** Mean percentage of consonants correct (PCC) demonstrated by participants who were reported to have exposure to breastfeeding (a) and pacifier use (b): no use, minimal use (<12 months) use, and prolonged use (>12 months). PI-only, phonological impairment only; NI, no identified impairment.

### Combined Nutritive and Non-Nutritive Sucking

Participants' combined sucking exposure was classified according to the presence or absence of two sucking behaviours, breastfeeding and pacifier use: (1) breastfeeding only (total  $n = 66$ , 35.5% [NI:  $n = 24$ , 39.3%; PI:  $n = 42$ , 33.6%]), (2) pacifier use only (total  $n = 28$ , 15.1% [NI:  $n = 5$ , 8.2%; PI:  $n = 23$ , 18.4%]), (3) breastfeeding and pacifier use (total  $n = 82$ , 44.1% [NI:  $n = 30$ , 49.2%; PI:  $n = 52$ , 41.6%]), and (4) no exposure to breastfeeding or pacifier use (total  $n = 10$ , 5.4% [NI:  $n = 2$ , 3.3%; PI:  $n = 8$ , 6.4%]) (see Table 2). A non-significant interaction was found between the combination of exposure to different sucking behaviours (as described in Table 2) and the presence of PI,  $\chi^2(3, n = 186) = 4.496, p = 0.213$ , and the severity of participants' PI,  $\chi^2(3, n = 125) = 2.028, p = 0.567$ .

### Discussion

This study examined the nutritive and non-nutritive sucking habits of Australian preschoolers with and without PI. Breastfeeding, bottle use, and pacifier use were common among both groups. Thumb/finger sucking was uncommon. Contrary to our predictions, nutritive and non-nutritive sucking habits were not associated with the presence or severity of PI.

The finding that the majority of preschoolers in our study were breastfed (79.9%), with one third (33.3%) of those children breastfed for more than 12 months, was commensurate with Barbosa et al. [21], who reported that

**Table 4.** Nutritive and non-nutritive sucking history of children with phonological impairment of two different severity levels: severe and mild-moderate

Sucking behaviour and duration	Phonological impairment		Total
	severe	mild-moderate	
<i>Breastfed (n = 131)</i>			
No	27 (20.6)	5 (3.8)	32 (24.4)
<12 months	50 (38.2)	18 (13.7)	68 (51.9)
>12 months	22 (16.8)	9 (6.9)	31 (23.7)
Total	99 (75.6)	32 (24.4)	131 (100)
<i>Pacifier use (n = 127)</i>			
No	36 (28.3)	14 (11.01)	50 (39.4)
<12 months	12 (9.4)	7 (5.5)	19 (15.0)
>12 months	49 (39.6)	9 (7.1)	58 (45.7)
Total	97 (76.4)	30 (23.6)	127 (100)

Values are  $n$  (%). Severity levels: severe, DEAP standard score <3; mild-moderate, DEAP standard score 4–6.

96.5% of their participants had been breastfed, and 30.5% were breastfed for more than 12 months. The similar proportions of preschoolers with (84.3%) and without PI (83.1%) who had used a bottle were somewhat lower than Patagonian preschoolers described by Barbosa et al. [21] (94.5%); however, like Barbosa et al., the majority of preschoolers who used a bottle continued to do so beyond the age of 12 months. Recall that Fox et al. [22] reported

that compared to a control group of children without PI, more children with PI used a bottle as a pacifier. Comparison of their findings with the current study is limited, because a question about the use of a bottle as a pacifier (i.e., sucking on a bottle excluding feeding times) was not included in our questionnaire. This specific issue could be considered in future research.

Compared to previous research, the similar proportions of preschoolers with (59.7%) and without PI (55.4%) who used a pacifier was higher than the rate of Patagonian preschoolers described by Barbosa et al. [21] (42%). The findings from the current study were, however, lower than previous research of first-time mothers in Australia (79%) [33], but higher than the global average (51%) and similar to cities in Northern Europe (Vienna 55.5%; Dublin 61%) [34]. The usage rate was also considerably higher than that in some Asian countries, e.g., Japan, (12.5%) and New Zealand (Dunedin, 14%) [34]. In light of the diverse usage rates across countries, further insight into the issue could be gained by comparing the prevalence and severity of PI with the children's country of birth and history of oral sucking habits.

Compared with other types of nutritive and non-nutritive sucking, thumb/finger sucking was less common, at an overall rate of 15.1%, similar to that reported by Littlefield [35] of 17% for English children published 60 years ago, and Moimaz et al. [36] of 15% for 12-month-old children in Brazil. Thumb/finger sucking has been associated with an increased risk of open bite and overjet [36], which has in turn been associated with speech errors, particularly on /s, t/ [37]. It would therefore be valuable for future research to investigate the occlusion of children with PI and their production and error types for /s, t/ compared with children with other types of SSD, particularly articulation impairment characterised by distortion errors on /s/ such as an interdental lisp.

In contrast to previous research, we did not find an association between the duration of children's oral sucking habits and the presence or severity of PI. One explanation for this finding is that we specifically selected children with PI-only. PI is presumed to be a cognitive-linguistic problem involving a difficulty abstracting rules about the phonological system, and creating abstract phonological representation of speech rather than an articulation difficulty. As such, it is reasonable to suggest that non-nutritive sucking habits would be unrelated. By contrast, the finding that breastfeeding (including prolonged breastfeeding beyond 12 months) did not differentiate children with and without PI, or children with different severities of PI, differs from previous research [2] and raises ques-

tions about the potential influence of breastfeeding on PI in children.

This study is not without limitations. We used a selected sample rather than a representative population sample. The children included in our study were identified based on parents' reports of concern for their children's speech. Using direct assessment by speech-language pathologists, 134 children had PI and 65 children had NI. Future research could compare the history of nutritive and non-nutritive sucking habits of children whose parents have no concerns about their child's speech and language development with children who have a diagnosed PI. It could also be helpful to gather more detail about the nature of both nutritive and non-nutritive sucking habits, such as the amount of daily use of a pacifier or thumb sucking over time (e.g., pacifier used for sleep only vs. used during waking hours for more than or less than 12 months).

The impact of nutritive and non-nutritive sucking habits on children's speech development has been contentious, not only among speech-language pathologists but also among other health professionals and parents. This contention can be partially attributed to the fact that prior literature examining the relationship between oral sucking habits and SSD has not clearly specified the participants' type of SSD. The findings from this study would suggest that pacifier use is not associated with the presence of PI in young children, or with the severity of PI. Future research is needed to determine whether nutritive and non-nutritive sucking habits play a role in the presence and severity of other types of SSD in children.

### Acknowledgements

This research was supported by Australian Research Council Discovery grant DP130102545. The authors thank Jane McCormack, Susan Roulstone, and Kathryn Crowe for their contribution to this research.

### Disclosure Statement

The authors declare that they have no conflicts of interest.



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