Service delivery and intervention intensity for phonology-based speech sound disorders

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Abstract

Background: When planning evidence-based intervention services for children with phonology-based speech sound disorders (SSD), speech and language therapists (SLTs) need to integrate research evidence regarding service delivery and intervention intensity within their clinical practice. However, relatively little is known about the optimal intensity of phonological interventions, and whether SLTs' services align with the research evidence.

Aims: The aims of this paper are twofold. First, to review external evidence (that is, empirical research evidence external to day-to-day clinical practice) regarding service delivery and intervention intensity for phonological interventions. Second, to investigate SLTs' clinical practice with children with phonology-based SSD in Australia, focussing on service delivery and intensity. By considering these two complementary sources of evidence, SLTs and researchers will be better placed to understand the state of the external evidence regarding the delivery of phonological interventions and appreciate the challenges facing SLTs in providing evidence-based services.

Methods: Two studies are presented. The first is a review of phonological intervention research published between 1979 and 2016. Details regarding service delivery and intervention intensity were extracted from the 199 papers that met inclusion criteria identified through a systematic search. The second study was an online survey of 288 SLTs working in Australia, focused on the service delivery and intensity of intervention provided in clinical practice.

Main contributions: There is a gap between the external evidence regarding service delivery and intervention intensity and the internal evidence from clinical practice. Most published intervention research has reported to provide intervention 2–3 times per week in individual sessions delivered by an SLT in a university clinic, in sessions lasting 30–60 minutes comprising

100 production trials. SLTs reported providing services at intensities below that found in the literature. Further, they reported workplace, client, and clinician factors that influenced the intensity of intervention they were able to provide to children with phonology-based SSD.

Conclusions: Insufficient detail in the reporting of intervention intensity within published research coupled with service delivery constraints may affect the implementation of empirical evidence into everyday clinical practice. Research investigating innovative solutions to service delivery challenges is needed to provide SLTs with evidence that is relevant and feasible for clinical practice.

What this paper adds

What is already known on this subject? A previous review by Baker & McLeod (2011) provided a valuable synthesis of phonological intervention research published between 1979 and 2009. However, this review did not consider the fundamental issue of dose, nor the barriers facing SLTs in delivering evidence-based intervention services. Anecdotal evidence suggests that SLTs are providing insufficient services to children with phonology-based SSD, but minimal empirical research investigating this is available.

What this paper adds? This paper provides a detailed and updated synthesis of the extant literature for phonological intervention, with a particular focus on service delivery and intervention intensity. By comparing empirical evidence with the evidence gained through a survey of clinical practice, insights about the challenges of implementing research into clinical practice are provided.

Clinical implications of this study. SLTs are encouraged to document the service delivery and intensity of the intervention they provide to children with phonology-based SSD and to work alongside researchers to generate practice-based evidence supporting their services.

Introduction

Worldwide, speech and language therapists (SLTs) are encouraged to make clinical decisions according to the principles of evidence-based practice (Royal College of Speech & Language Therapists, 2016, Speech Pathology Australia, 2015). This framework for clinical decision-making involves using clinical expertise to integrate the best available evidence internal to clinical practice and the preferences of a fully-informed client with the "best available external evidence from systematic research" (Dollaghan, 2007: 2). It is important that SLTs are able to make evidence-based decisions regarding the management of their caseload, as outcomes are assumed to be related to the integration and implementation of these sources of evidence (Odom, 2009). A high proportion of SLTs' caseloads comprise children with speech sound disorders (SSD; Broomfield and Dodd, 2004a).

Children with SSD may experience "any combination of difficulties with perception, articulation/motor production, and/or phonological representation of speech segments (consonants and vowels), phonotactics (syllable and word shapes), and prosody (lexical and grammatical tones, rhythm, stress, and intonation) that may impact speech intelligibility and acceptability" (International Expert Panel on Multilingual Children's Speech, 2012: 1). The most common subtype of SSD is a phonology-based SSD which involves a difficulty in learning the phonological system of the ambient language (Broomfield and Dodd, 2004b). Without the right type and amount of help during the years before a child starts school, children with SSD face an increased risk of academic and socioemotional difficulties (McCormack et al., 2011, Lewis et al., 2016). When planning intervention for these children, SLTs need to consider and integrate external (that is, empirical) evidence regarding service delivery, intervention approaches and intervention intensity within their clinical practice. However, SLTs working in clinical practice

report having little time and resources to access, appraise and integrate research from the growing external evidence base (O'Connor and Pettigrew, 2009). One strategy to facilitate this process is to consider reviews and summaries of the literature. The external evidence base for phonological intervention has been reviewed by Baker and McLeod (2011).

In a comprehensive narrative review, Baker and McLeod (2011) examined phonological intervention research published between 1979 and 2009, and found that 46 intervention approaches had been examined in the evidence base. Of these 46 different approaches, 23 were described in more than one publication. Although phonological interventions are known to be effective (Law et al., 2004), no one approach was recommended as the most effective for all children with a phonology-based SSD. For SLTs, a decision about which approach to choose is further complicated by the varying models of service delivery used in everyday clinical practice (Pring et al., 2012). Indeed, models of service delivery and resource constraints are known to drive clinical decision-making (McCurtin and Clifford, 2015).

Issues within service delivery include how intervention is provided (for example, group or individual, or telehealth), who provides the intervention (for example, the SLT or parent), where intervention is conducted (for example, at school or at a clinic), and how much intervention is provided (intervention intensity). In their review of intervention literature for SSD Baker and McLeod (2011) showed that most external research evidence published between 1979 and 2009 was based on the following service delivery model: individual intervention, delivered by an SLT, in a university clinic. Other reviews have explored the external evidence base for different service delivery models, including parent-delivered intervention (e.g., Sugden et al., 2016). One important aspect of service delivery that has received increasing attention is intervention intensity.

Intervention intensity encompasses *dose frequency*, *total intervention duration, dose form, dose*, and *cumulative intervention intensity* (Warren et al., 2007). Dose frequency refers to the number of intervention sessions provided over a period of time (for example, 1 × week or 2 × month), with total intervention duration being the total period over which an intervention is provided (for example, 12 weeks or 1 year). Dose form refers to the activity or task in which a teaching episode—containing the *active ingredients* of an intervention—are delivered (Baker, 2012), with dose being the number of times an active ingredient or teaching episode is delivered per session (for example, 100 productions trials per session). Cumulative intervention intensity is the product of dose × dose frequency × total intervention duration, a construct which provides a "useful general indicator of overall intensity" (Warren et al., 2007: 72). The narrative review by Baker and McLeod (2011) showed that most published evidence for phonological intervention reports a dose frequency of 2-3 times per week, in sessions lasting 30-60 minutes. Other reviews have also emphasised the importance of dose frequency for positive outcomes following phonological intervention (Kaipa and Peterson, 2016). Regarding the total duration of intervention needed for discharge from speech therapy services, the evidence is less expansive. Where it has been reported, total intervention duration has ranged from 7 to 46 months, with a mean duration of approximately 12 months (Baker and McLeod, 2011). Although providing a valuable synthesis of some elements of intervention intensity for phonological intervention approaches, the narrative review by Baker and McLeod (2011) did not consider the dose of intervention provided within these research studies. This is currently unknown yet essential to the conduct of evidence-based practice.

The increased interest regarding optimal intervention intensity for phonology-based SSD (Williams, 2012, Baker, 2012) in combination with the essential role that dose plays in treatment

outcomes, warrants a review and synthesis of this evidence. As stated by To et al. (2012: 465), the limited available evidence regarding intervention intensity "leads to difficulties in establishing guidelines on treatment intensity for SLTs when managing SSDs". If SLTs are to make evidence-based clinical decisions to optimise children's intervention outcomes, recommendations from the empirical evidence, particularly on intervention intensity, are needed. Moreover, if the goal is for implementation of this evidence into clinical practice, the evidence needs to be examined in light of the services that SLTs currently provide. Therefore, the purpose of this paper is twofold. First, to examine the evidence base for intensity in phonological interventions, with a particular focus on dose. Second, to report the results of a survey of SLTs' clinical practice and the intensity of services they provide to children with phonology-based SSD. The results of these two studies are then contrasted, to facilitate an understanding of how the external evidence is applied within clinical practice. By considering these two sources of evidence—external research evidence and internal evidence from day-to-day clinical practice—SLTs and researchers will be better positioned to understand the state of the empirical evidence regarding the provision of phonological intervention and appreciate the challenges facing SLTs as they strive to provide evidence-based services.

Study 1: A Review of the Evidence

Method

A systematic search and review was conducted. According to Grant and Booth (2009), this type of review is appropriate for synthesising a large body of research evidence, and contrasts with systematic reviews by including a variety of study designs.

Search strategy. The following online databases were searched: Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Education Resources Information

Centre (ERIC), Scopus, Linguistic and Language Behaviour Abstracts (LLBA), SpeechBITE and the American-Speech-Language-Hearing Association's (ASHA's) online journal search site. The following search terms were used: phonological OR phonology OR articulation OR speech sound disorder AND intervention OR therapy OR treatment. The reference lists of included papers were hand-searched for additional papers. Additionally, all papers contained in reviews by Baker and McLeod (2011) and Sugden et al. (2016) were included in this study.

Inclusion criteria. Papers met the following inclusion criteria:

- Peer-reviewed paper written or translated into English published between 1979 and 2016;
- Reported on phonological intervention/therapy/treatment research for children identified as having a phonological/articulation/speech impairment/delay/disorder with or without concomitant difficulties such as developmental language disorder, hearing loss, cleft-lip and/or palate, and/or stuttering;
- Research design corresponding to the ASHA (2004) level-of-evidence categories 1 (meta-analysis) to level III (case studies).

Exclusion criteria. Papers were excluded if they:

- Were level IV (expert opinion pieces) according to ASHA (2004) level-of evidence categories
- Reported on studies that had previously been published (and thus were already included in the review) and did not present new data, hypotheses or conclusions.

Data extraction and analysis. Data extraction was conducted by the first two authors. The following data was extracted from all papers that met the inclusion criteria and entered into a Microsoft Excel ® spreadsheet: authors, year of publication, journal name, country where research was conducted (if not explicitly stated within the manuscript, the location of the first

author's institutional affiliation was entered), participant numbers and age, intervention approach, and study design. Several papers reported on two or more studies: where this was the case, information about participant numbers, intervention approaches and study design were coded separately for each study. In keeping with the review by Baker and McLeod (2011), for studies that did not provide an explicit name for intervention delivered to children identified as having a phonological delay/disorder/impairment, the term *generic phonological approach* was used.

Following this process, information about service delivery and intervention intensity was extracted for all studies that were not classified as reviews. Review papers were not subject to further data extraction and analysis as they collate studies rather than report on specific investigations. The information extracted about service delivery included: how intervention was delivered (e.g. individually or in groups), the primary intervention agent, and where intervention was delivered. Information about intervention intensity was extracted according to the categories identified by Warren et al. (2007), including *dose, dose frequency, total intervention duration* (in weeks and number of sessions), and *cumulative intervention intensity*. Information on dose form was not extracted, as this was deemed to have been extracted under *intervention approach* coded previously. In addition to the categories of intervention intensity presented by Warren et al. (2007), we extracted information on session duration, and whether intervention was delivered over a restricted period or until the child(ren) were seen from the point of initial referral to a specific service until discharge.

Throughout the data extraction process, it became apparent that one category for *dose* was insufficient to encompass the range of information that was reported in the literature. Thus, this category was expanded to include three different types of dose: production dose, akin to the

number of attempts a child had to produce their targets within a session; perception dose, akin to the number of times a child completes focussed perceptual or input-based tasks (such as auditory bombardment or auditory discrimination tasks), and; conceptual dose, which included the number of times a child completed conceptual-type activities, such as phonological awareness or metaphonological tasks.

Several decisions relating to data extraction were made. First, only information reported in each paper was extracted, even if further details were available elsewhere. Second, when information regarding service delivery or intervention intensity presented in a paper was unclear or ambiguous, these categories were coded conservatively as *not reported* or *unclear*. Third, the focus of the review was on SLT-delivered interventions: as such, only SLT-delivered services were coded for intensity. Finally, for studies explicitly investigating comparisons in service delivery and/or intensity, both models of service delivery and/or intensity were coded so as to capture the range of these models within the literature.

Reporting of intervention intensity. In light of the importance of reporting intensity for implementation and replication of interventions (Hoffmann et al., 2014), an appraisal of the reporting of intervention intensity was conducted for all studies that were not identified as a review paper. Studies received a score out of 7, with one point allocated for sufficient reporting of each of the following components of intervention intensity to enable replication: dose, dose form, dose frequency, session duration, total intervention duration (in weeks or months), total intervention duration (in sessions), and cumulative intervention intensity.

Reliability. The second author re-coded 20 (10.1%) randomly selected papers. Inter-judge reliability was 97.5%. The first author re-coded the same papers: intra-judge reliability was 96.8%.

Results

Of the 6584 papers identified in the search process, 199 papers matched the inclusion criteria. Details of the included papers are provided in Appendix A. Figure 1 shows the year of publication of the 199 papers, which came from the following countries: the US (*n* = 109, 54.8%), the UK (*n* = 27, 13.6%), Canada (*n* = 18, 9.0%), Australia (*n* = 16, 8.0%), Brazil (*n* = 15, 7.5%), New Zealand (*n* = 4, 2.0%), Mexico (*n* = 3, 1.5%), Portugal (*n* = 2, 1.0%), Iran (*n* = 1, 0.5%), Norway (*n* = 1, 0.5%), Sweden (*n* = 1, 0.5%) and Turkey (*n* = 1, 0.5%). One paper (0.5%) reported on a study conducted in both the US and New Zealand. The 199 papers included 211 studies. These studies had the following designs: review (*n* = 5, 2.4%), randomised controlled trial (RCT; *n* = 34, 16.1%), non-randomised controlled trial (*n* = 14, 6.6%), quasi-experimental group design (*n* = 27, 12.8%), single-case experimental design (SCED; *n* = 70, 32.7%), and case studies (*n* = 61, 29.4%). Fifty-eight intervention approaches were identified in these studies, the most common of which were: minimal pairs (in 51 studies), a collection of approaches based on the principles of complexity (in 38 studies, such as maximal oppositions, treatment of the empty set, and intervention targeting complex onsets), a generic phonological approach (in 34 studies), traditional articulation therapy (in 14 studies), and a modified cycles approach (in 12 studies). Of these 58 approaches, 26 had been investigated in more than one study.

[INSERT FIGURE 1 ABOUT HERE]

One-hundred and ninety-four papers comprising 206 studies reported on specific investigations or cases of phonological intervention. These studies included between 1 and 730 participants (average = 16.7, median = 6, mode = 1) who were between 18 and 144 months in age (average minimum age = 49.8 months, average maximum age = 67.4 months). Sixty-five

(31.6%) of these studies included at least one child with a concomitant disorder such as hearing impairment, cleft lip and/or palate, language disorder, or stuttering.

Service delivery. The service delivery models used in the 206 studies reporting on phonological intervention are presented in Table 1. The most common service delivery model used within the literature was individual intervention (75.5% of studies) delivered by an SLT (86.8%) in a university clinic (54.7%).

[INSERT TABLE 1 ABOUT HERE]

Intervention intensity. The frequency and duration of intervention sessions are presented in Table 2. Dose frequency ranged from once every 6 weeks (e.g., the parent group from experiment 2 in Lancaster et al., 2010) to daily (e.g., Pamplona et al., 2014), with the majority of studies (55.2%) reporting a dose frequency of 2 to 3 × weekly. Two studies reported a dose frequency of "biweekly", which was coded as *unclear* due to the potential for misinterpretation of 2 × week or once every 2 weeks. Sessions ranged in duration from 15 minutes (e.g., Dunn and Barron, 1982) to a 2-day workshop (e.g., Study 2 from Dodd and Barker, 1990), with 70.3% of studies (n = 149) reporting a session duration of between 30 and 60 minutes.

[INSERT TABLE 2 ABOUT HERE]

Fifty-one studies (24.8%) reported some information about dose, with 155 studies (75.2%) not reporting any information regarding dose. Of these 51 studies, 42 (20.4% of all studies) provided dosage information about all of the interventions included within the study, with the remaining 9 studies providing information only about some of the intervention that was delivered. The minimum, maximum and average production, perception and conceptual dose provided within a session are provided in Table 3. The most commonly reported production dose

was 100 trials per session (29.8% of studies reporting on production dose), which was typically delivered in sessions lasting 30 to 45 minutes. Regarding perception dose, 30 trials was the most commonly reported (in 20.0% of the studies reporting perception dose). Although many studies reported including conceptual tasks in intervention (e.g., Gillon, 2000), no studies provided information about the conceptual dose provided within a session.

[INSERT TABLE 3 ABOUT HERE].

Twelve studies (5.7%) reported on the total duration of intervention provided to children with phonology-based SSD from initial assessment to discharge. These studies reported a total intervention duration of between 12 and 184 weeks (average = 61.3 weeks), comprising between 10 and 105 sessions (average = 43.8 sessions) provided until discharge. The majority of studies (n = 197, 92.9%) provided intervention over a restricted duration (for example, a pre-determined number of weeks or sessions), with three studies (1.4%) not reporting whether intervention was delivered over a restricted duration or not.

It was not possible to calculate the cumulative intensity of intervention provided in studies reporting on the total duration of intervention from initial assessment to discharge. For instance, of the twelve studies that reported providing intervention until discharge from services, none provided sufficient information about dose to enable calculation of the cumulative intervention intensity received by the participants. Thus, the cumulative intensity required for discharge from phonological intervention remains unknown. That noted, one study did indicate that four out of nine children were discharged after receiving school-based group intervention services for between 66 and 100 hours (Montgomery and Bonderman, 1989). For studies reporting on intervention provided over a restricted duration (92.9% of all studies), limited

reporting coupled with heterogeneity in methods, intervention, and outcomes prohibited calculation of cumulative intervention intensity.

Reporting of intervention intensity. All 206 studies that were not coded as reviews reported dose form, with 176 studies (85.4%) reporting dose frequency, 170 studies (82.5%) reporting session duration, 158 studies (76.7%) reporting total intervention duration of the study in weeks or months, 148 (71.8%) studies reporting total intervention duration in sessions, 42 studies (20.4%) reporting dose, and 7 studies (3.4%) reporting cumulative intervention intensity.

Most studies reported either 5 (n = 84, 40.8%) or 4 (n = 66, 32.0%) elements of intervention intensity. Two studies (1.0%) reported only dose form (Penney et al., 1994, Mota et al., 2007). Two studies reported sufficient information about all 7 elements of intensity to enable replication (Allen, 2013; Gildersleeve-Neumann and Goldstein, 2015). There was a trend for studies using a SCED design to report more detail regarding intervention intensity than reported in RCTs; 23.2% of SCED studies reported 6 or 7 elements of intensity, compared to 11.8% of RCTs.

Discussion of Study 1

This review presented an updated synthesis of the evidence base for phonological intervention and offered new insights into intervention intensity. Specifically, this was the first study to synthesise the external evidence regarding the fundamental concept of dose in phonological intervention research. Of the 199 papers that were identified, 194 papers comprising 206 studies reported on children's speech outcomes following intervention. Multiple study designs, primarily single-case research and case studies, and 58 intervention approaches were used across the evidence base. Echoing findings from the review by Baker and McLeod (2011), we found that the most common intervention approaches used within the evidence base

were minimal pairs and intervention based on principles of complexity, while the most common service delivery model used was individual intervention, delivered by an SLT in a university clinic. Although the present review included an additional 65 papers than the review by Baker and McLeod (2011), the evidence for phonological intervention still primarily reports a dose frequency of 2 to 3 × week in sessions lasting 30 to 60 minutes. No additional evidence exploring the total duration of intervention required to remediate an SSD from initial assessment to discharge has been published: thus, the evidence for the total amount of intervention needed for children to be discharged with intelligible speech remains unclear.

The present review extended on the findings made by Baker and McLeod by investigating intervention intensity in more detail. When it was reported, the most common dose was 100 production trials within a 30 to 45 minute session. The findings of this review highlight the limited and often insufficient reporting of intervention intensity within the research base for phonological interventions. As stated by Sommers et al. (1992: 19), "the frequency of reporting only limited information [about intervention intensity] or not reporting at all was alarming". It is even more alarming that the reporting of intervention intensity has not substantially improved in the 25 years since.

Although limited reporting of intervention intensity restricts the application of research into clinical practice (Hoffmann et al., 2014), the design of some intervention research may preclude sufficient reporting. The current study identified that SCED research tends to report more information about intensity than larger group designs, such as RCTs. RCTs in the field of speech and language therapy are known to be problematic for the reporting of interventions (Ludemann et al., 2017); while the reasons for this are unclear, it may be that authors of RCTs focus on reporting the scientific methods of a study whereas authors of SCED research may

instead focus on an individual's response to intervention, requiring more detailed reporting of the intervention delivered. Although understandable in certain contexts, limited details in the reporting of intervention research impacts the useability of research evidence for clinicians and researchers.

It is important to note that the service delivery models and schedules of intervention intensity reported within the evidence base may not be optimal for treating children with phonology-based SSD: rather, the use of these models may have occurred for a range of reasons, including resource constraints, customary practice patterns, or personal preferences of those conducting the research. The heterogeneity within the evidence base regarding research design, intervention approach, and participant details further complicates clear interpretation of optimal intervention intensity for children with phonology-based SSD.

When the findings of this review are combined with other sources of evidence, however, SLTs have some guidelines on which to base their service delivery and intervention intensity. For example, evidence from US-based SLTs' clinical practice suggests that individual intervention provides better outcomes for children with SSD than group intervention (American Speech-Language-Hearing Association, 2011). Although the optimal intensity of intervention for SSD is unknown (Baker, 2012), randomised-controlled trial evidence suggests a higher dose frequency of 3 × per week yields better speech outcomes for children with phonology-based SSD than intervention delivered 1 × per week (Allen, 2013). Further, in a retrospective analysis of outcomes from phonological interventions, Williams (2012) reported that a minimum dose of 50 trials in a 30 minute session was needed for intervention to be effective for children with moderate-severe phonology-based SSD. For children with severe disorders, this increased to a minimum of 70 trials in a 30 minute session. Limited evidence exploring the total duration of

intervention or cumulative intervention intensity is available. Considering the available evidence, however, it appears that—when treating phonology-based SSD—SLTs should strive to deliver individual intervention, 2-3 times per week, in sessions lasting 30-60 minutes comprising at least 50 to 100 production trials. Unfortunately, this model of practice may not be possible for many SLTs worldwide, who need to consider the realities of clinical practice including limited funding, resources, and time.

Study 2: Survey of Australian SLTs' Clinical Practice

In an ideal world, clinical decisions about service delivery and intervention intensity would be grounded in evidence-based practice. Yet clinical decision-making is not straightforward, and SLTs face barriers—including those related to the workplace, client and the clinician—to implementing external evidence within their practice (Lim et al., 2017, Brandel and Loeb, 2011). Such barriers may include workload or caseload size, availability of intervention resources, client disorder type and severity, and an SLT's professional training and continuing development opportunities. Combined, these barriers paint a complex picture around what influences evidence-based decision-making with regards to the service delivery and intervention intensity provided to children with phonology-based SSD. It would be useful, then, to consider how the external evidence for phonological interventions is applied within a specific context. One country with a long history of speech and language therapy services and a penchant for evidence-based practice is Australia.

What is Known About Intervention Services for Children With SSD in Australia?

Intervention services in Australia are usually provided through the health, education or private sector; however, there is no unifying piece of legislation mandating access to services for children, and eligibility criteria differ between states and territories (McLeod et al., 2010). Given

the large and increasing demand for these services, they are often limited (for example, by providing a limited number of sessions before discharge, or provided only to children who have not yet started school) and families may face a long wait (commonly 12 months) to access these services (Speech Pathology Australia, 2014, Ruggero et al., 2012). Due to the limited services available to children with SSD, many families seek services from the fast-growing private sector; however, the costs of these services can be prohibitive (Senate Community Affairs References Committee, 2014, Speech Pathology Australia, 2014). Access to services can be difficult for families living in rural or remote areas of Australia, who often have to travel long distances for infrequent or insufficient services (Verdon et al., 2011). Thus, access to services for SSD is dependent on where—and in which state or territory—children live, in addition to their family's economic situation. What do these services typically look like?

McLeod and Baker (2014) surveyed 231 Australian SLTs about their service delivery when working with children with SSD. They found that SLTs most commonly report providing individual intervention (95.7% of respondents) that is delivered by the SLT (91.4%) in a clinic setting (73.8%). Other common service delivery models included parent training (68.6%) and provision of a home program (64.8%). Just over half (57.6%) of the SLTs reported providing services within preschools or schools. Two-thirds of the SLTs reported having a waiting list for services. The SLTs who completed this survey reported using a wide range of intervention approaches, commonly auditory discrimination, minimal pairs, Cued Articulation, phonological awareness, traditional articulation therapy, auditory bombardment, the Nuffield Centre Dyspraxia Programme and core vocabulary (McLeod and Baker, 2014). When compared with the findings from Study 1, above, this survey provides evidence that the typical service delivery models and intervention approaches used to treat SSD in Australia broadly reflect the research

base. However, this survey did not consider the intensity of intervention provided to these children. This is currently unknown. Further, the study by McLeod and Baker (2014) did not investigate the factors—workplace, client or clinician—that may shape the delivery of services. These, too, are unknown. Thus, there is a need to examine both the intensity of services delivered to children with SSD and the barriers faced by SLTs that may influence services. By comparing and integrating this information with the results of Study 1, above, insights about the implementation of external evidence within clinical practice may be gained.

Method

Development of the survey instrument. This questionnaire contained 67 questions covering the following topics: general caseload questions, demographic information, service delivery, intervention approaches, intervention intensity, target selection, practices when working with families and the provision of home practice. The results of the final two of these topics (working with families and home practice) are presented elsewhere (details removed for peer review). See Appendix B for the questions reported in this paper. The questions were adapted from previous surveys of clinical practice (e.g. Joffe and Pring, 2008, Skahan et al., 2007, McLeod and Baker, 2004, Watts Pappas et al., 2008). This questionnaire contained multiple choice, yes/no and open response fields.

Procedures. A pilot version of the questionnaire was sent to five Australian paediatric SLTs who were asked to comment on the overall design of the survey. This process resulted in minimal changes to the survey instrument. The final version of the questionnaire was then administered through the online survey host *SurveyMonkey* ®. The survey was anonymous, and was open for two periods each of 8-weeks duration commencing in October 2014 and again in March 2015. The first author contacted organisations (such as Speech Pathology Australia,

national special interest groups related to SSD, and Australian universities that offer courses in speech and language therapy) who were asked to distribute information about the survey to their networks. Additionally, information about the survey was posted on social media sites (including Twitter and speech and language therapy-related Facebook groups). More detailed information about recruitment and the administration of this survey is provided in (details removed for peer review). Ethical approval was obtained (details removed for peer review).

Participants. The target population for this survey were SLTs working in Australia with children with phonology-based SSD. This survey was attempted by 335 Australian SLTs; however, 14.1% of these (n = 47) completed only the first page of the survey which asked about demographic information. Given that these responses did not provide information useful to the aims of the survey, they were not included in the analyses. Thus, a total of 288 responses were analysed. Their demographic information is presented in Table 4.

[INSERT TABLE 4 ABOUT HERE]

Data analysis. Data were analysed using IBM SPSS Statistics Version 22 ®, with a codebook used to record decisions related to data analysis. Descriptive statistics are reported. Some participants did not answer all of the questions within the questionnaire; where percentages are presented within this paper, they were calculated after excluding these missing responses (i.e., percentages are for valid data only). The total number of valid responses is provided within the text or a table.

Results

Caseload. The SLTs reported to have between zero to 800 children on their caseload (valid responses n = 275), with a median of 41 (interquartile range = 25-70). Participants reported that between zero and 188 children on their caseload had a primary diagnosis of

phonology-based SSD (median = 11, interquartile range = 5-25). SLTs were asked to provide the most common age of children with SSD on their caseload: 55 months was the average response. Other information regarding the caseloads of SLTs who completed this questionnaire is available elsewhere (details removed for peer review).

Service delivery. The service delivery models reported to be used by SLTs who participated in this survey are presented in Table 5. Individual intervention (96.4%) delivered by an SLT (97.8%) was the most common service delivery model, which was delivered in a range of locations.

[INSERT TABLE 5 ABOUT HERE]

Intervention approaches. Participants were asked to identify the intervention approaches they usually use with children with phonology-based SSD; results are shown in Table 6. Minimal oppositions contrast (minimal pairs) and auditory discrimination approaches were the most commonly used approaches (by 83.0% and 75.6% of SLTs, respectively). SLTs were also asked to select the type of treatment targets they usually select when treating phonology-based SSD. A majority (52.4%) reported usually selecting developmental targets, with 20.4% reporting to select collapse of contrast targets, 20.8% reporting to select non-developmental targets, and 6.3% reporting to select other types of targets (valid responses n = 269). Participants were also asked to identify if they follow a hierarchy of sound production (starting in isolation and progressing through syllables and words to conversation) when treating phonology-based SSD or if they focus on error patterns within a child's speech: 50.2% of SLTs reported that they focussed on error patterns, with 42.0% reporting to follow a hierarchy, and 7.8% reporting "other" (valid responses n = 269). Additionally, participants were asked to indicate the types of tasks they usually include in intervention for phonology-based SSD: 98.9%

indicated they usually include production tasks, 86.2% reported that they usually include perception tasks, 66.9% reported that they usually included conceptual tasks, and 4.5% indicated that they usually include other tasks (valid responses *n* = 269). The definitions of these tasks provided to participants are included in Appendix B

[INSERT TABLE 6 ABOUT HERE]

Intervention intensity. Results regarding dose frequency and session duration reported to be provided are presented in Table 7. Most SLTs reported providing intervention 1 × week (62.3%) for 30 to 44 minutes (62.4%). Regarding dose, SLTs were asked to select the number of production trials, perception trials and conceptual trials provided to children within each intervention session. Results are presented in Table 8. SLTs reported providing between 21-49 (37.6%) and 50-99 (39.8%) production trials within a session. The SLTs reported providing more production trials within each session than either perception or conceptual trials.

[INSERT TABLE 7 ABOUT HERE]

[INSERT TABLE 8 ABOUT HERE]

Participants reported that children received a total intervention duration of 4 to 156 weeks, with an average of 38.2 (*SD* = 28.0; valid response *n* = 203). Participants were also asked to report the total number of sessions provided to children with phonology-based SSD. SLTs reported that children received between 2 and 400 sessions, with an average of 22.7 (*SD* = 30.68; valid responses *n* = 281). Most SLTs who completed this survey (65.2%) indicated that the majority of children on their caseload receive the same intensity of intervention (valid responses *n* = 256). Almost a quarter of SLTs reported that they provide blocks of intervention to children with phonology-based SSD (22.3%; valid responses *n* = 265), which most commonly involved children receiving 10 weeks of intervention (23.4%) with 10 weeks off (22.1%) between blocks.

Participants were asked to identify factors that influence the intensity of intervention that they provide. Results are presented in Table 9. Participants were asked to identify which of workplace, client and clinician factors had the biggest influence on the intensity of intervention they provide to children with phonology-based SSD. The majority of participants reported that workplace factors had the biggest influence (52.8%), followed by client (43.9%) and clinician factors (3.3%; valid responses $n = 246$).

Finally, participants were asked to identify their ideal intensity of intervention (including dose frequency, session duration, and total intervention duration in weeks and number of sessions) for a preschool-aged child with a moderate-severe phonology-based SSD. Results for dose frequency and session duration are shown in Table 10. Most SLTs (50.9%) reported an ideal dose frequency of 2-3 × week, in sessions lasting 30 to 60 minutes (88.7%). Regarding ideal total intervention duration, SLTs reported that they would ideally deliver an average of 31.7 sessions ($SD = 23.3$, range = 5-120, $n = 175$) over an average of 40.3 weeks ($SD = 26$, range = 4-104, $n = 222$).

[INSERT TABLE 9 ABOUT HERE]

[INSERT TABLE 10 ABOUT HERE]

Discussion of Study 2

This study aimed to explore the clinical services delivered by SLTs in Australia. Similar to previous surveys of clinical practice in Australia and internationally, we found that SLTs report using a range of intervention approaches which have varying levels of external evidence supporting their efficacy (e.g., McLeod and Baker, 2014, Joffe and Pring, 2008). Congruent with the findings from Study 1, above, this survey found that the most common service delivery model used by SLTs in Australia is individual intervention (96.4%), delivered by an SLT

(97.8%). However, we found that SLTs in Australia reported that a wider range of people directly deliver intervention to children with phonology-based SSD than is found in the external evidence base: for example, parents and teachers were commonly reported to be involved in directly delivering intervention services to children with SSD in Australia. The results of the survey indicate that SLTs report delivering intervention in a range of locations, including schools (48.7%), private clinics (38.0%) and community health or hospital settings (31.9%). This mirrors findings from other international surveys of clinical practice, which have identified that services for children with SSD are commonly delivered in preschools, early childhood centres, schools and homes (Brumbaugh and Smit, 2013). Although delivering services in these locations was not commonplace in the evidence base, the propensity for intervention research to be delivered in university clinics likely reflects that most intervention research has been carried out by academic-researchers. This point aside, the results of the survey indicated that the most common service delivery models used by SLTs in Australia broadly align with the external evidence base for phonological interventions. However, this was not the case for the intensity of these services.

When comparing the intensity of intervention reported to be delivered by SLTs in Australia with the evidence base, some stark differences are apparent. Australian SLTs most commonly deliver intervention 1 × week (62.3%) in sessions lasting 30-44 minutes (62.4%), indicating a lower dose frequency and session duration than found in the external evidence base. Further, SLTs in Australia reported providing fewer intervention sessions (an average of 22.7 compared to 43.8) over a shorter total intervention duration (an average of 38.2 weeks compared to 61.3) than is presented within the evidence base for discharge from services. Although most SLTs working in Australia reported meeting or exceeding the recommended 50-99 production trials per session (51.9% of SLTs), many (44.4%) fell short of this benchmark. A striking finding

was SLTs' preference for delivering production, rather than perception or conceptual, trials within a session. Such a preference for intervention involving the production of speech targets mirrors the emphasis on production found in many intervention approaches within the extant literature.

While some studies included in Study 1 were published after the survey was conducted (n = 10), this more recent external evidence provided no new insights or information regarding intervention intensity for phonological interventions. Interestingly, SLTs in Australia reported that ideally they would deliver services more frequently, in longer sessions to children with SSD. In fact, the ideal dose frequency and session duration reported by respondents broadly align with the external evidence base, suggesting that Australian SLTs are aware of, but limited in applying, external evidence to their clinical practice.

The intensity of services reported to be delivered by SLTs in Australia is similar to that reported by Glogowska et al. (2000) in their RCT comparing "watchful waiting" with community-based speech and language therapy services. This RCT provided little evidence for the effectiveness of services delivered at this low intensity, raising concerns for the effectiveness of services being provided to many children in Australia. The findings of this survey parallel results from other international surveys of SLTs' intervention intensity when working with children with SSD, which have also shown that services are often delivered at intensities below those commonly found in the evidence base (e.g., To et al., 2012, Brumbaugh and Smit, 2013). This raises the questions: why is there a mismatch in intervention intensity, and what strategies could be used to overcome this mismatch? These questions will be considered below.

General Discussion

In this paper, we presented two studies examining the issues of service delivery and intervention intensity for phonology-based SSD. The first study was an updated review of the external evidence base for phonological interventions, which presented detailed information about the intensity of intervention typically delivered in empirical research. The second study—a survey of Australian SLTs' clinical practice—showed that children with phonology-based SSD in Australia may not be receiving evidence-based intensities of intervention: a concerning finding, given the importance of implementing interventions as described, with the same service delivery models and at equivalent intensities, within the published external evidence (e.g., Kaderavek and Justice, 2010). By considering these two sources of evidence—empirical evidence and evidence from day-to-day clinical practice—we offer unique insights into the challenges of engaging in evidence-based practice.

Barriers such as time, access to research evidence, and training are often cited as limiting the application of external evidence to clinical practice (Hoffman et al., 2013, O'Connor and Pettigrew, 2009). Other barriers include the evidence base itself: although this paper presented a review of intervention intensity reported within the extant literature, the optimal intensity of intervention needed to remediate phonology-based SSD from the point of referral to discharge remains unknown (Baker, 2012). In addition, much of the research evidence for intervention within the field of speech and language therapy includes insufficient detail to allow for faithful replication and implementation into clinical practice (Ludemann et al., 2017). These barriers speak to the challenges and complexities of conducting evidence-based practice within the realities of everyday practice (Kamhi, 2006). The steps of accessing the external evidence, appraising its quality, implementing it faithfully and evaluating the outcome to answer a clinical

question are appropriate for an ideal world, but may ignore the real-world context in which SLTs work. Strategies to support SLTs apply empirical evidence into their clinical practice are needed.

Solutions that generate evidence, while considering these day-to-day realities of clinical practice, are essential. One option championed by researchers is for clinicians to generate practice-based evidence (Lof, 2011). This involves clinicians documenting evidence about treatment—including service delivery, intensity, outcomes and modifications—from within their own clinical practice. Such evidence would capture the complexities of clinical caseloads within local contexts and be "highly clinically relevant" (Ebbels, 2017: 218). This evidence would also inform SLTs about the effectiveness of their clinical practice for children with SSD, and could demonstrate that their intervention is having a positive outcome for the children on their caseload or lead to appropriate modifications. One example of this type of evidence within the field of SSD was presented by Skelton and Richard (2016), in which the everyday school-based group intervention services for children with articulation disorders were evaluated.

Another solution could be for researchers, when designing and conducting clinical research, to consider these broader issues facing SLTs who are attempting to apply external evidence into their clinical practice. For example, researchers could consider the local contexts in which interventions are delivered to create evidence that is directly applicable to clinical practice and thus potentially easier for SLTs to implement. Another example would be to investigate the effectiveness of strategies commonly used by SLTs to overcome service delivery barriers: one such strategy frequently used by SLTs in Australia and Canada is to train parents to deliver intervention (Lim et al., 2017). In light of the findings from a review cautioning the use of this strategy to overcome service delivery barriers, research investigating this model of service delivery would be welcome (Tosh et al., 2017). Investigations considering the local context

would address concerns raised by SLTs that research evidence lacks clinical utility (Foster et al., 2015). Such clinically-relevant research, developed through partnerships between clinicians and researchers (Ebbels, 2017), could support SLTs as they strive to deliver evidence-based services to the children on their caseloads.

Limitations

The papers included in Study 1—all reporting to investigate a phonological intervention or treatment or therapy—were identified through a comprehensive search using broad search terms. Many of these studies—31.6%—reported to include at least one participant with a concomitant disorder such as a language disorder, childhood apraxia of speech, or hearing impairment. It may be that the phonological intervention delivered to these children was influenced by the presence of these concomitant disorders, potentially limiting the interpretation of the results specific to phonology-based SSD. Conversely, the inclusion of these studies may increase the clinical utility of the findings, as children with SSD on SLTs' caseloads often present with concomitant disorders (Broomfield and Dodd, 2004a).

Due to the range of research designs included in Study 1, an appraisal of the quality of the studies was not completed. Such a decision reflected the need for a variety of quality assessment tools to properly assess each research design. Given that different quality assessment tools each comprise different items, arriving at meaningful comparisons and conclusions about the quality of each study would be difficult.

The primary limitation of Study 2 is the self-reported nature of the findings. While this limitation is inherent to most survey research, future research could consider using a wider range of research methods to investigate SLTs' clinical practice. This could include, for example, file audits or direct observation of SLTs working with children with phonology-based SSD. The use

of such methods may overcome the dual issues of self-selection bias and social desirability response bias in survey research (Podsakoff et al., 2012).

Conclusions and Directions for the Future

The first study presented in this paper reviewed the external evidence base for phonological interventions, with a particular focus on service delivery and intervention intensity. Intervention within the evidence base has predominately been delivered 2-3 times per week by an SLT, in individual sessions lasting 30-60 minutes comprising at least 50 to 100 production trials. While providing some guidance on service delivery and intervention intensity, the findings of Study 1 emphasise the need for more detailed reporting of intervention intensity within published research and further investigations of optimal intervention intensity for SSD, particularly regarding cumulative intervention intensity and the total duration of intervention needed to discharge a child with intelligible speech. The second study presented in this paper demonstrated that this intensity of intervention is infrequently being delivered in clinical practice in Australia. While it appears that SLTs in Australia are aware of the external evidence for dose frequency and session duration, workplace factors limit its application to intervention services. This gap between the external evidence and clinical practice is not unique to Australia: surveys of SLTs from the US and Hong Kong have shown that many SLTs are delivering services to children with SSD at lower intensities than that found in the evidence base (Brumbaugh and Smit, 2013, To et al., 2012). Although workplace and caseload barriers may influence SLTs' clinical decisions about intervention intensity, other factors—such as limited details in reporting—may hinder the application of research evidence to clinical practice.

The differences and the range of service delivery models, intervention approaches and intensities found in these two studies of the external and internal evidence bases raise challenges

for researchers aiming to determine the effectiveness of interventions within a real-world context (Brumbaugh and Smit, 2013). This reinforces the need for the widespread creation and dissemination of practice-based evidence (Ebbels, 2017, Lof, 2011), in which intervention effectiveness can be determined within the realities of clinical practice. Future research needs to consider these realities while simultaneously aspiring to match the empirical recommendations regarding intervention intensity. Generating empirical evidence for innovative solutions to the service delivery restrictions experienced worldwide would provide SLTs with evidence that is relevant and directly applicable to clinical practice.

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Declarations

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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TABLE 1. SERVICE DELIVERY MODELS USED WITHIN 206[a] INTERVENTION STUDIES PUBLISHED BETWEEN 1979 AND 2016

How	*n* (%)	Who	*n* (%)	Where	*n* (%)
Individual	160 (75.5%)	SLT[b]	184 (86.8%)	University	116 (54.7%)
Group	17 (8.0%)	SLT and parent	10 (4.7%)	School/preschool	19 (9.0%)
Individual and group	17 (8.0%)	Experimenter	5 (2.4%)	Hospital	15 (7.1%)
Group parent training	4 (1.9%)	Parent	4 (1.9%)	Community clinic or health centre	14 (6.6%)
Group teacher training	1 (0.5%)	SLT and/or speech aide	4 (1.9%)	University or preschool	5 (2.4%)
Individual OR group	1 (0.5%)	Teacher or specialist teacher	3 (1.4%)	University and home	4 (1.9%)
Not reported	12 (5.7%)	Non-SLT student	1 (0.5%)	Private clinic	3 (1.4%)
		Research assistant or parent	1 (0.5%)	Home	3 (1.4%)
				Home and school	2 (0.9%)
				Home and early intervention centre	2 (0.9%)
				Community clinic and home	2 (0.9%)
				School or home	2 (0.9%)
				University or community clinic	1 (0.5%)
				University and school	1 (0.5%)
				Hospital and home	1 (0.5%)
				Not reported	22 (10.4%)

[a]This includes the 194 papers reporting on a specific intervention or case, which comprised 206 studies. Six of these studies included two service delivery models within their investigation, which were coded separately, resulting in 212 service delivery models investigated within the literature.

[b]SLT = speech-language therapist. This includes studies reporting that SLT students delivered intervention services.

TABLE 2. DOSE FREQUENCY AND SESSION DURATION PROVIDED IN 206[a] PHONOLOGICAL INTERVENTION STUDIES

Dose frequency	*n* (%)	Session duration	*n* (%)
Less than 1 × month	1 (0.5%)	Less than 30 minutes	7 (3.3%)
1 × month	1 (0.5%)	30 minutes	38 (17.9%)
2 × month	3 (1.4%)	45 minutes	34 (16.0%)
1 × week	41 (19.3%)	50 minutes	16 (7.5%)
2 × week	71 (33.5%)	60 minutes	42 (19.8%)
3 × week	40 (18.9%)	More than 60 minutes	13 (6.1%)
More than 3 × week	9 (4.2%)	Other	12 (5.7%)
Other	8 (3.8%)	Combination[b]	17 (8.0%)
Combination[b]	8 (3.8%)	Not reported	33 (15.6%)
Unclear	2 (0.9%)		
Not reported	28 (13.2%)		

[a]The numbers total 212 as six studies explicitly reported different dose frequencies and session duration for each of the groups in the study

[b]Studies may have included more than one duration and/or frequency for a participant, group or intervention (e.g. in the case study presented in Jarvis, 1989, intervention was delivered 3 × per week, then 2 × per week, then 1 × per week)

TABLE 3. DOSE PROVIDED PER SESSION ACROSS 206[a] PHONOLOGICAL INTERVENTION STUDIES

	Production dose	Perception dose	Conceptual dose
Total studies reporting information *n* (%)	47 (21.6%)	10 (4.6%)	0
Total studies with unclear reporting *n* (%)	3 (1.4%)	3 (1.4%)	0
Total studies reporting no information *n* (%)	168 (77.1%)	205 (94.0%)	218 (100.0%)
Minimum dose per session	23	10	-
Maximum dose per session	200	120	-
Average dose per session	77.0	51.5	-

[a]Numbers total 212 as six studies included groups that each received different intensities of intervention; these groups were coded separately.

Note: The number of studies "reporting no information" about dose includes studies that may or may not have reported to include a specific type of dose within the intervention approach (for example, although not all studies included conceptual intervention, they were coded as *not reported*).

TABLE 4. DEMOGRAPHIC INFORMATION OF AUSTRALIAN SLTS

Demographic	*n* (%)
State/Territory of work [a]	
Australian Capital Territory	5 (1.8%)
New South Wales	85 (29.9%)
Northern Territory	4 (1.4%)
Queensland	120 (42.3%)
South Australia	8 (2.8%)
Tasmania	4 (1.4%)
Victoria	41 (14.4%)
Western Australia	17 (6.0%)
Years practising as an SLT [b]	
Less than 1 year	32 (11.3%)
Between 1 and 3 years	61 (21.6%)
Between 4 and 6 years	63 (22.3%)
Between 7 and 10 years	41 (14.5%)
More than 10 years	85 (30.1%)
Urban or regional location [a]	
Capital city (e.g., Sydney, Melbourne)	163 (57.4%)
Regional city	70 (24.6%)
Large country town	26 (9.2%)
Small country town	18 (6.3%)
Other	7 (2.5%)
Employment status [c]	
Full-time	187 (67.3%)
Part-time	91 (32.7%)
Gender [a]	
Female	282 (99.3%)
Male	2 (0.7%)

[a] valid responses $n = 284$
[b] valid responses $n = 282$
[c] valid responses $n = 278$

TABLE 5. SERVICE DELIVERY REPORTED TO BE USED BY SLTS IN AUSTRALIA

Service Delivery	*n* (%)
Model of Intervention [a]	
Individual intervention	267 (96.4%)
Group intervention	73 (26.4%)
Parent training	224 (80.9%)
Home program	184 (66.4%)
Telehealth	15 (5.4%)
Teacher training	85 (30.7%)
Classroom-based therapy	43 (15.5%)
Computer-based therapy	44 (15.9%)
Community education	32 (11.6%)
Other	14 (5.1%)
Provider of Intervention [b]	
Speech pathologist[c]	269 (97.8%)
Preschool or classroom teacher	67 (24.4%)
Parents or caregivers	215 (78.2%)
Teacher's aide	110 (40.0%)
Speech pathology assistant	15 (5.5%)
Learning support teacher / Itinerant support teacher	38 (13.8%)
Supervised speech pathology student	47 (17.1%)
Interpreter	2 (0.7%)
Other allied health professional	11 (4.0%)
Other	3 (1.1%)
Location of Services [a]	
Community health / hospital clinic setting	105 (37.9%)
Private practice clinic setting	107 (38.6%)
Early childhood / preschool setting	75 (27.1%)
School setting	135 (48.7%)
Client's home	57 (20.6%)
Other	7 (2.5%)

[a]valid responses $n = 277$
[b]valid responses $n = 275$
[c]the term *speech pathologist* is used in Australia to refer to speech and language therapists. The use of this term is retained here in keeping with its presentation in the questionnaire.

TABLE 6. INTERVENTION APPROACHES REPORTED TO BE USUALLY USED BY 270 SLTS IN AUSTRALIA

Intervention approach	*n* (%)
Auditory bombardment/stimulation (e.g., Hodson and Paden, 1991)	125 (46.3%)
Auditory discrimination (e.g., Berry and Eisenson, 1956)	204 (75.6%)
Core Vocabulary (e.g., Dodd and Bradford, 2000)	127 (47.0%)
Cued Articulation (e.g., Passey, 1990)	152 (56.3%)
Cycles (e.g., Hodson and Paden, 1983)	58 (21.5%)
Imagery approach (e.g., Klein, 1996)	13 (4.8%)
Maximal oppositions approach (e.g., Gierut, 1990)	98 (36.3%)
Metaphon (e.g., Howell and Dean, 1994)	57 (21.1%)
Minimal oppositions contrast (minimal pairs) (e.g., Weiner, 1981)	224 (83.0%)
Multiple oppositions (e.g., Williams, 2000)	133 (49.3%)
Non-speech oromotor intervention(e.g., Lancaster and Pope, 1989)	5 (1.9%)
Nuffield Centre Dyspraxia Programme (e.g., Nuffield Hearing and Speech Centre, 2004)	94 (34.8%)
Parents and Children Together (PACT) (e.g., Bowen and Cupples, 1999)	22 (8.1%)
Phonological awareness (e.g., Gillon, 2000)	141 (52.2%)
Prompts for Restructuring Oral Musculature Phonetic Targets (PROMPT) (e.g., Hayden, 2006)	46 (17.0%)
Traditional articulation therapy (e.g., Van Riper, 1939)	174 (64.4%)
Whole language therapy (e.g., Hoffman et al., 1990)	30 (11.1%)
Other	11 (4.1%))

TABLE 7. DOSE FREQUENCY AND SESSION DURATION REPORTED TO BE PROVIDED BY SLTS IN AUSTRALIA

Component of Intervention Intensity	*n* (%)
Dose frequency [a]	
Less than 1 session per month	3 (1.1%)
One session per month	4 (1.5%)
1 to 2 sessions per month	72 (27.2%)
1 × weekly	165 (62.3%)
2 × weekly	9 (3.5%)
3 × weekly	9 (3.4%)
More than 3 per week	3 (1.1%)
Session duration [b]	
Less than 30 minutes	50 (18.8%)
30 to 44 minutes	166 (62.4%)
45 to 59 minutes	46 (17.3%)
60 to 89 minutes	0 (0.0%)
90 minutes or longer	4 (1.5%)

[a]valid responses $n = 265$
[b]valid responses $n = 266$

TABLE 8. DOSE OF PRODUCTION, PERCEPTUAL AND CONCEPTUAL TRIALS PROVIDED BY AUSTRALIAN SLTS

Type and number of trials	*n* (%)
Production [a]	
None	1 (0.4%)
Less than 20	18 (6.8%)
21-49	100 (37.6%)
50-99	106 (39.8%)
100-149	22 (8.3%)
150-199	8 (3.0%)
200+	2 (0.8%)
Unsure	9 (3.4%)
Perceptual [b]	
None	6 (2.3%)
Less than 20	129 (56.2%)
21-49	21-49 (30.6%)
50-99	17 (6.4%)
100-149	2 (0.8%)
150-199	2 (0.8%)
200+	0 (0.0%)
Unsure	8 (3.0%)
Conceptual [a]	
None	37 (13.9%)
Less than 20	149 (56.0%)
21-49	59 (22.2%)
50-99	7 (2.6%)
100-149	4 (1.5%)
150-199	0 (0.0%)
200+	0 (0.0%)
Unsure	10 (3.8%)

[a] valid responses $n = 266$
[b] valid responses $n = 265$

TABLE 9. FACTORS INFLUENCING INTERVENTION INTENSITY REPORTED BY AUSTRALIAN SLTS

Factor	*n* (%)
Workplace factors [a]	
Waiting lists	124 (50.2%)
Scheduling conflicts	138 (55.9%)
Workplace policy	95 (38.5%)
Size of active caseload	172 (69.6%)
Funding reasons	77 (31.2%)
Service delivery model	147 (59.5%)
Other	15 (6.1%)
Clinician factors [b]	
Personal factors	91 (38.6%)
Application of research evidence	94 (39.8%)
Implementing specific program	41 (17.4%)
Previous experience	139 (58.9%)
Always provided this intensity	47 (19.9%)
Other	7 (3.0%)
Client factors [c]	
Funding reasons	117 (48.3%)
Rate of progress	167 (69.0%)
Family preference	178 (73.6%)
Severity of disorder	176 (72.7%)
Travel time	66 (27.3%)
Age of client	122 (50.4%)
Cultural and/or linguistic background	51 (21.1%)
Other	33 (13.6%)

[a]valid responses $n = 247$
[b]valid responses $n = 236$
[c]valid responses $n = 242$

TABLE 10. IDEAL DOSE FREQUENCY AND SESSION DURATION AS RATED BY SLTS IN AUSTRALIA

	n (%)
Dose frequency[a]	
Less than 1 × month	0
1 × month	0
1 to 2 sessions per month	19 (8.2%)
1 × weekly	83 (35.8%)
2 × weekly	66 (28.4%)
3 × weekly	52 (22.4%)
More than 3 × week	8 (3.4%)
Other or combination	4 (1.7%)
Session duration[b]	
Less than 30 minutes	22 (9.5%)
30 minutes	79 (34.2%)
30 to 45 minutes	54 (23.4%)
45 minutes	48 (20.8%)
45 to 60 minutes	12 (5.2%)
60 minutes	12 (5.2%)
Other	4 (1.7%)

[a]Valid responses = 232
[b]Valid responses = 231

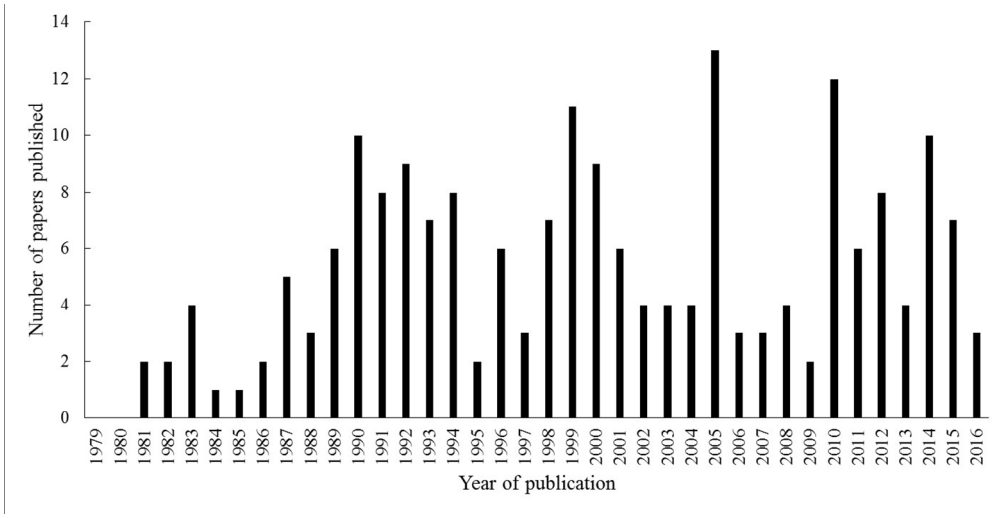

FIGURE 1. YEAR OF PUBLICATION OF 199 PHONOLOGICAL INTERVENTION PAPERS PUBLISHED BETWEEN 1979 AND 2016

236x120mm (150 x 150 DPI)

Appendix A: Details of service delivery and intervention intensity in phonological intervention studies published between 1979 and 2016

This appendix provides a summary of the 199 peer-reviewed journal publications from 1979-2016 which were included in this review. Readers are encouraged to source the original publication in order to gain a greater understanding of the intervention approach, processes, and outcomes in addition to more detailed descriptions of the service delivery and intervention intensity provided in each study.

Key for research design:
RCT = randomised controlled trial
Non-RCT = non-randomised controlled trial
SCED = single-case experimental designs that include MBD (multiple baseline design across participants or behaviours), ATD (alternating treatment design), MPD (multiple probe design), and AB or ABA (baseline [A] followed by treatment phase [B], with a possible return to baseline phase [A])
Case study designs = non-experimental studies involving one or more cases

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Abraham (1993)	ATD	Phonetic approach (syllable imitation) compared with minimal pairs	*n* = 4 (5;0–10;5)	Individual intervention.	1 × 45-min session per day on consecutive school days. For both intervention approaches approach, a production dose of 25 was provided (total 50 per session).	4/7
Adams, Nightingale, Hesketh and Hall (2000)	Non-RCT	Metaphonological intervention	*n* = 65 Experimental group, *n* = 31 (3;6–5;0) Control group, *n* = 34 (M_{age} = 4;2)	Individual intervention delivered by an SLT.	10 sessions delivered over 10 weeks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Allen (2013)	RCT	Multiple oppositions	*n* = 54 Experimental group (P1), *n* = 19 (M_{age} = 52.8 months) Experimental group (P3), *n* = 19 (M_{age} = 50.6 months) Active control group (C), *n* = 16 (M_{age} = 51.9 months)	For all groups, intervention was delivered either singly or in a pair by an SLT or SLT-assistant. Intervention was delivered in developmental preschools, preschools, childcare, or home.	P1 condition: 1 × 30-min session weekly for 24 weeks (total 24 sessions), with a minimum dose of 81 production trials per session (cumulative intervention intensity 1,944). P3 condition: 3 × 30-min session weekly for 8 weeks (total 24 sessions), with a minimum dose of 81 production trials per session (cumulative intervention intensity 1,944).	7/7
Almost and Rosenbaum (1998)	RCT	Modified cycles including minimal pairs	*n* = 26 (2;9–5;1)	Individual intervention, delivered by an SLT in the SLT department of a hospital.	2 × 30-min sessions per week over a 4 month block. Participants received between 14 and 29 sessions in total.	5/7
Bagetti, Ceron, Mota and Keske-Soares (2012)	Between groups design	Modified maximal oppositions	*n* = 7 (3;10–6;9)	Delivered in a university clinic by an SLT.	20 sessions for six of the participants, with one participant discharged after 10 sessions.	2/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Baker and McLeod (2004)	AB with control behaviour	Minimal pairs	*n* = 2, 'James' (4;4), 'Cody' (4;9)	Individual intervention, delivered by an SLT in a university clinic.	2 × 45-min sessions per week. Each session comprised 100 production trials. Cody acquired the speech target within 7 weeks (12 sessions) of intervention, whereas James required 5 months (32 sessions) of intervention.	6/7
Baker and McLeod (2011)	Narrative review	A range of phonological and articulation-based approaches	134 articles spanning 40 years	Varied across included studies.	Varied across included studies.	-[c]
Barberena, Keske-Soares, Cervi and Brandão (2014)	Between groups design	ABAB withdrawal and multiple probes	*n* = 8 (M_{age} = 5;5)	Delivered in a university clinic by an SLT.	2 × 45-min sessions per week for 5 weeks.	4/7
Barlow (2005)	Case study	Complexity approach: Complex clusters	*n* = 1 (3;9)	Delivered by SLT student at the participant's home.	2–3 sessions per week, each lasting 45–60 min. Overall, 19 sessions were delivered, each comprising at least 100 production trials.	5/7
Bedore, Leonard and Gandour (1994)	Case study	Generic phonological approach[d]	*n* = 1 'C' (4;4)	Delivered in a university clinic by an SLT.	2 sessions per week, with a total intervention duration of 4 sessions over 2 weeks.	4/7
Bellon-Harn, Credeur-Pampolina and LeBoeuf (2013)	Staggered MBD across participants	Scaffolded language intervention using storybooks	*n* = 2, 'Casey' (4;8), 'Delbert' (4;2)	Delivered by SLT student in a university clinic.	10 × 20-min intervention sessions. Dose reported but unclear.	4/7
Bernhardt (1992)	Combined MBD across behaviours with ATD	Nonlinear phonological intervention	*n* = 1 (5;10)	Individual intervention, delivered by an SLT in a university clinic.	3 × 45-min sessions per week for 2 × 6 week blocks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Bernhardt and Major (2005)	Within subjects design	Nonlinear phonological intervention with or without metaphonological intervention	*n* = 12 (3;3–4;11 at time of intervention, then 6;1–8;5 at time of follow-up)	Individual intervention, delivered by an SLT in community clinics.	3 × 45-min sessions per week for 16 weeks.	4/7
Blache, Parsons and Humphreys (1981)	Within subjects design	Minimal pairs	*n* = 7 (5;4–6;7)	Individual intervention delivered by SLT.	3–5 sessions.	2/7
Bowen and Cupples (1998)	Case study	Parents and Children Together (PACT)	*n* = 1 'Nina' (4;4)	Individual intervention delivered by an SLT in a clinic.	27 × 50-min consultations (22 intervention and 5 assessment) over 17 months, delivered in blocks of approx. 8 sessions with approx. 10-week breaks in between the blocks. In each block intervention was delivered weekly. Intervention was provided from referral to discharge.	5/7
Bowen and Cupples (1999a)	Non-RCT	Parents and Children Together (PACT)	*n* = 22 (2;11–4;9)	Individual intervention delivered by an SLT in a clinic.	1 × 50-min session per week, delivered in blocks of 10 consultations. Breaks of 10 weeks provided between blocks of intervention. Average of 21 consultations over 10.6 months. Intervention was provided from referral to discharge.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Bowen and Cupples (1999b)	Case study	Parents and Children Together (PACT)	*n* = 1 'Cheri' (4;5)	Individual intervention delivered by an SLT in a clinic.	1 × 50-min session per week. A total of 23 sessions (18 intervention and 5 assessment) delivered over 5 months. Intervention was provided from referral to discharge.	5/7
Broen and Westman (1990)	Non-RCT	Generic phonological approach	*n* = 20 Experimental group *n* = 12 (3;7–5;0) Control group *n* = 8 (3;7–4;8)	Group parent training sessions delivered by SLT, including some individual intervention. Most intervention delivered at home by parents.	1 × 90-min group parent training sessions per week over approx. 6 months (17 sessions in total), each including 5–10 mins of individual intervention.	5/7
Broomfield and Dodd (2011)	RCT	Range of intervention approaches	*n* = 730 aged up to 16 years. Of these, *n* = 320 received a primary diagnostic category of 'speech'.	Intervention typically delivered in groups by two SLTs/SLT assistants in a community clinic.	Average 5.5 hours of intervention (range 0–24 hours) over 6 months.	2/7
Bryan and Howard (1992)	Case study	Psycholinguistic approach	*n* = 1 'DF' (4;10)	Individual and group intervention delivered by an SLT in a community clinic.	Delivered over 14 weeks.	2/7
Camarata (1993)	MBD across behaviours and participants	Naturalistic intervention for speech intelligibility	*n* = 2 'BH' (3;10), 'RM' (4;3)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week. RM received 14 sessions over 7 weeks and BH received 34 sessions over 17 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Ceron, Keske-Soares, de Freitas and Gubiani (2010)	Between groups design	ABAB withdrawal and multiple probes compared with modified maximal oppositions compared with modified cycles	*n* = 21 (M_{age} = 5;7)	Delivered by an SLT in a university clinic.	12–36 intervention sessions.	2/7
Ceron and Keske-Soares (2013)	AB design	Multiple oppositions	*n* = 5 (4;2–8;11)	Delivered by an SLT in a university clinic.	2 × 45-min sessions per week, for 25 sessions. One participant was discharged after 15 sessions. Auditory bombardment of 20 words was provided at the start and end of each session (total 40 perception dose).	5/7
Checalin, Ghisleni, Ferreira-Gonçalves, Keske-Soares and Mota (2010)	Case study	ABAB withdrawal and multiple probes	*n* = 3 (6;0–7;0)	Delivered by an SLT in a university clinic.	Total intervention duration of 9 sessions.	2/7
Conture, Louko and Edwards (1993)	Non-RCT	Modified cycles with minimal pairs and articulation intervention	*n* = 8 (M_{age} = 5;9)	Group intervention delivered by two SLT students in a university clinic. Group parent training was also delivered.	1 × 45-min session per week during semester time over a university year.	4/7
Crosbie , Holm and Dodd (2005)	Combined MBD across behaviours with ATD	Minimal pairs compared with core vocabulary	*n* = 18 (4;8–6;05)	Individual intervention, delivered by SLT at school and home.	2 × 30-min sessions per week for 8–9 weeks per intervention. A four week break was included between two blocks of intervention.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Crosbie , Pine, Holm and Dodd (2006)	Case study	Core vocabulary	*n* = 1 'Jarrod' (7;0)	Individual intervention, delivered by an SLT at school.	2 × 30-min sessions per week for 8 weeks; 16 sessions delivered in total. Each session comprised an average of 100 production trials.	6/7
Culatta, Setzer and Horn (2005)	Case study	Modified cycles	*n* = 1 'Casey' (4;2)	Intervention delivered by an SLT in a university clinic	2 × 50-min sessions per week over 9 months.	4/7
Cummings and Barlow (2011)	Staggered MBD across participants	Complexity approach: Non-words	*n* = 4 (3;0–6;9)	Individual intervention, delivered by an SLT in a university clinic.	2 × 60-min sessions per week, each comprising a production dose of 96–166. A total of 19 sessions were provided to each participant.	5/7
Dean, Howell, Waters and Reid (1995)	Case study	Metaphon	*n* = 13 (3;7–4;7)	Individual intervention, delivered by an SLT in a community clinic.	1 × 30-min session per week. An average of 17 sessions were provided over 17 weeks.	5/7
Denne, Langdown, Pring and Roy (2005)	RCT	Phonological awareness intervention	*n* = 20 (5–7)	Group intervention, delivered by an SLT in a community clinic.	1 × 90-min session per week for 8 weeks. A total of 8 sessions were offered, resulting in 12 hours of intervention.	5/7
Derakhshandeh, Nikmaram, Hosseinabad, Memarzadeh, Taheri, Omrani, Jalaie, Bijankhan and Sell (2016)	ABA	Generic phonological approach with articulation intervention	*n* = 5 (4.5–9)	Individual intervention, delivered by an SLT in a clinic.	4 × 45-min sessions per week for 10 weeks. Total intervention duration of 40 sessions over 10 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Dinnsen, Chin and Elbert (1992)	MBD across participants	Minimal pairs	*n* = 34 (3;4–6;8)	Individual intervention delivered by an SLT.	2 × 30-min session per week; 83–409 days (average 204) between pre-intervention assessment and post-intervention assessment.	4/7
Dodd and Barker (1990)	Within subjects design	Minimal pairs, including traditional articulation intervention	Study 1: *n* = 5 (2;1–4;9)	Study 1: Parent-delivered individual intervention at home after receiving training.	Study 1: 1 × 2-hour group training session per week for 11 weeks.	5/7
			Study 2: *n* = 6 (4;0–4;11)	Study 2: Teacher-delivered individual intervention at preschool after receiving training.	Study 2: Group teacher training, consisting of "an initial two-day workshop, followed by three half-day workshops (each between 2–4 hours long) at approximately three weekly intervals, and a final half-day workshop after a six week break" (p. 38).	5/7
Dodd and Bradford (2000)	Combined MBD across behaviours with ATD	Metaphon compared with PROMPT compared with core vocabulary	*n* = 3 (3;5–4;3)	Individual intervention delivered by an SLT.	3 × 6-week blocks of intervention. Each block consisted of 12 × 30-min sessions.	4/7
Dodd, Crosbie, McIntosh, Holm, Harvey, Liddy, Fontyne, Pinchin and Rigby (2008)	RCT	Minimal pairs compared with non-minimal pairs	*n* = 19 (3;11–6;5)	Individual intervention delivered by an SLT in a community clinic.	1 × 30-min session per week for a total of 12 sessions over 12 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Dodd and Iacano (1989)	Case study	Minimal pairs	*n* = 7 (3;0–4;9)	Individual intervention delivered by an SLT in a university clinic. For one participant ('Subject E') intervention was delivered at home by a trained parent.	1 × session per week, for a total of between 11–40 sessions over 3–16 months.	4/7
Donicht, Pagliarin, Mota and Keske-Soares (2011)	Case study	ABAB withdrawal and multiple probes compared with complexity approach: Maximal oppositions	*n* = 4 (4;0–6;5)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for 5 weeks, totalling 9 intervention sessions per cycle of treatment. Participants treated with the maximal oppositions approach received 25 sessions of intervention.	5/7
Dunn and Barron (1982)	Case study	Modified McDonald's (1964) approach	*n* = 1 'K' (4;11)	Individual intervention delivered by an SLT in a university clinic.	2 × 15-min sessions per week for a total of 16 sessions over 8 weeks.	5/7
Eikeseth and Nesset (2003)	Case study	Vocal imitation training	*n* = 2 (5;4–6;0)	Individual intervention delivered by special education students in school or preschool.	For participant 1: 2 × 2-hour sessions per week, for a total of 15 sessions over 7.5 weeks. For participant 2: 5 × 2-hour sessions per week for a total of 21 sessions over 29 days. For both participants, each session contained between 80 and 200 production trials.	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Eiserman, McCoun and Escobar (1990)	RCT	Generic phonological approach	*n* = 40 (3;1–4;10)	For the clinic-based group, intervention was delivered by an SLT to groups of 2 children in a community clinic. For the home parent training group, intervention was primarily delivered by parents. The SLT provided training to parents at home.	For the clinic-based group, 1 × 1-hour session per week for 7 months. For the home parent training group, 2 × 40-min training sessions per month for 7 months.	4/7
Eiserman, Weber and McCoun (1992)	RCT (follow-up to Eiserman et al., 1990)	Generic phonological approach	*n* = 40 (3;1–4;10 at time of intervention, then followed up one year later)	As per Eiserman et al. (1990).	As per Eiserman et al. (1990).	4/7
Elbert (1983)	Case study	Generic phonological approach	*n* = 1 'Matthew' (3;10)	Individual intervention delivered by an SLT in a university clinic.	2–3 sessions per week over 11 months, with periodic breaks from intervention.	237
Elbert, Dinnsen, Swartzlander and Chin (1990)	Within subjects design	Minimal pairs	*n* = 10 (3;7–5;9)	Individual intervention delivered by an SLT in a university clinic.	2 × 30-min sessions per week.	3/7
Elbert, Powell and Swartzlander (1991)	Within subjects design	Minimal pairs	*n* = 19 (4;0–6;7)	Individual intervention, delivered by an SLT in a university clinic.	2 × 30-min sessions per week. Approx. 80–100 production trials were elicited in each session. Cumulative intervention intensity of 180–2840 production trials.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Feehan, Francis, Bernhardt and Colozzo (2015)	Case study	Modified cycles and morphosyntax intervention	*n* = 2 (twins, 6;7)	Individual intervention, delivered by an SLT student, in a university clinic.	Each child received 2 blocks of intervention. Each block comprised 1 × 60-min session per week for 8 weeks. Children received a total of 16 sessions over 23 weeks.	5/7
Fey, Cleave, Ravida, Long, Dejmal and Easton (1994)	RCT	Grammar intervention using focused stimulation techniques	*n* = 26 (3;8–5;10)	Treatment group 1: Individual and group sessions, delivered by an SLT. Treatment group 2: Parent-only group training sessions delivered by an SLT, and individual intervention delivered by an SLT. Treatment group 3: delayed treatment group. Randomly allocated to the same treatment as group 1 or 2, above.	Treatment group 1: 3 × 1-hour sessions per week over a total intervention duration of 10 months. Treatment group 2: 1 × 2-hour parent training sessions per week for 12 weeks. Following this 12-week period, parents attended 1 × group parent training session per month and children received 1 × individual session per month. Total intervention duration of 10 months. Treatment group 3: delayed treatment group. Total intervention duration of 5 months.	4/7
Fey and Stalker (1986)	Case study	Minimal pairs	*n* = 1 'Nora' (6;9)	Individual intervention delivered by an SLT in a university clinic.	2 × 90-min sessions per week. Breaks in intervention due to holiday periods. Total intervention duration of 46 hours over 8.5 months.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Flint and Costello Ingham (2005)	Within subjects design	Generic phonological approach	*n* = 7 (4;0–5;7)	Individual intervention delivered by an SLT in a university clinic.	3 × 30–50-min sessions per week.	3/7
Forrest, Dinnsen and Elbert (1997)	Within subjects design	Minimal pairs	*n* = 14 (3;6–5;9)	Individual intervention delivered by an SLT in a university clinic.	2 × 30-min sessions per week, up to a maximum of 20 sessions.	4/7
Forrest and Elbert (2001)	MBD across behaviours	Generic phonological approach	*n* = 4 (4;11–5;3)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week.	3/7
Forrest, Elbert and Dinnsen (2000)	Staggered MBD across participants	Generic phonological approach	*n* = 10 (3;4–4;6)	Individual intervention delivered by a student SLT in a university clinic.	2 × sessions per week, for between 9 and 20 sessions.	3/7
Gibbon, Shockey and Reid (1992)	Case study	Vowel intervention	*n* = 1 'Danny' (4;0)	Individual intervention delivered by an SLT in a university clinic.	1 × 45-min session per week for a total of 6 sessions over 6 weeks.	5/7
Gierut (1989)	MBD across behaviours	Complexity approach: Maximal oppositions	*n* = 1 'J' (4;7)	Individual intervention delivered by an SLT in a university clinic.	2 × 30-min sessions per week, for 23 sessions over a 3-month period.	5/7
Gierut (1990)	Combined ATD with staggered MBD across participants	Complexity approach: Maximal oppositions compared with minimal pairs	*n* = 3 (4;1–4;10)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week.	3/7
Gierut (1991)	Combined ATD with staggered MBD across participants	Complexity approach: Empty set compared with minimal pairs	*n* = 3 (4;2–5;4)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 17–19 sessions.	4/7
Gierut (1992)	Combined ATD with staggered MBD across participants	Complexity approach: Empty set compared with maximal oppositions	*n* = 4 (3;6–4;2)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 19 sessions over a maximum of 7 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Gierut (1996)	Staggered MBD across participants	Complexity approach: Laryngeal/ supralaryngeal distinctions	*n* = 7 (3;4–5;8)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week over 4.5 months.	4/7
Gierut (1998)	Combined staggered MBD with MPD	Complexity approach: singletons and/or clusters involving laryngeal / supralaryngeal distinctions	*n* = 6 (3;2–7;3)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for an average of 16 sessions delivered over a maximum of 6 weeks. Each session comprised 100 production trials.	6/7
Gierut (1999)	Staggered MBD across participants	Complexity approach: Sonority differences within clusters	Experiment 1: *n* = 6 (3;2–7;8)	Experiment 1: Individual intervention delivered by an SLT in a university clinic.	Experiment 1: 3 × 60-min sessions per week for up to 19 sessions over a maximum of 7 weeks.	5/7
			Experiment 2: *n* = 5 (3;5–4;8)	Experiment 2: Individual intervention delivered by an SLT in a university clinic.	Experiment 2: 3 × 60-min sessions per week for up to 19 sessions over a maximum of 7 weeks.	5/7
Gierut and Champion (1999)	Staggered MBD across participants	Complexity approach: Chain shifts	*n* = 2 (4;0–4;8)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 19 sessions delivered over approx. 7 weeks.	5/7
Gierut and Champion (2000)	AB design with control behaviour	Generic phonological approach	*n* = 1 'IJ' (4;5)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 19 sessions delivered over approx. 7 weeks.	5/7
Gierut and Champion (2001)	Staggered MBD across participants	Complexity approach: 3-element clusters	*n* = 8 (3;4 – 6;3)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 16–19 sessions over a maximum of 7 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Gierut, Elbert and Dinnsen (1987)	Combined MBD across participants with MPD	Minimal pairs	*n* = 6 (3;7–4;6)	Individual intervention delivered by an SLT in a university clinic.	30-min sessions, each comprising approx. 150 production trials.	3/7
Gierut and Morrisette (1996)	Combined staggered MBD across participants with MPD	Complexity approach: Laryngeal/ supralaryngeal distinctions	*n* = 2 (4;5–5;8)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week, each comprising 100 production trials.	4/7
Gierut and Morrisette (2010)	Combined ATD with staggered MBD across participants	Complexity approach: non-words	*n* = 4 (3;6–5;7)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 5-19 sessions delivered over approx. 7 weeks. Each session comprised an average of 62 production trials.	6/7
Gierut and Morrisette (2012a)	Staggered MBD across participants	Complexity approach: Age of acquisition	*n* = 10 (3;10–5;11)	Individual intervention delivered by an SLT in a university clinic.	3 sessions per week, for a maximum of 19 sessions.	3/7
Gierut and Morrisette (2012b)	Staggered MBD across participants	Complexity approach: Density and frequency	*n* = 8 (3;0–5;5)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week, for a total of 7 – 19 sessions (average 15) delivered over a maximum of 7 weeks.	5/7
Gierut and Morrisette (2014)	Staggered MBD across participants	Complexity approach: Dense neighbours with priming	*n* = 9 (3;5–5;7)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 5 – 19 sessions delivered over approx. 2 – 7 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Gierut and Morrisette (2015)	Staggered MBD across participants	Complexity approach: Dense neighbours with priming	Study 1: *n* = 6 (3;5–4;7)	Study 1: Individual intervention delivered by an SLT in a university clinic.	Study 1: 3 × 60-min sessions per week for a total of 6–19 sessions (average 15) delivered over approx. 2–7 weeks. Each session comprised an average of 71 production trials.	6/7
			Study 2: *n* = 6 (3;4–5;5)	Study 2: Individual intervention delivered by an SLT in a university clinic.	Study 2: 3 × 60-min sessions per week for a total of –sessions (average 11) delivered over approx. 2– 6 weeks. Each session comprised an average of 71 production trials.	6/7
Gierut, Morrisette and Champion (1999)	Combined ATD with MBD across participants	Complexity approach: Frequency and neighbourhood density	*n* = 12 (3;0–7;4)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for up to 19 sessions.	4/7
Gierut, Morrisette, Hughes and Rowland (1996)	Study 1: ATD with staggered MBD across participants	Complexity approach: Early versus late acquired phonemes	Study 1: *n* = 3 (3;7–5;6)	Study 1: Individual intervention delivered by an SLT in a university clinic.	Study 1: 3 × 60-min sessions per week for up to 19 sessions.	4/7
	Study 2: Staggered MBD across participants		Study 2: *n* = 6 (3;5–5;6)	Study 2: Individual intervention delivered by an SLT in a university clinic.	Study 2: 3 × 60-min sessions per week for up to 19 sessions.	4/7
Gierut, Morrisette and Ziemer (2010)	Retrospective analysis (between groups)	Complexity approach: Real-words versus non-words	*n* = 60 (3;1–7;5)	Individual intervention delivered by an SLT in a university clinic.	3 × 1-hour sessions per week, for an average of 13 (treatment using real-words group) or 15 sessions (non-words group) for up to a total of 19 sessions.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Gierut and Neumann (1992)	ATD	Complexity approach: Empty set compared with minimal pairs	*n* = 1 (4;8)	Individual intervention delivered by an SLT in a university clinic.	3 × 1-hour sessions per week for a total of 13 sessions.	4/7
Gildersleeve-Neumann and Goldstein (2015)	Multiple probe across behaviours	Generic phonological approach combined with elements of articulation therapy	*n* = 2 (5;6–5;8)	Individual intervention delivered by an SLT student in a university clinic.	2-3 × 50-min sessions per week for 8 weeks. Intervention delivered for a total of 19 or 25 sessions, each comprising 40–100 production trials. Cumulative intervention intensity inferred to be approximately 1330 production trials for one participant and 1750 for the second participant.	7/7
Gillon (2000)	Non-RCT	Phonological awareness intervention	*n* = 91 (5;6–7;6)	Experimental group: Individual intervention delivered by an SLT in a university clinic or a local community clinic.	2 × 60-min sessions per week for a total of 20 sessions over an average of 4.5 months.	5/7
Gillon (2005)	Non-RCT	Cycles combined with phonological awareness intervention	*n* = 12 (3;0–3;11)	Individual and group intervention delivered by an SLT in a university clinic.	Each child received 3 or 4 blocks of intervention. Each block lasted 4–6 weeks and comprised 2 × 45-min sessions per week. In total, children received between 16 and 34 sessions before school entry (average 25.5), and 10–12 hours of intervention following school entry.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Girolametto, Pearce and Weitzman (1997)	RCT	Lexical intervention based on Hanen principles	*n* = 25 (1;11–2;9)	Group parent-training sessions delivered by an SLT at a clinic, with most intervention delivered at home by parents. The SLT also conducted individual home-based sessions with each participant.	8 × 2.5-hour group parent training sessions and 3 × home-visits over a total of 11 weeks. Sessions were conducted approximately weekly.	5/7
Glaspey and Macleod (2010)	Case study	Modified cycles	*n* = 1 'G' (3;5)	Individual intervention delivered by an SLT at school.	2 × 50-min sessions per week for a total of 32 sessions delivered over a 6-month period.	5/7
Glaspey and Stoel-Gammon (2005)	Case study	Cycles	*n* = 1 'Ann' (3;7)	Individual intervention delivered by an SLT.	2 × 50-min sessions per week for a total of 8 weeks.	4/7
Glaspey and Stoel-Gammon (2007)	Case study	Cycles	*n* = 1 'Mark' (4)	Individual intervention by an SLT.	2 sessions per week over a 6-month period.	3/7
Glogowska, Roulstone, Enderby and Peters (2000)	RCT	Community-based speech and language therapy	*n* = 159 Experimental group: *n* = 71 (1;6–3;9) Control group: *n* = 88 (2;0–3;6)	Individual intervention delivered by an SLT in a community clinic.	Average of 8.1 sessions, totalling an average of 6.2 hours of intervention delivered over a mean of 8.4 months. Sessions were an average of 47 mins, delivered an average of once per month.	5/7
Goldstein (1996)	Case study	Generic phonological approach	*n* = 1 'Mario' (3;5)	Individual intervention delivered by an SLT.	Average of 2 sessions per week for 4 months.	3/7
Gordon-Brannan, Hodson and Wynne (1992)	Case study	Cycles	*n* = 1 'Luke' (4;6)	Individual intervention delivered by an SLT in a university clinic.	1 × 75-min session per week for a total of 66 sessions delivered over approx. 66 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Grawburg and Rvachew (2007)	Within subjects design	Phonological awareness intervention combined with speech perception training (SAILS)	*n* = 30 (M_{age} = 56.7–57.6 months) Experimental group: *n* = 10 (M_{age} = 56.7 months)	Intervention delivered by a student SLT in a university clinic.	1 × 45–60 min session per week for a total of 8 sessions delivered over 8 weeks. A total of 6–8 hours of intervention was delivered.	5/7
Grunwell and Dive (1988)	Case study	Minimal pairs including elements of traditional articulation intervention.	*n* = 2 'L'(6;0) 'H' (8;0)	Intensive residential program, including individual and group intervention delivered by an SLT in a hospital clinic.	5 × 4.5-hour sessions of intervention per week for a total of 10 sessions over 2 weeks.	5/7
Grunwell and Russell (1990)	Case study	Minimal pairs	*n* = 1 'Neil' (4;3)	Individual intervention delivered by an SLT in a hospital clinic.	4 × 30–40-min sessions per week for 12 weeks, for approx. 48 sessions in total.	5/7
Grunwell, Yavas, Russell and Le Maistre (1988)	Case study	Minimal pairs	*n* = 1 'N' (5;0)	Small group intervention with an SLT.	Weekly sessions delivered over a period of 4 months.	3/7
Harbers, Paden and Halle (1999)	MBD across participants	Metaphon combined with cycles	*n* = 4 (3;5–4;2)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for 6–9 months. Total duration of intervention (in sessions) reported but unclear.	5/7
Hart and Gonzalez (2010)	MPD across participants	Communication-centred intervention using storybooks	*n* = 3 (3;7–4;11)	Individual intervention delivered by an SLT in a preschool.	2 × 30-min sessions per week for a total of 12 sessions over 6 weeks. A total of 10 perception trials and 20–30 production trials were provided in each session.	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Herman, Ford, Thomas, Oyebade, Bennett and Dodd (2015)	Case study	Core vocabulary	*n* = 4 (9;0–11;3)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for 16 sessions over 8 weeks. A production dose of 200 was provided in the second session each week.	6/7
Hesketh, Adams, Nightingale and Hall (2000)	Non-RCT	Metaphonological intervention compared with traditional articulation	*n* = 61 (3;6–5;0) and 59 controls	Individual intervention delivered by an SLT in a university clinic.	1 × session per week for a total of 10 sessions over 10 weeks.	4/7
Hesketh, Dima and Nelson (2007)	RCT	Phonological awareness intervention	*n* = 42 (4;0–4;6)	Individual intervention delivered by an SLT in homes or schools.	2–3 × 30-min sessions per week for a total of 20 sessions delivered over a maximum of 10 weeks.	5/7
Hodson (1983)	Case study	Cycles	*n* = 1 'Candi' (3;11)	Individual intervention delivered by an SLT student in a university clinic.	1 × session per week for a total of 45 sessions over 18 months. Sessions included a perceptual dose of approx. 30. Production dose included but not reported. Intervention was provided from referral to discharge.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Hodson, Chin, Redmond and Simpson (1983)	Case study	Cycles	*n* = 1 'Tim' (5)	Individual intervention delivered by an SLT in a university clinic and by a school-based SLT at school.	1 × 60–90-min session per week at the university clinic (36 sessions in total) plus 2 × 20-min sessions per week at school. Sessions included a perceptual dose of approx. 30 trials. Production dose included but not reported. In total, 65 hours of intervention over 13 months.	5/7
Hodson, Nonomura and Zappia (1989)	Case study	Cycles	*n* = 1 'Lisa' (5;0)	Individual intervention delivered by an SLT in a university clinic.	1 × 90-min session per week delivered over 3 university semesters.	4/7
Hoffman, Norris and Monjure (1990)	Case study	Minimal pairs and whole language	*n* = 2 (4;1, two of a set of triplets)	Individual intervention delivered by an SLT student in a university clinic.	3 × 50-min sessions per week for 6 weeks.	4/7
Holm and Dodd (1999)	Case study	Core vocabulary	*n* = 1 'HK' (4;6)	Individual intervention delivered by an SLT at home and at school.	2 × 30-min sessions per week for 8 weeks (16 sessions in total).	5/7
Holm and Dodd (2001)	Case study	Core vocabulary, traditional articulation therapy, and minimal pairs	*n* = 2 (4;8–5;2)	'Hafis' (age 4;8): Individual intervention delivered by an SLT.	'Hafis': 2 × 30-min sessions per week for 8 weeks for a total of 16 sessions.	5/7
				'Jason' (age 5;2): Individual intervention delivered by at SLT at childcare.	'Jason': 2 × 20-min sessions per week for 7 weeks, followed by 1 × 45-min session per week for 8 weeks. Total duration of intervention was 22 sessions over 15 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Holm, Dodd and Ozanne (1997)	Case study	Traditional articulation therapy and minimal pairs	*n* = 1 'JL' (5;2)	Articulation therapy: Individual intervention delivered by an SLT at childcare. Minimal pairs: Individual intervention delivered by an SLT at au university clinic or at home.	Articulation therapy: 2 × 20-min sessions per week for 7 weeks (total 14 sessions). Minimal pairs: 1 × 45-min session per week for 8 weeks (total 8 sessions).	5/7
Jarvis (1989)	Case study	Metaphon	*n* = 1 'Luke' (4;9)	Individual intervention delivered by a specialist teacher (teacher of the deaf) at school.	20-min sessions, initially delivered 3 × per week then reducing to 2 × per week and then to 1 × per week. Intervention delivered over an academic year (10 months). Intervention was provided from referral to discharge.	4/7
Keske-Soares, Brancalioni, Marini, Pagliarin and Ceron (2008)	Between groups design	ABAB withdrawal and multiple probes compared with modified maximal oppositions compared with modified cycles	*n* = 66 (4;4–8;2)	Delivered by a student SLT at a university clinic.	15–25 sessions delivered.	2/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Klein (1996)	Retrospective between groups comparison	Imagery approach compared with traditional articulation therapy	*n* = 36 (3;0–5;10)	Individual intervention delivered by SLT students at a university clinic.	2–3 × 50-min sessions per week. For the phonological group, the total duration of intervention was an average of 81.88 sessions over 13.47 months. For the articulation group, an average of 100.95 sessions were delivered over 22.32 months. Intervention was provided from referral to discharge.	5/7
Lancaster, Keusch, Levin, Pring and Martin (2010)	Study 1: RCT	Study 1: Community based intervention	Study 1: *n* = 12 (3;4–5;10)	Study 1: Individual intervention delivered by an SLT in a community clinic.	Study 1: 1 × 30-min session per week for a total of 8 sessions over 3 months.	5/7
	Study 2: RCT	Study 2: Community based intervention	Study 2: *n* = 15 (3;4–4;5)	Study 2: *Treated group:* Individual intervention delivered by an SLT in a community clinic. *Parent group:* Parent-delivered intervention at home.	Study 2: *Treated group* 1 × 30-min session per week for a total of 15 sessions over 6 months. *Parent group* received 1 × 2-hour group parent training session with follow-up meetings every 6 weeks over a period of 6 months.	5/7
Law, Garrett and Nye (2004)	Systematic review and meta-analysis	A range of phonological and articulation-based approaches	13 articles spanning 25 years (including 6 phonological intervention studies)	Varied across included studies	Varied across included studies	-

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Leahy and Dodd (1987)	Case study	Minimal pairs	*n* = 1 'AJ' (3;5)	Individual intervention delivered by an SLT at a university clinic, supported by parent at home.	Fortnightly sessions, for a total of 13 sessions delivered over 6 months. Of the 13 sessions, 5 were assessment and 8 were treatment.	4/7
Leite, Wertzner, Goncalves, Magliaro and Matas (2014)	Non-RCT	Modified cycles	*n* = 23 (M_{age} = 8;10)	Individual intervention delivered by an SLT in a university clinic.	1 × 45-min session per week for a total of 12 sessions delivered over 12 weeks.	5/7
Lousada, Jesus, Capelas, Margaca, Simoes, Valente, Hall and Joffe (2013)	RCT	Generic phonological approach combined with phonological awareness compared with traditional articulation intervention	*n* = 14 (4;0–6;7)	Individual intervention delivered by an SLT in a university clinic.	1 × 45-min session per week for a total of 25 sessions over 25 weeks. Sessions were divided into 3 blocks (of 9, 8 and 8 weeks in duration) without breaks.	5/7
Lousada, Jesus, Hall and Joffe (2014)	RCT	Generic phonological approach combined with phonological awareness compared with traditional articulation intervention	*n* = 14 (4;0–6;7)	Individual intervention delivered by an SLT in a university clinic.	1 × 45-min session per week for a total of 25 sessions over 25 weeks. Sessions were divided into 3 blocks (of 9, 8 and 8 weeks in duration) without breaks.	5/7
MacLeod and Glaspey (2014)	Case study	Cycles	*n* = 3 (3;0)	Individual intervention delivered by an SLT in a university clinic.	2 × sessions per week for a total of 16 sessions over approx. 8 weeks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Major and Bernhardt (1998)	Between groups design	Nonlinear intervention with or without metaphonological intervention	*n* = 19 (3;0–4;11)	Individual intervention delivered by an SLT in a community clinic.	3 × sessions per week for a total of 48 sessions over three treatment blocks of 12 or 18 sessions in duration. One child ('Kendra') received intervention 1 × weekly for two 8-week blocks. Intervention was delivered over 5–10 months.	4/7
Masterson and Daniels (1991)	Case study	Minimal pairs and motoric automatization	*n* = 1 'C' (3;8)	Individual intervention delivered by an SLT student in a university clinic.	2 × 50-min sessions per week delivered over 4 university semesters (25 months). Intervention was provided from referral to discharge.	4/7
McIntosh and Dodd (2008)	Case study	Core vocabulary	*n* = 3 (3;9–4;3)	Individual intervention delivered by an SLT in a hospital clinic.	2 × 30–40-min sessions per week for between 12 and 38 sessions delivered over approx. 6–19 weeks. The second session of each week contained 20–240 production trials.	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
McKean, Phillips and Thompson (2012)	RCT	Generic phonological approach using elements of family-centred practice	*n* = 20 (3;3–4;10)	Usual practice group: Individual intervention and a group parent training session delivered by an SLT in a community clinic, plus parent-delivered intervention at home. Family-centred practice group: Individual intervention and a group parent training delivered by an SLT in a community clinic and at home, plus parent-delivered intervention at home.	1 × 45-min session per week for a total of 9 SLT-delivered intervention sessions over 14 weeks.	5/7
Mecrow, Beckwith and Klee (2010)	Between groups design	Generic phonological approach	*n* = 35 (4;2–6;10)	Individual intervention delivered by an SLT assistant at school.	Average of 4 × 45–60-min sessions per week for 10 weeks for an average of 39 sessions.	5/7
Mezzomo, Mota, Keske-Soares, Ceron and Dias (2014)	Case study	ABAB withdrawal and multiple probes compared with minimal pairs compared with maximal oppositions	*n* = 5 (5;0–6;11)	Individual intervention delivered by an SLT at a university clinic.	A total of 9 to 25 sessions provided.	2/7
Miccio and Elbert (1996)	Case study	Stimulability intervention	*n* = 1 'Stacy' (3;4)	Individual intervention delivered by an SLT.	2 × 45-min sessions per week for a total of 12 sessions delivered over 6 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Miccio, Elbert and Forrest (1999)	MBD across participants	Minimal pairs	*n* = 4 (3;10–5;7)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for a total of 20 sessions delivered over 10 weeks. Each session included 100 production trials.	6/7
Miccio and Ingrisano (2000)	MBD across behaviours	Minimal pairs	*n* = 1 'K' (5;3)	Individual intervention delivered by an SLT at school.	4 × 20–30-min sessions per week over 29 weeks.	4/7
Monahan (1986)	Case study	Monahan Program	*n* = 4 (5;5–5;8)	Small group intervention delivered by an SLT at school.	2 × 30-min sessions per week for between 10 and 40 sessions delivered over 2 to 8 months.	5/7
Montgomery and Bonderman (1989)	Case study	Cycles	*n* = 9 (3;1–4;10)	Group intervention delivered by an SLT and a paraprofessional in a school.	3 × 2-hour sessions per week for a total of between 66 and 100 hours of intervention (average 90 hours) delivered over 17 weeks of intervention within a 7-month time period. Intervention was provided from referral to discharge.	5/7
Morrisette and Gierut (2002)	Staggered MBD across participants	Generic phonological approach, with lexical properties of targets varied	*n* = 8 (3;10–5;4)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of between 5 and 19 sessions (average 11) over 2–8 weeks (average 6).	5/7
Mota, Bagetti, Keske-Soares and Pereira (2005)	Case study	Complexity: Maximal oppositions	*n* = 4 (5;3–7;5)	Delivered by an SLT in a university clinic.	15–25 sessions delivered.	2/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Mota, Keske-Soares, Bagetti, Ceron and Filha (2007)	Non-RCT	Cycles compared with maximal oppositions compared with ABAB withdrawal and multiple probes	*n* = 21 (4;0–7;10)	Unclear.	Unclear.	1/7
Murphy, Pagan-Neves, Wertzner and Schochat (2015)	RCT	Phonological Stimulation Program compared with on-linguistic auditory intervention	*n* = 17 (Phonological group M_{age} = 8;8, Auditory M_{age} = 7;7)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for a total of 12 sessions.	4/7
Nelson, Nygren, Walker and Panoscha (2006)	Systematic review	A range of speech and language interventions	25 RCTs included in 24 publications	Varied across included studies.	Varied across included studies.	-
Olswang and Bain (1985)	Combined MBD across behaviours and ABA(B) withdrawal design	Traditional articulation intervention	*n* = 3 (4;0–4;9)	Individual intervention delivered by an SLT student in a university clinic.	2–3 × 50-min sessions per week delivered over 28–38 weeks. Intervention was provided from referral to discharge.	4/7
Page, Pertile, Torresi and Hudson (1994)	Non-RCT	Generic phonological approach	*n* = 80 (3;0–5;10)	Group intervention delivered by an SLT in a hospital clinic.	Group A ('weekly group') received 1 × 60-min session per week for 6 weeks (total of 6 sessions). Group B ('intensive group') received 3 × 60-min sessions per week for 2 weeks (total of 6 sessions).	5/7
Pagliarin, Brancalioni and Keske-Soares (2012)	Between groups design	Multiple oppositions compared with ABAB withdrawal and multiple probes	*n* = 10 (4;8–7;3)	Delivered by an SLT in a university clinic.	2 × 45-min sessions per week for 15–30 sessions.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Pagliarin, Mota and Keske-Soares (2009)	Between groups design	Minimal pairs compared with multiple oppositions compared with maximal oppositions	*n* = 9 (4;2–6;6)	Delivered by an SLT in a university clinic.	2 × 45-min sessions per week for between 15 and 25 sessions.	4/7
Pagliarin, Mota and Keske-Soares (2011)	Between groups design	Minimal pairs compared with multiple oppositions compared with maximal oppositions	*n* = 9 (4;2–6;6)	Delivered by an SLT in a university clinic.	2 × 45-min sessions per week for between 15 and 25 sessions.	4/7
Palle, Berntsson, Miniscalco and Persson (2014)	MBD across behaviours	Generic phonological approach	*n* = 6 (4;1–5;7)	Individual intervention delivered by an SLT in a hospital clinic.	1 × session per week for between 6–18 sessions delivered over 6–18 weeks.	4/7
Pamplona, Ysunza and Espinosa (1999)	RCT	Traditional articulation compared with a generic phonological approach	*n* = 29 (3;1–7;1)	Group intervention delivered by an SLT in a hospital clinic.	2 × 60-min sessions per week, delivered over 6–46 months. Intervention was provided from referral to discharge.	4/7
Pamplona, Ysunza and Morales (2014)	RCT	Whole language with generic phonological principles	*n* = 90 (3–6;8)	Group intervention delivered by an SLT in a hospital clinic.	4-hours of intervention per day (5 × weekly) for 4 weeks.	4/7
Pamplona, Ysunza and Ramırez (2004)	RCT	Generic phonological approach compared with whole language	*n* = 30 (3;0–7;2)	Group intervention delivered by an SLT in a hospital clinic.	2 × 60-min sessions per week, delivered over 4 to 27 months. Intervention was provided from referral to discharge.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Pascoe, Stackhouse and Wells (2005)	Case study	Psycholinguistic approach	*n* = 1 'Katy' (6;5)	Individual intervention delivered by an SLT at school.	2 × 60-min sessions per week delivered over 3 × blocks of 10 sessions each. In total, 30 sessions of intervention delivered over 7 months, with a 7-month follow-up.	5/7
Penney, Fee and Dowdle (1994)	Case study	Vowel intervention	*n* = 1 'CG' (4;11)	Individual intervention delivered by an SLT in a university clinic.	-	1/7
Pieretti, Kaul, Zarchy and O'Hanlon (2015)	Multiple baseline ABCA design	Traditional articulation therapy compared with a multimodal phonological approach	*n* = 2 (4;1–4;3)	Individual intervention delivered by an SLT in a preschool.	30-min sessions delivered 'biweekly' (p. 135, coded as *unclear*) for 20 sessions delivered over 20 weeks.	4/7
Pollock (1983)	Case study	Traditional articulation intervention	*n* = 1 'Mike' (3;5)	Individual and group intervention delivered by an SLT.	Reports on intervention delivered over a period of 2 years and 5 months.	2/7
Powell (1991)	Case study	Minimal pairs	*n* = 1 'JA' (5;8)	Individual intervention delivered by an SLT in a university clinic.	15 × 30-min sessions delivered, each comprising a production dose of 100 trials.	4/7
Powell (1993)	MBD across behaviours	Minimal pairs	*n* = 6 (4;11–5;6)	Individual intervention delivered by an SLT in a university clinic.	3 × 30-min sessions per week for a total of 13–38 sessions. Each session comprised a production dose of 100 trials.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Powell and Elbert (1984)	MBD across participants	Minimal pairs	*n* = 6 (4;4–6;3)	Individual intervention delivered by a researcher in a university clinic.	30-min sessions each comprising a production dose of 100 trials. Excluding baseline sessions, the total duration of intervention was between 1 and 4 months (total study duration of 5 – 9 months).	4/7
Powell, Elbert and Dinnsen (1991)	MBD across behaviours	Minimal pairs	*n* = 6 (4;11–5;6)	Individual intervention delivered by an SLT.	3 × 30-min sessions per week, with each session comprising a production dose of 100 trials. In total, each participant received between 14 and 39 intervention sessions.	5/7
Powell, Elbert, Miccio, Strike-roussos and Brasseur (1998)	MBD across participants	Minimal pairs (conceptual-listening tasks only) compared with traditional articulation intervention	*n* = 18 (3;6–6;10)	Individual intervention delivered by an SLT in a university clinic.	40-min sessions delivered 'several times per week' (p. 152) [note: coded as *unclear*]. Each session comprised a production dose of 100. In total, children receiving the phonological intervention received 20 sessions of intervention delivered over 9–12 weeks.	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Ray (2002)	Case study	Minimal pairs	*n* = 1 'MC' (5)	Individual intervention delivered by an SLT at a university clinic and at home.	3 × 45–60 min sessions per week for a total of 40 sessions delivered over 20 weeks (5 months). In each session, a perceptual dose of 20 was provided; production activities were also included in the intervention, but no details on dose were provided.	5/7
Robb, Bleile and Yee (1999)	Case study	Minimal pairs	*n* = 1 'Jenny' (4;0)	Individual intervention delivered by the researcher in a university clinic.	2 × 45-min sessions per week for a total of 20 sessions delivered over 10 weeks.	5/7
Rudolph and Wendt (2014)	MBD across behaviours	Cycles	*n* = 3 (4;3–5;3)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for 18 sessions. Intervention was delivered over two blocks, each 3-weeks (9 sessions) in duration, separated by a 1-week break.	5/7
Ruscello, Cartwright, Haines and Shuster (1993)	RCT	Minimal pairs	*n* = 12 (4;1–5;8)	Group I: Individual intervention delivered by an SLT in a university clinic. Group II: Individual intervention delivered by an SLT and a parent in a university clinic.	Both groups: 2 × 60-min sessions per week for a total of 16 sessions delivered over 8 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Rvachew (1994)	RCT	Speech perception training (using SAILS) plus traditional articulation intervention	*n* = 27 (3;6–5;6)	Individual intervention delivered by an SLT in a hospital clinic.	1 × 45-min session per week for a total of 6 intervention sessions delivered over 6 weeks. Each session comprised 60 perception trials and 60 production trials.	6/7
Rvachew and Bernhardt (2010)	Analysis of a subgroup of children who participated in an RCT (Rvachew and Nowak, 2001)	Complexity approach targeting later developing/least knowledge phonemes compared with a developmental goal approach	*n* = 6 (3;5–4;4)	Individual intervention delivered by an SLT in a hospital clinic.	1 × 30–40 min session per week for a total of 12 intervention sessions delivered over 12–14 weeks.	5/7
Rvachew and Brosseau-Lapré (2015)	RCT	Different combinations of input- and output-oriented interventions with phonological awareness training	*n* = 65 (M_{age} of treatment groups = 52.25–54.08 months)	Intervention delivered over two blocks. In the first block, participants received individual intervention delivered by an SLT student in a hospital clinic. In the second block, participants received group intervention from an SLT student in a hospital clinic while parents attended a group training session.	Block 1: 1 × 45-min session per week for a total of up to 6 sessions (group averages = 5.15–5.44) over 6 weeks. Block 2: (group averages = 4.77–5.13) over 6 weeks. In total, participants in each group took an average of 13.33–14.92 weeks to complete the intervention program.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Rvachew and Nowak (2001)	RCT	Complexity approach targeting later developing/least knowledge phonemes compared with a developmental goal approach	*n* = 48 (Group I M_{age} = 51.46 months, Group II M_{age} = 49.63 months)	Individual intervention delivered by an SLT in a hospital clinic.	1 × 30–40-min session per week for a total of 12 intervention sessions delivered over 12–14 weeks.	5/7
Rvachew, Nowak and Cloutier (2004)	RCT	Speech perception training (SAILS) alongside regular speech therapy (using a range of approaches)	*n* = 34 (3;5–4;11)	Individual intervention delivered by an SLT student or parent in a hospital (delivered in addition to regular speech and language therapy services).	1 × 15-min session per week for an average of 12 sessions over 4.7 months (delivered in addition to regular speech and language therapy services). Each session provided a minimum perception dose of 120 trials.	6/7
Rvachew, Rafaat and Martin (1999)	Within subjects design	Study I: Modified cycles approach	Study I: *n* = 10 (4;2–4;11)	Study I: Group intervention delivered by an SLT in a hospital clinic.	Study I: 1 × 45–60-min sessions per week for a total of 9 sessions delivered over 9 weeks.	5/7
		Study II: Speech perception training (SAILS) plus modified cycles and stimulability training	Study II: *n* = 13 (3;9–4;11)	Study II: Individual intervention delivered by an SLT and a speech aide in a hospital clinic, followed by group intervention delivered by an SLT in a hospital clinic.	Study II: 1 × 20-min session per week for a total of 3 sessions delivered over 3 weeks, followed by 1 × 45–60-min session per week for 6 weeks. In total, 9 sessions of intervention delivered over 9 weeks.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Saben and Costello Ingham (1991)	Case study	Minimal pairs	*n* = 2 (3;9–4;4)	Individual intervention delivered by an SLT.	Participant 1 (age 4;4) received 67 sessions of intervention delivered over 9.5 months. Participant 2 (age 3;9) received 32 sessions delivered over 4.5 months.	3/7
Seeff-Gabriel, Chiat and Pring (2012)	Case study	Generic phonological approach combined with elements of traditional articulation and morphosyntax intervention	*n* = 1 'B' (5;1)	Individual intervention delivered by an SLT in a university clinic.	1 × 30-min session per week for a total of 20 sessions delivered over 20 weeks.	5/7
Shea and Tyler (2001)	MBD across participants	Prosodic intervention targeting stress patterns	*n* = 2 (3;1–3;7)	Individual intervention delivered by an SLT.	3 × 45-min sessions per week delivered over 4 months. Participant 1 attended 28 sessions (of which 16 were intervention) and participant 2 attended 22 sessions (12 intervention).	5/7
Shiller, Rvachew and Brosseau-Lapré (2010)	Case study	Speech perception (SAILS), focused stimulation, and minimal pairs	*n* = 1 (4;8)	Individual intervention delivered by an SLT in a university clinic.	6 sessions of intervention delivered over 6 weeks.	3/7
Shoaf, Iyer and Bothe (2009)	ABAB design	Nonlinear phonological intervention	*n* = 1 (6;4)	Individual and group intervention delivered by an SLT in a school.	4 × 30-min sessions per week for a total of 18 sessions delivered over 2 months.	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Shriberg and Kwiatkowski (1982)	Within subjects design	Generic phonological approach	*n* = 31 (3;10–9;0)	Group intervention delivered by an SLT student in a university clinic.	4 × approx. 2-hour sessions per week delivered over 5–6 weeks. Participants in Group A received a total of 19 sessions; total number of sessions was not reported for participants in Groups B and C.	5/7
Shriberg and Kwiatkowski (1987)	Retrospective within subjects design	A range of generic phonological approaches	*n* = 73 (2;9–9;6)	Individual intervention delivered by an SLT student in a university clinic.	A total of 8–19 sessions (average = 14) delivered over a university semester.	3/7
Shriberg and Kwiatkowski (1990)	Case study	Self-monitoring within a generic phonological approach	*n* = 8 (3;8–5;7)	Individual intervention delivered by an SLT student in a university clinic.	2 × 50-min sessions per week delivered over a university semester. Each child received treatment for two targets, which required between 6 and 21 sessions to reach termination criteria.	5/7
Shriberg, Kwiatkowski and Snyder (1989)	Within subjects design	Generic phonological approach	*n* = 18 (3;6–8;9)	Individual intervention delivered by an SLT in a university clinic.	60-min sessions delivered over 1–2 weeks.	3/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Shriberg, Kwiatkowski and Snyder (1990)	Study 1: Within subjects design	Study 1: Generic phonological approach	Study 1: *n* = 9 (2;11–6;5)	Study 1: Individual intervention delivered by an SLT in a university clinic.	Study 1: 50-min sessions, each comprising a production dose of 50 trials. In total, 3 sessions were delivered.	4/7
	Study 2: Within subjects design	Study 2: Computer-based generic phonological approach	Study 2: *n* = 6 (4;2–7;5)	Study 2: As in study 1, above.	Study 2: As in study 1, above.	4/7
	Study 3: Case study	Study 3: Computer-based generic phonological approach	Study 3: *n* = 5 (3;7–8;2)	Study 3: As in studies 1 and 2, above.	Study 3: 50-min sessions.	2/7
Smith, Downs and Mogford-Bevan (1998)	Matched crossover design	Minimal pairs compared with phonological awareness intervention	*n* = 18 (5;8 – 8;2)	Group intervention delivered by an SLT in a community clinic.	2 × 75-min sessions per week for approx. 12 weeks of intervention.	4/7
Sommers, Logsdon and Wright (1992)	Review and critical analysis	A range of phonological and articulation-based approaches	63 articles published between 1970 and 1990	Varied across included studies.	Varied across included studies.	-
Speake, Stackhouse and Pascoe (2012)	Case study	Vowel intervention incorporating phonological intervention principles	*n* = 2 (both 10;7)	Individual intervention delivered by an SLT in a speech and language therapy unit attached to a school.	3 × 30-min sessions per week for a total of 35 or 40 sessions delivered over a 6-month period.	5/7
Stoel-Gammon, Stone-Goldman and Glaspey (2002)	Case study	Cycles	*n* = 1 'Eric' (4)	Individual intervention delivered by an SLT in a university clinic.	2 × 50-min sessions per week delivered over more than 2 years.	4/7
Stringfellow and McLeod (1994)	Case study	Facilitating phonetic contexts	*n* = 1 'SH' (5;0)	Individual intervention delivered by an SLT in a university clinic.	1 × 30-min session per week for a total of 9 sessions.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Sugden, Baker, Munro and Williams (2016)	Systematic search and review	A range of phonological and articulation-based approaches	61 papers published between 1979 and 2013 that included parent involvement or home practice.	Varied across included studies.	Varied across included studies.	-
Topbaş and Ünal (2010)	ATD with staggered MBD across participants	Complexity approach: Maximal oppositions compared with minimal pairs	*n* = 2 (twins, 6;0)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week for a total of 10 sessions delivered over 4 weeks.	5/7
Tyler (1995)	Case study	Minimal pairs	*n* = 6 (3;11–5;11)	Individual intervention delivered by an SLT in a university clinic.	2 × 45-min sessions per week for between 6 and 31 sessions.	4/7
Tyler, Edwards and Saxman (1987)	AB design	Minimal pairs compared with modified cycles	*n* = 4 (3;1–5;1)	Individual intervention delivered by an SLT in a university clinic.	2 × 60-min sessions per week for a total of 12 to 25 sessions delivered over approx. 8–10 weeks. Each session comprised a perceptual dose of 50 trials; production dose reported but unclear.	6/7
Tyler, Edwards and Saxman (1990)	Case studies with a control case	Minimal pairs	*n* = 4 (4;10–5;3)	Individual intervention delivered by an SLT student in a university clinic.	2 × 45-min sessions per week for a total of 16 sessions delivered over 8 weeks.	5/7
Tyler and Figurski (1994)	Combined ABAB with MPD	Generic phonological approach	*n* = 2 (2;8–2;10)	Individual intervention delivered by an SLT in a university clinic.	2 × 9-week blocks of intervention separated by a 5 week withdrawal period.	2/7
Tyler, Figurski and Langsdale (1993)	MBD across participants	Minimal pairs	*n* = 7 (3;10–5;6)	Individual intervention delivered by the researchers in a university clinic.	2 × 45-min sessions per week delivered over 8–9 weeks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Tyler, Gillon, Macrae and Johnson (2011)	RCT	Morphosyntax and speech sound intervention compared with phonological awareness and speech sound intervention	*n* = 30 (3;10–5;2)	Group intervention delivered by SLT students	Participants received 2 × blocks of intervention separated by a 6–7 week break. Each 6-week block comprised 2 × 60-min sessions per week, for a total of 24 sessions delivered over 12 weeks of intervention. For the morphosyntax intervention, each session comprised a production dose of 35–45 and an average perception dose of 75–80. Dose was not reported for the phonological awareness intervention.	5/7
Tyler and Lewis (2005)	Retrospective between-subjects design	Generic phonological approach and morphosyntax intervention	*n* = 40 (3;0–5;11)	Individual and group intervention delivered by an SLT student in an early childhood centre.	1 × 30-min individual and 1 × 45-min group session per week for 24 weeks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Tyler, Lewis, Haskill and Tolbert (2002)	Non-RCT	Generic phonological approach and morphosyntax intervention	*n* = 27 (3;0–5;11)	Individual and group intervention delivered by an SLT student in a preschool.	1 × 30-min individual and 1 × 45-min group session per week for 2 × 12-week blocks delivered over a school year. For the phonological intervention, each session comprised a production dose of 24–32 trials. For the morphosyntax intervention, each session comprised a production dose of 20–30 trials. Both interventions included perceptual and/or conceptual trials, but the dose was not reported.	4/7
Tyler, Lewis, Haskill and Tolbert (2003a)	RCT	Generic phonological approach and morphosyntax intervention	*n* = 47 (3;0–5;11)	Individual and group intervention delivered by an SLT student in a preschool.	1 × 30-min individual and 1 × 45-min group session per week for a total of 35–48 sessions delivered over 24 weeks. For the phonological intervention, sessions comprised between 14 and 60 production trials. For the morphosyntax intervention, each session comprised an average 23 production trials and an average 75–80 perception trials.	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Tyler, Lewis and Welch (2003b)	Study 1: RCT (based on Tyler *et al.*, 2003a)	Study 1: Generic phonological approach and morphosyntax intervention	Study 1: *n* = 20 (3;0–5;11)	Study 1: Individual and group intervention delivered by an SLT student in a preschool.	Study 1: 1 × 30-min individual and 1 × 45-min group session per week for a total of 24 weeks. For the phonological intervention, each session comprised 24–32 production trials. For the morphosyntax intervention, each session comprised 20–30 production trials. Both interventions included perceptual and/or conceptual trials, but the dose was not reported.	
	Replication study: RCT	Replication study: As in study 1, above.	Replication study: *n* = 20 (M_{age} = 4;2)	Replication study: As in study 1, above.	Replication study: As in study 1, above.	4/7
Tyler and Sandoval (1994)	MBD across participants with MPD	Minimal pairs compared with a narrative intervention compared with a combination of the two approaches	*n* = 6 (3;6–4;8)	Individual intervention delivered by an SLT in a university clinic.	2 – 3 × 45-min sessions per week for a total of 24 sessions delivered over 12 weeks. One participant terminated intervention after 6 weeks.	5/7
Tyler and Watterson (1991)	Non-RCT	Modified cycles compared with a morphosyntax intervention	*n* = 12 (3;7–5;7)	Group intervention delivered by an SLT in a university clinic.	2 sessions per week for 9 weeks. Each child received a total of approx. 16 sessions.	4/7
Tyler, Williams and Lewis (2006)	Retrospective between-subjects design (based on Tyler *et al.*, 2003a)	Generic phonological approach and morphosyntax intervention	*n* = 20 (3;0–5;11)	Individual and group intervention delivered by an SLT student at an elementary school.	1 × 30-min individual and 1 × 45-min group session per week for a total of 24 weeks.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
van Bysterveldt, Gillon and Foster-Cohen (2010)	'Multiple single-subject repeated measures (duplicated AB) design' (p. 323)	Phonological awareness intervention incorporating speech errors	*n* = 10 (4;4–5;5)	Individual intervention delivered by an SLT in an early intervention centre and by a parent at home.	2 × 6-week blocks separated by a 6-week break. Each block comprised 2 × 20-min sessions per week (1 × speech therapy session and 1 × 'learning through computer' session supporting speech and language therapy goals). Production dose for the speech therapy sessions was described, but exact dose unclear. In total, 24 intervention sessions were delivered over 18 weeks.	5/7
van Bysterveldt, Gillon and Foster-Cohen (2014)	Case study (participant from van Bysterveldt *et al.*, 2010)	Phonological awareness intervention incorporating speech errors	*n* = 1 'Ben' (5;2)	Individual intervention delivered by an SLT in an early intervention centre and by a parent at home.	2 × 6-week blocks separated by a 6-week break. Each block comprised 2 × 20-min sessions per week.	4/7
Waters, Hawkes and Burnett (1998)	Case study	Psycholinguistic approach	*n* = 1 'AG' (5;2)	Individual intervention delivered by an SLT.	2 × sessions per week delivered over a 7-month period.	3/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Weiner (1981)	MBD across behaviours	Minimal pairs	*n* = 2 (4;4–4;10)	Individual intervention delivered by an SLT in a university clinic.	3 × 60-min sessions per week, for a total of either 5 or 13 treatment sessions. Each session comprised between 40 and 80 production trials, for a cumulative intervention intensity of 400 or 540 production trials for each participant.	6/7
Williams (1991)	MBD across behaviours	Complexity approach: Clusters associated with least knowledge	*n* = 9 (3;8–5;9)	Individual intervention delivered by an SLT in a university clinic.	Up to 21 sessions, each comprising 100 production trials.	3/7
Williams (1993)	Case study	Complexity approach: Modified maximal oppositions	*n* = 1 'Michael' (6;11)	Individual intervention delivered by an SLT at school.	13 × 45-min sessions completed, each comprising 100 production trials.	4/7
Williams (2000)	Case study	Multiple oppositions followed by minimal pairs and/or naturalistic speech intelligibility training	*n* = 10 (4;0–6;5)	Individual intervention delivered by an SLT in a university clinic.	2 × 30-min sessions per week, for a total of between 26 and 105 sessions (average = 60) delivered over 2–5 university semesters (average = 3.4). Intervention was provided from referral to discharge.	5/7
Williams (2005)	MBD across behaviours	Multiple oppositions compared with minimal pairs	*n* = 1 'Jane' (6;5)	Individual intervention delivered by an SLT in a university clinic.	42 × 30-min sessions (21 sessions per intervention approach), each comprising 80–100 production trials.	4/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Williams (2012)	Study 1: Combined MBD across behaviours and participants	Study 1: Multiple oppositions	Study 1: *n* = 14 (4;0–6;0)	Study 1: Individual intervention delivered by an SLT in a university clinic.	Study 1: 2 × 30-min sessions per week for a total of 20–42 sessions, each comprising an average of 65.39 production trials. Cumulative intervention intensity ranged from 1404 to 3708 per participant (average = 2455.59).	6/7
	Study 2: MBD across behaviours	Study 2: Multiple oppositions compared with minimal pairs	Study 2: *n* = 4 (4;6–6;5)	Study 2: Individual intervention delivered by an SLT in a university clinic.	Study 2: 2 × 30-min sessions per week for a total of 12 – 44 sessions, each comprising an average of 78.99 production trials. Cumulative intervention intensity ranged from 1364 to 3008 per participant (average = 2499.25).	6/7
	Study 3: MBD across behaviours	Study 3: Computer-based generic phonological approach compared with minimal pairs	Study 3: *n* = 4 (3;7–4;9)	Study 3: Individual intervention delivered by an SLT in a university clinic.	Study 3: 2 × 30-min sessions per week for a total of 5–17 sessions, each comprising an average of 51.56 production trials. Cumulative intervention intensity ranged from 186 to 1015 per participant (average = 529.5).	6/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Wolfe, Blocker and Prater (1988)	Case study	Generic phonological approach	*n* = 2 (3;5–4;7)	Individual intervention delivered by an SLT.	Intervention delivered over 5 or 15 months for each participant, with each session comprising 100 production trials.	3/7
Wolfe, Presley and Mesaris (2003)	RCT	Traditional multiple phonemic approach, with or without speech perception training (SAILS)	*n* = 9 (3;5–4;2)	Individual intervention delivered by an SLT assistant or SLT student.	30-min sessions delivered 'biweekly' (p. 284, coded as *unclear*), for an average of 11 sessions (range = 8–17) delivered over an academic quarter.	4/7
Wren and Roulstone (2008)	RCT	Table-top and computer-based intervention using a psycholinguistic framework	*n* = 33 (4;2–7;10)	Individual intervention delivered by an SLT and an assistant at school.	1 × 30-min session per week with the SLT and 2 × 30-min sessions per week with the assistant for 8 weeks, for a total of between 18 and 24 sessions.	5/7
Yoder, Camarata and Gardner (2005)	RCT	Broad target speech recasts	*n* = 52 (M_{age} = 3.65 years)	Individual intervention delivered by a researcher.	3 × 30-min sessions per week delivered over a 6-month period. Each session comprised a perceptual dose of 4 recasts per minute (coded as *unclear*).	5/7

Reference	Research design	Intervention approach	Participant number and age (years;months)	Summary of service delivery[a]	Summary of intervention intensity[a]	Reporting of intervention intensity[b]
Yoder, Camarata and Woynaroski (2016)	RCT	Broad target speech recasts compared with modified cycles	*n* = 51 (M_{age} = 6.5 and 7.8 years for each group)	Individual intervention delivered by an SLT at school.	2 × 60-min sessions per week for 6 months. For the broad target speech recasts intervention, each session comprised an average perceptual dose of 4.07 recasts per minute (p. 452, coded as *unclear*). For the modified cycles approach, SLTs requested the participant imitate productions 2.25 times per minute (p. 452, coded as *unclear*).	5/7
Young (1987)	MBD across behaviours	Backward chaining with rebuses	*n* = 2 (4;4–4;5)	Individual intervention delivered by an SLT in a university clinic.	2 × sessions per week, each comprising 50 production trials.	3/7

[a]Not all studies provided details about all elements of service delivery or intervention intensity. Absence of this information in the table reflects an absences of this information in the published paper. Note that home practice is not included in descriptions of intervention intensity (for more detail on the intervention intensity delivered by home practice, see Sugden, Baker, Munro, & Williams, 2016).
[b]Studies received a score out of 7, with one point allocated for reporting each of the following components of intervention intensity: dose, dose form, dose frequency, session duration, total intervention duration (in weeks or months), total intervention duration (in sessions), and cumulative intervention intensity.
[c]Reviews were not rated for reporting of intervention intensity, as they aim to collate previously-published studies rather than report on a specific investigation of a phonological intervention.
[d]The term *generic phonological approach* was used when an explicit name was not provided for an intervention delivered to children with a phonological delay/disorder/impairment.

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Appendix B: Questions Regarding Service Delivery, Intervention Approaches, and Intervention Intensity

Questions Regarding Service Delivery and Intervention Approaches

1. Which of the following intervention models do you use when working with children with phonology-based speech sound disorders? Select ALL that apply
    - Direct models (i.e., speech pathologist working directly with the child)
    - Indirect models (i.e., speech pathologist working in consultation with others such as parents and/or teachers to support the child)
    - Community education (e.g., raising awareness of phonology-based speech sound disorders)
    - "Watch and wait" (e.g., monitoring a child's speech development to determine if intervention is necessary)
    - Other (please specify)
2. Please indicate which is your MOST COMMON intervention model for children with phonology-based speech sound disorders:
    - Direct models
    - Indirect models
    - Community education
    - "Watch and wait"
    - Other
3. Which of the following methods of service delivery do you use in intervention for children with phonology-based speech sound disorders? Select ALL that apply
    - Individual intervention
    - Group intervention
    - Parent training
    - Home program (e.g., a selection of worksheets/activities provided to the family for completion at home with minimal continued input from the speech pathologist)
    - Telehealth
    - Teacher training
    - Classroom-based therapy
    - Computer-based therapy (e.g. iPad, computer programs—excludes telehealth)
    - Community education
    - Other (please specify)
4. Please select the MOST COMMON method of service delivery you use to provide intervention to children with phonology-based speech sound disorders:
    - Individual intervention
    - Group intervention
    - Parent training
    - Home program (e.g., a selection of worksheets/activities provided to the family for completion at home with minimal continued input from the speech pathologist)
    - Telehealth
    - Teacher training
    - Classroom-based therapy
    - Computer-based therapy (e.g. iPad, computer programs—excludes telehealth)
    - Community education
    - Other

5. Where do you provide intervention to children with phonology-based speech sound disorders? Select ALL that apply
    - Community health/hospital clinic setting
    - Private practice clinic setting
    - Early childhood/preschool setting
    - School setting
    - Client's home
    - Other (please specify)
6. Please select the MOST COMMON place where you provide intervention to children with phonology-based speech sound disorders:
    - Community health/hospital clinic setting
    - Private practice clinic setting
    - Early childhood/preschool setting
    - School setting
    - Client's home
    - Other
7. Who directly provides the intervention to the children on your caseload with phonology-based speech sound disorders? Select ALL that apply
    - Speech pathologist
    - Preschool or classroom teacher
    - Parents or caregivers
    - Teacher's aide
    - Speech pathology assistant
    - Learning support teacher/itinerant support teacher
    - Supervised speech pathology student
    - Interpreter
    - Other allied health professional
    - Other (please specify)
8. Please indicate the MOST COMMON intervention provider:
    - Speech pathologist
    - Preschool or classroom teacher
    - Parents or caregivers
    - Teacher's aide
    - Speech pathology assistant
    - Learning support teacher/itinerant support teacher
    - Supervised speech pathology student
    - Interpreter
    - Other allied health professional
    - Other

The following questions relate to the intervention you provide to children with phonology-based speech sound disorders

9. When selecting targets for intervention, which types of targets do you usually select?
    - Developmental targets (e.g. stimulable sounds, earlier developing sounds, early phonological processes)
    - Non-developmental targets (e.g. non-stimulable sounds, later developing sounds, later phonological processes)
    - Collapse of contrast targets (e.g. multiple sounds that a child produces as the same sound)
    - Other (please specify)

10. How do you USUALLY treat phonology-based speech sound disorders?
    - You focus on the production of speech sounds in isolation, syllables, words, phrases, sentences then conversation
    - You focus on error patterns (starting at word level) and the communicative functions of speech sounds in words
    - Other (please provide details)
11. Please indicate which of the following tasks you USUALLY include in intervention for phonology-based speech sound disorders. Select ALL that apply
    - Production tasks (e.g. the child produces their target sounds)
    - Perceptual tasks (e.g. auditory awareness activities, such as auditory bombardment or auditory discrimination)
    - Conceptual tasks (e.g. activities designed to develop the child's awareness of the features of target sounds, such as long/short sounds or rhyming features)
    - Other (please specify)
12. Please select which of the following treatment methods you USUALLY use for children with phonology-based speech sound disorders. Select ALL that apply
    - Auditory bombardment/stimulation (e.g. Hodson & Paden, 1991)
    - Auditory discrimination (e.g. Berry & Eisenson, 1956)
    - Core vocabulary (e.g. Dodd & Bradford, 2000)
    - Cued articulation (e.g. Passey, 1990)
    - Cycles (e.g. Hodson & Paden, 1983)
    - Imagery approach (e.g. Klein, 1996)
    - Maximal oppositions contrast (e.g. Gierut, 1990)
    - Metaphon (e.g. Howell & Dean, 1984)
    - Minimal oppositions contrast (Minimal Pairs) (e.g. Weiner, 1981)
    - Multiple oppositions contrast (e.g. Williams, 2000)
    - Non-speech oromotor intervention (e.g. Lancaster & Pope, 1989)
    - Nuffield Centre Dyspraxia Programme (e.g. Nuffield Hearing and Speech Centre, 2004)
    - Parents and Children Together (PACT) (e.g. Bowen & Cupples, 1999)
    - Phonological awareness (e.g. Gillon, 2000)
    - Prompts for Restructuring Oral Muscular Phonetic Targets (e.g. PROMPT) (e.g. Hayden, 2006)
    - Traditional articulation therapy (e.g. van Riper, 1939)
    - Whole language therapy (e.g. Hoffman, Norris & Monjure, 1990)
    - Other (please specify)

Questions on Intervention Intensity

This section refers to the intensity of the direct intervention you provide to a child with a phonology-based speech sound disorder.

We define intensity in keeping with Warren, Fey & Yoder (2007), including:

- Session duration (how long each session lasts)
- Dose (the number of teaching moments in each session [e.g. the number of opportunities for production practice, auditory bombardment and/or phonological awareness tasks in a session])
- Session frequency (how often sessions occur), and;
- Total intervention duration (length of stay the overall time from the first therapy session to discharge)

Service Delivery and Intensity

Please answer the following questions in relation to your main service delivery context.

1. Session duration: how long are your MOST COMMON intervention sessions for children with phonology based speech sound disorders?
    - Less than 30 minutes
    - 30 to 44 minutes
    - 45 to 59 minutes
    - 60 to 89 minutes
    - 90 minutes or longer
2. Dose: within your MOST COMMON intervention sessions, how many opportunities does a child with a phonology-based speech sound disorder receive to PRODUCE their speech targets?
    - None
    - Less than 20
    - 21-49
    - 50-99
    - 100-149
    - 150-199
    - 200 +
    - Unsure
3. Dose: within your MOST COMMON intervention sessions, how many opportunities does a child with a phonology-based speech sound disorder receive to complete PERCEPTUAL tasks (such as auditory awareness and auditory discrimination tasks)?
    - None
    - Less than 20
    - 21-49
    - 50-99
    - 100-149
    - 150-199
    - 200 +
    - Unsure
4. Dose: within your MOST COMMON intervention sessions, how many opportunities does a child with a phonology-based speech sound disorder receive to complete CONCEPTUAL tasks (such as phonological awareness and metaphonological tasks)?
    - None
    - Less than 20
    - 21-49
    - 50-99
    - 100-149
    - 150-199
    - 200 +
    - Unsure
5. Session frequency: how frequently do you USUALLY schedule sessions for children with phonology-based speech sound disorders?
    - Less than 1 session per month
    - One session per month
    - 1 to 2 sessions per month
    - 1 x weekly
    - 2 x weekly
    - 3 x weekly

- More than 3 x weekly

6. Total intervention duration: how long (in weeks or months), is the typical length of stay for children with phonology-based speech sound disorders (i.e. how many weeks or months from the initial intervention session to discharge)? Please specify if it is in weeks or months.
7. Total intervention duration: how many sessions do children with phonology-based speech sound disorders typically receive over their length of stay (i.e. how many sessions does the child receive from the initial intervention session to discharge)?
8. Do the majority of children on your caseload with phonology-based speech sound disorders receive the same intervention intensity?
    - Yes
    - No
9. Do you provide block on/block off therapy to children with phonology-based speech sound disorders (e.g. the child receives 10 weeks of therapy then receives a 10 week break, then recommences 10 weeks of therapy)?
    - Yes
    - No
    - Sometimes

The following questions (Questions 10 – 13) were only asked of participants who reported that they provide (or sometimes provide) block on/block off therapy:

10. Approximately what percentage of children with phonology-based speech sound disorders on your caseload receive block therapy?
    - None
    - Less than 10%
    - Between 10% and 39%
    - Between 40 and 70%
    - Greater than 70%
    - Unsure
11. What is the duration of the "on" block (in weeks)?
12. What is the duration of the "off" block (in weeks)?
13. Please describe the frequency and duration of the intervention sessions in the "on' blocks.

The intervention intensity provided to children with phonology-based speech sound disorders can be influenced by several factors, including workplace, clinician and client factors.

14. Which of the following WORKPLACE factors influence the intervention intensity that you provide to children with phonology-based speech sound disorders (i.e. the frequency of sessions, the duration of sessions, and the total intervention duration)? Select ALL that apply
    - Waiting lists
    - Scheduling of intervention around other workplace commitments
    - Workplace policy
    - Size of current active caseload
    - Funding reasons
    - Service delivery model
    - Other (please specify)
15. Which of the following CLINICIAN factors influence the intervention intensity that you provide to children with phonology-based speech sound disorders (i.e. the

frequency of sessions, the duration of sessions, and the total intervention duration)? Select ALL that apply

- Personal factors (e.g. you only work one day per week)
- Your application of research evidence around recommended intervention intensities
- You are implementing an intervention program that specifies intervention intensity
- Previous experience with similar clients
- You have always provided this level of intervention intensity
- Other (please specify)

16. Which of the following CLIENT factors influence the intervention intensity that you provide to children with phonology-based speech sound disorders (e.g. the frequency of sessions, the duration of sessions, and the total intervention duration)? Select ALL that apply
    - Funding reasons (e.g. Medicare rebates, or affordability of ongoing private practice)
    - Rate of progress in therapy
    - Family preferences
    - Severity of phonology-based speech sound disorder
    - Travel time (e.g. client lives close to/far away from the service)
    - Age of client
    - Cultural and/or linguistic background of client/client's family
    - Other (please specify)
17. Between *workplace, clinician* and *client* factors, which has the biggest influence on the intervention intensity that you provide to children with phonology-based speech sound disorders?
    - Workplace factors
    - Clinician factors
    - Client factors
18. For a preschool child with a moderate-severe phonology-based speech sound disorder, what would be your ideal direct intervention intensity?
    - Frequency of sessions
    - Duration of each session
    - Total number of sessions
    - Total intervention duration (the time period, in weeks or months or years, over which the child receives intervention)